A case study of how learners apply a Grade 10 study skills module in a mathematics class.

A thesis submitted in partial fulfilment of the requirements for the degree of Magister Educationis in

Mathematics Education.

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Declaration

I declare that *A case study of how learners apply a Grade 10 study skills module in a mathematics class* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

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Date: 18 March 2016

Signed: ……..

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Contents

Abstract

A qualitative case study was used to investigate how learners apply a study skills guide during the teaching of mathematics content in a Grade 10 class. A great amount of research and money is continually spent focussing on improving mathematics performance throughout the world. Performance of our learners in South Africa is of concern to the government as well as educators. Researchers agree that many learners lack effective study skills, which is the reason for their poor performance in mathematics. This study intended to infuse study skills in mathematics lessons as an intervention. The study skills intervention sessions were done over a period of 6 weeks. These study skills were infused in topics of the mathematics curriculum which was done in the previous quarter of the school program. Data was collected through interviews, journal entries and a questionnaire. The interviews were done before study skills instruction while the questionnaire was administered after completion of the sessions. Journal entries were completed during the 6 week instruction period by learners. It was found that some learners used the study guide as intended whilst others did not. Furthermore there was improvement in learners' scores for the topics focused on at the end of the study compared to the scores for similar topics in a school-based test written about two months before the intervention. It is concluded that the infusion of study skills in lessons has the potential for improving achievement in high-stakes mathematics examinations.

Keywords: effective study skills, intervention, study skills guide.

Chapter 1

Introduction

1.1. Introduction

Educational researchers have placed a great emphasis on investigations dealing with improving learners' academic achievement. In particular, mathematics education has become a concern for many nations around the globe. Mathematics educators around the world share related concerns (Kiewra, 2002; Van der Walt & Maree, 2007; Taylor & Mander, 2003). Reddy (2014) alludes to the fact that mathematics and science are vital areas of knowledge for the development of individuals, as well as the social and economic development of South Africa in a globalising world. The modern workforce demands critical thinkers and problem solvers in the constantly evolving workplace.

Milner and Khoza (2008) share the widely acknowledged point that the provision of quality education in South African schools is one of the greatest challenges facing South Africa in the twenty-first century. The majority of South Africans received inferior education during the apartheid era and it is therefore imperative with the advent of democracy to rectify the mistakes of the past. The Assistant Director-General of the United Nations Education, Science and Cultural Organisation (UNESCO) (2011), Qain Tang of China, stated at the Budapest Declaration of 1999 "... that (mathematics and science) is relevant and …(should be of) quality ..." in order to "develop critical and creative thinkers..." (p. 4). In addition he emphasised that mathematics education can encourage and stimulate socio-economic development contributing to the Millennium Development Goals as adopted by world leaders in 2000. Quality mathematics education is significant for the economic progress of a country.

This notion is shared by Milner and Khoza (2008), and Van der Walt and Maree (2007), who state that skilled workers are a prerequisite for South Africa to compete in the current global, technology driven economic environment and therefore education is vital in the development of such a workforce. Economic and technological development of South Africa necessitates skilled individuals. Technological progress depends upon centres in sectors where skills are lacking such as astronomy, engineering, medical research and finance and others. Skilled workers have, as a consequence, had to be imported from other countries for their expertise to South Africa. An article in the Cape Times confirmed that "All types of artisan(s) and every

category of engineer are now imported; we are simply not producing these skills through our own education system." ("SA maths, science teachers get an F", Williams, 2014, p.1)

Education went through a process of revision after the election of a new democratic government. Under the previous regime different ethnic groups functioned independently in their separate education departments. The newly elected government revised the curriculum in 1996 into one unified curriculum. The Curriculum and Assessment Policy Statement (CAPS, 2011, Department of Basic Education), the current revised curriculum, aims to produce learners who are able to identify and solve problems, and make decisions using critical and creative thinking. This policy document is in line with the Budapest Declaration of 1999.

Basic Education Minister, Angie Motshekga, announced the 2015 matric results on Tuesday 5 January 2016. These results revealed a lower percentage pass than the previous year. The statutory body which is responsible for verifying results, Umalusi, specified a drop in results especially in the subjects, Accounting, History, Geography and Mathematical literacy (Cape Argus, 2016). The national matric pass rate for 2014 was 75.8 % compared to 78.2 % for 2013. In spite of the fact that the pass rate for 2015 was lower, the number of passes were higher at 455 825 (Cape Argus, 2016). The pass rate for 2014 was 75.8 %, and that of 2015 was 70.7 %. There has therefore been a consistent decline in the pass rate yearly. The Minister of Basic Education, Angie Motshekga, argued that progressed learners were the reason for the lower pass rate. It has been estimated that about ten percent of the matriculants have been progressed from grade 11(Cape Argus, 2016).

The Western Cape Province achieved the highest pass rate in the country, that of 84.7 %. The Minister also announced an increase in numbers at the "lower income schools" (Cape Argus, 2016). There is an increase in the number of admissions to universities from 150 737 to 166 263. The number of learners passing mathematics increased from 120 523 to 129 481(Cape Argus, 2016). In spite of the fact that there has been an increase in the pass rate for mathematics, there is still room for improvement. Nearly 9 000 more learners passed mathematics in 2015.

In the South African context grade 10 is categorised in the Further Education and Training phase (FET). The FET phase consists of grade 10 to grade 12, which are the final schooling years for South African high school learners. The FET band is preceded by the General

Education and Training phase (GET), ranging from grades 7 to 9. Learners choose their subjects after grade 9 which they will be doing from grade 10 onward.

At a provincial level the Western Cape has shown a marginal decline in their Grade 12 mathematics results between 2008 and 2010. A requisite for being awarded a pass in mathematics in South Africa is 30%. In 2010 there were 21 schools in the Western Cape Province of which 30% of learners did not achieve this requirement. This means that nearly one third of learners who wrote the National Senior Certificate (NSC) for Mathematics in these 21 schools were unsuccessful in mathematics. Further analysis of the Western Cape Education statistics reveal that these 21 public schools are all situated in previously disadvantaged communities of the province. It is on these disadvantaged communities that the focus of the research concentrates. South Africa has produced poor results in mathematics for a number of years. There are diverse opinions for this poor outcome.

1.2. Rationale

Researchers in mathematics education have constantly investigated ways of improving teaching and learning. Learning mathematics is equated to empowering yourself and becoming "quantitatively literate" (Schoenfeld, 1992, p. 4). These learners are seen to have the ability to make 'sound judgements' concerning the array of "quantitative data" they come across daily (Schoenfeld, 1992, p. 4). Furthermore, Schoenfeld (1992) elaborates that these learners are critical thinkers and able to use mathematics practically. My concern relates to how learners study mathematics.

There are diverse explanations as to why learners are low achievers in mathematics. Researchers agree that one of the reasons is the deficiency or inefficiency of study skills that causes learners to be incapable of achieving excellence in mathematics (Gettinger & Seibert, 2002; Kiewra, 2002; Taylor & Mander, 2003; Demir, Kilinc & Dogan, 2012; Van der Walt & Maree, 2007). It is suggested by Nolen Bobbitt and Haladyna (1990) that researchers are displaying greater interest than before in the reasons for why learners' choose to engage in certain study strategies. The "'studiers' belief in its strategic value" is one of the reasons for their choice suggested by Nolen Bobbitt and Haladyna (1990, p. 116).

This study aims to investigate how learners use a study skills guide. Identifying the ways in which learners study mathematics should assist educators as well as learners. Another reason why numerous learners do not excel in mathematics is that they fail to apply study skills

efficiently (Thomas, 1993; Taylor & Mander, 2003; Crede & Kuncel, 2008, Demir, Kilinc & Dogan, 2012). In my years of experience as a mathematics educator, I discovered that learners do not apply study skills effectively or competently. The fact that learners profess to understand in class and then seemingly forget when writing tests and examinations, indicates that they possess ineffective skills or fail to apply study skills efficiently. According to Zimmerman (1990) self-regulated learners tackle educational tasks with self-assurance, thoroughness, and creativity.

Self-regulated learners are highly effective at studying and perform well in tests and examinations. Zimmerman (1990) is of the opinion that learners know whether or not they have the skill needed to perform a task and would therefore search for information needed to complete or master it. Obstacles such as poor study conditions, textbooks, drive those learners to search for alternative ways to succeed. These facts were confirmed by a learner. This learner comes from a township in the Western Cape Province and has an average score of 80%. He studies regularly and only takes a break as a reward when he has mastered the section he intended to. Two weeks before the examinations he had already completed all his studying and only intended to read through his notes, and to identify areas with which he found difficulty or which he did not understand.

The reply from teachers when asked why they think learners do not study mathematics, generally is lack of motivation or "some learners inability to understand". Teachers find that learners fail to comprehend why they failed a test or examination, in spite of having studied for long periods of time. What may also contribute to their failure is the inconsistency in their studying. It is now commonly accepted that the teaching methods of teachers alone are not sufficient for effective learning (Kiewra, 2002; Gettinger & Seibert, 2002; Taylor & Mander, 2003). The learner needs to take responsibility for his or her own actions. Learners' tendency to cram during short periods before examinations and the lack of consistency in study time contributes towards their low achievement. Cramming a great amount of work into a short period before a test or examination is immensely unwise. Inadequate time management is another contributing reason for why learners are unsuccessful. Teaching learners how to study would enable them to become more skilful in their studying mathematics.

Study skills modules form part of the curriculum in both school and tertiary levels in some countries (Zimmerman, 1990; Hagedorn, Sagher & Siadat, 2000). It is necessary that study

strategies which were previously "...thought to be acquired almost by osmosis...” are made available to students enrolled in mathematics courses at university (Taylor &Mander, 2003, p. 224). In countries such as Turkey, Demir, Kilinc and Dogan (2012) refer to the notion of a study skills module incorporated in the school curriculum. Van der Walt and Maree (2007) agree that “learning how to learn” has yet to form part of the South African school program (p. 224). Thomas (1993) suggests that “learning how to study” is the answer for learners who lack the skills essential for academic success (p. 1). The Western Cape Department of Education (WCED) has a generic study guide targeted at Grade 12 learners (‘tips for success,’ 2013). Unlike the Grade10 study skills guide used in this research, this guide is intended for all subjects and not specifically for the purpose of studying mathematics. The guide comprises merely of tips on how to prepare for an examination. This fact emphasises the need to investigate how learners behave while studying mathematics and whether they in fact apply the study tips available in this guide consistently and effectively. There is indeed a pressing need for a mathematics study skills module, targeted at both learners in schools as well as students in tertiary institutions in South Africa.

These ideas highlight the fact that mathematics study skills are exceedingly important in a school mathematics program. Teachers should also have the information about how learners study, enabling assistance to learners. The fact that many teaching programs fail to assist learners, is a challenge to many mathematics educators. The objective of this study is therefore to find out how effectively learners use a study skills guide when they study mathematics. Study skills should ideally be infused within the mathematics content effectively and consistently and should be managed correctly in order to achieve the best outcomes.

1.3. Research Question

A case study was used to investigate how learners apply a study skills guide during the teaching of mathematics. The research question is thus: How do learners apply a study skills module in a Grade 10 mathematics class?

1.4. Conclusion

This chapter orientated readers to high school mathematics in South Africa as well as to provide the rationale for the research. In the following chapter a review of different sources will be presented. A discussion of critical concepts is also engaged in the next chapter in order that the reader can become acquainted with a clear picture of the research topic.

Chapter 3 deliberates on the methodology of the research- a qualitative case study. Also, in this chapter qualitative research, case studies, sampling and data collection methods, as well as the ethical considerations in the research are debated. The data analysis and results are elaborated on in Chapter 4. This chapter also provides illustrations of detailed narratives of learners during interviews, their journal writing and responses on questionnaires. The final chapter expounds on the findings and conclusions of the research.

Chapter 2

Conceptual framework and Literature Review

2.1. Introduction

This chapter provides a review of literature concerning the study and learning of mathematics. These resources include accredited journal articles, books, dissertations and government documents. These documents illustrate clearly that the teaching and learning of mathematics has been a topic of debate and research for many decades. Much of the writing and research on mathematics education can be interpreted to assert that:

> "Helping students to develop effective ways to handle the barrage of information coming from the environment, as well as their own thinking processes, is a major goal of our educational system that will only increase in importance in the future."
> (Weinstein & Mayer, 1986, p. 315)

Developing effective ways of learning is thus very important in a child's educational development. South African society demands of learners that they successfully complete twelve years of schooling and graduate to tertiary education in order to prepare for life and the economic wellbeing of the country. Teachers are required to teach overburdened mathematics content which makes it difficult for them to find extra time to teach learners how to learn.

How mathematics is studied however is a relatively new topic of inquiry in South Africa. Researchers in other countries such as Gettinger and Seibert (2002), Zimmerman (1998), Weinstein (1999), and Hagedorn, Sagher and Siadat (2000) are a few of the forerunners concerned with mathematics study skills instruction. The review of the literature focuses on key study skills.

2.2. Origins of studying and learning theories in mathematics education

Research concerning study skills development started towards the end of 1950 (Mutsotso & Abenga, 2010). Psychologists such as Gagne conducted student-centred research aimed at high school learners. In high schools and universities study skills courses were part of the counselling services and taught students how to learn (Mutsotso & Abenga, 2010).

The interventionist nature of this research is that it seeks to improve learners' mathematics study skills. Cobb (1988, p. 89 as cited in Radford, 2008, p. 2) argues that the goal of

instruction "is or should be to help students build [mental] structures that are [more] complex, powerful and abstract than those that they possess when instruction commences". In other words Cobb argues that learners' intellectual structures should be improved or enhanced through instruction. The CAME (Cognitive Acceleration in Mathematics Education) Project reflects the same argument of enhancing learners' cognitive development through an approach of reflective practice in mathematics learning (Shayer & Adhami, 2006). The CAME (Eaton & Bell, 2006) study suggests that teaching should "…foster development…" of learners, as well as "subject knowledge."(p. 101).

2.3. Defining critical terms of the study

It is essential to discuss the constructs identified in the literature in order to get a comprehensive insight into study skills identified. A discussion of these mathematics study skills are elaborated upon in the next section.

2.3.1. Studying

There are many definitions of study skills in the literature, but generally study skills are defined as the precise efficient use of methods in order to learn something (Thomas, 1993; Ulug, 2000; Yilidirim, Dogonay & Turkoglu, 2000, as cited in Demir, Kilinc & Dogan, p. 429**).** Also**,** studying is characterized as a decisive activity which is skilful and requires training and practice in certain skills (Gettinger & Seibert, 2002). This then means that studying is not an act that happens per chance, but one which requires guidance or facilitation from someone with skills to give learners a plan on how to study. Studying is also intentional and differs from incidental learning as it requires deliberate and conscious effort (Gettinger & Seibert, p. 351). Bacanli (2005) refers to studying as a process whereby learners can attain high achievement by "... perceiving the given information accurately…" (as cited in Demir, Kilinc & Dogan, 2012, p. 428). Thereafter the information may be analysed and internalised. Studying is private as the individual takes control of his or her learning.

The fact that many learners spend a great deal of time and energy studying mathematics and without success is a concern to educators, parents and learners (Yilmaz, 1987; Teker, 2002; as cited in Demir, Kilinc & Dogan, 2012, p. 428). The amount of time and effort versus the academic success is not justified and learners may become de-motivated.

2.3.2. Learning

Weinstein and Mayer (1986) suggest that "…good teaching includes teaching students how to learn, how to remember, how to think, and how to motivate themselves" (p. 315). The

Merriam-Webster Dictionary defines learning as "the activity or process of gaining knowledge or skill by studying, practicing, being taught, or experiencing something: the activity of someone who learns."("Learning," 2014)

Learning is conceptualized as the process which leads to "relatively permanent behavioural change due to experience" (Van Deventer & Mojapelo- Batka, 2013. p. 179). In other words, there is a change in behaviour when learning occurs. Van Deventer and Mojapelo-Batka (2013) caution changes in behaviour does not always guarantee that learning takes place; a permanent behavioural change has to occur through experience.

Demir, Kilinc, and Dogan (2012) are of the opinion that learning is the change in behaviour (p.428). Furthermore, Demir, Kilinc, & Dogan (2012) argue that the experience of learning occurs when the influence of the task is being done "necessitates psychological functions which lead to differences in behaviours" (p. 428). The quality of such learning is directly dependent on the quality of study skills employed (Svensson, 1984, as cited in Marton, 1988). Marton and Svensson (1979, as cited by Cloete & Shochet, 1986, p. 249) refer to the notion of learning as three dimensional consisting firstly of "the learner's awareness of learning"; secondly, of their awareness of the "content or subject matter" being learned; and thirdly of their awareness of the features of the "context" learned. Clearly there is a difference between learning and studying, despite the common confusion surrounding these elements. Learning is the outcome of studying. In other words in order for learning to take place significant studying is essential.

Learning strategies are denoted by Weinstein and Mayer (1986) as the techniques taught to a learner to be used during learning and which will affect the training process. These learning strategies comprise any of the following "coaching, imaging, summarizing, and note-taking" (Weinstein & Mayer, 1986, p. 315).

Schoenfeld (1992) describes learning in mathematics as "mastering in some coherent order, the set of facts and procedures" encompassing mathematics (p. 334). The pathway to learning comprises: defining the exact "subject matter content as clearly as possible", structuring it into "bite-sized pieces", giving exact "instruction and practice" on every piece in order that learners master it (p. 26). Schoenfeld (1992) further elaborates that the totality of these quantities will constitute the learner's mathematical understanding. In the context of this research, however, learning to think mathematically as Schoenfeld (1992) suggests means "developing a mathematical point of view … and…competence with the tools of the trade…

and using those tools" in making sense of mathematics (p.335). These tools or skills assist learners in becoming effective 'studiers'. Furthermore, Schoenfeld (1992) notes that by organizing the curriculum into manageable parts, learners have the tendency to think that solutions to questions are readily given and they are not required to determine their own methods (Schoenfeld, 1992). Schoenfeld (1992) therefore argues that learners, who readily receive solutions to problems, either do not attempt the problem to which they do not have the method, or give up after attempting without having achieved success. However, Hagedorn, Sagher and Siadat (2000) emphasize the notion that the teaching of learning strategies, in other words teaching learners how to learn is as important as teaching the subject content.

2.3.3. Effective Study skills

Crede and Kuncel (2008) claim that study skills are broadly referred to as a learner's knowledge of relevant study strategies, as well as any methods, time management and other resources necessary to complete a task (p. 427). Cloete and Shochet (1986) refer to study skills as aspects of study which include study habits, methods, techniques and motivation (p. 247). Tonjes and Zintz (1981) describe study skills as "competency skills" over which learners need to achieve mastery (as cited in Mutsotso & Abenga, 2010, p. 810). Such behavioural perspectives on study skills include those which could be observed by or in the learner, while others are intrinsic (such as motivation and cognition). Cloete and Shochet (1986) moreover suggest that the notion of any individual "intentionally learning" is vital in study skills (p. 249). All of these researchers agree that study skills consist of any skills required to complete any task effectively. Cloete and Shochet (1986), Gettinger and Seibert (2002), and Demir, Kilinc and Dogan (2012) and others, add the perspective of intentionally learning when studying. In other words, they suggest that studying should be purposeful or decisive.

Gettinger and Seibert (2002) are of the opinion that study skills must be effective as they are critical to learning. Study skills are most effective when learned and practiced. Furthermore, "The goal of study-strategy instruction is to teach a strategy in a manner that is both effective (the strategy is learned) and efficient (it is learned to an optimal level with minimal effort)" (Gettinger & Seibert, 2002, p. 351). Demir, Kilinc and Dogan (2012, as cited by Gettinger & Seibert, 2002; Ulug, 2000; Yilidirim, Dogonay & Turkoglu, 2000) agree that "… high levels of success can only be achieved by using all of them (the study skills) responsively together"

(p. 429). These researchers therefore agree that high levels of success can only be accomplished when all the study skills are applied together.

Successful academic achievers know when to apply specific study skills and know how to tackle tasks such as tutorials, investigations, projects, and examinations etc. each requiring dissimilar approaches. Low achievers on the other hand rely on outside help from teachers and classmates. Low academic achievers are also identified by the limited study skills they possess, which they seem to apply to all academic tasks. Clearly specific tasks result in completely different outcomes and need to be approached differently. The outcomes of tasks guide learners to select appropriate study skills – the when and what of study skills to apply for specific tasks.

2.3.4. Consistency

Crede and Kuncel (2008) refer to the amount of time in which a learner "…engages in regular acts of studying…" as study habits which are characteristically done frequently and in a suitable environment (p. 427). When low achieving learners study they tend to study infrequently and with minimal effort. This results in feelings of inadequacy and of being overwhelmed. Many learners fall into the habit of cramming great quantities of work the night before a test or examination. After the test all the learned work is forgotten because of inadequate time spent on reinforcement and practice. This diagnosis of practises of studying inconsistently and cramming of huge amounts of work into short periods of time is shared by Gettinger and Seibert (2002). Successful academic achievers persevere until they achieve their desired goal of completing tasks and understanding content. When learners write regular tests this is a means of "consistent monitoring", and it teaches learners to allocate "regular study times and (to) promote positive organizational strategies." (Hagedorn, Sagher & Siadat, 2000, p.135). However, these tests should preferably be short instead of lengthy content-loaded tests. Consistency is required in the application of study skills in order to achieve academic success in mathematics.

2.3.5. Time management

An important aspect of study skills is time management. Consistency in studying requires a plan in order to produce efficient and effective learners. Demir (2011), states that disorganization in studies can be prevented by planning one's study sessions and by being purposeful when studying (as cited in Demir, Kilinc & Dogan, 2012, p. 429). Preferably learners should develop their own unique study schedule, tailored to their needs. Gettinger and Seibert (2002), and Taylor and Mander (2003) concur that placing the onus on learners to

customize their own schedules is much more effective. These schedules or timetables could be done daily, weekly, monthly, quarterly or yearly. The best is to outline specifics such as the time spent studying per week. These schedules enable learners to clearly identify the amount of time they have to allocate to certain portions of work. In conjunction with this teachers should periodically find out whether learners are experiencing difficulties (Gall, Gall, Jacobsen & Bullock, 1990). A study log will outline a learner's study patterns and will indicate their best study times. While some prefer to study at night, others prefer to do so in the morning. They should re-plan (review their plan) when time becomes insufficient to complete tasks or projects which require more or less time (Gall, Gall, Jacobsen & Bullock, 1990). This study skill leads to reflection.

2.3.6. Reflection

Learners should be able to reflect on their "past mathematics experiences" and also on their "learning experiences" (Taylor & Mander, 2003, p. 221). When learners are able to reflect on their past experiences, not only are they learning from their mistakes, but they are able to rectify them. The use of cumulative testing can motivate learners to review earlier topics. "The hierarchical nature of mathematics…may make cumulative testing particularly appropriate" (Hagedorn, Sagher & Siadat, 2000, p. 136). "Spiral revision", as explicated by Julie (2013, p. 93) and the "snappies" of Cramp and Nardi (2000, p. 46) are similar methods of reflecting on work done previously. This approach gives learners both the ability to identify problems and the opportunities to remedy them.

Reflection may also be used in the teaching of time management and specifically when drawing up a study timetable. When learners reflect on how they manage their time, they are better able to reach deadlines and when doing tasks they are able to see their progress. Learners are encouraged to apply self-questioning during reflection, using why, when, how questions. Kiewra's (2002) research indicates that when learners are taught to generate why-type questions as a review strategy after lectures, they outperform others who reviewed in the normal way by just reading notes (p. 77).

2.3.7. Organizing

Any academic success story is achieved through excellent organizational skills. Learners should learn the skill of organizing their notes, examination question papers, summaries, etc. This study skill would alleviate pressure and feeling of being overwhelmed. The huge amount of content can be broken down into smaller sections, making studying easier. High academic achievers demonstrate good organizational skills while low achievers lack organizational

skills (Gettinger &Seibert, 2002, p. 356). Learners should keep a file wherein they organize their work by type, that is, summaries, tests, examinations, review, reviews and concept descriptions. This file would then become the learner's quick reference source. Gall, Gall, Jacobsen and Bullock (1990) recommend that teachers encourage learners to "clean-up" their spaces at the end of each lesson (p. 74). When learners organize their desks and learning spaces regularly this improves their organizational skills. Not all students in South Africa are financially able to have their own rooms, or desks or private spaces to study. Creating spaces after school in which these learners can study or implementing a general study period would be beneficial and advisable (Zimmerman, 1998). Also, Zimmerman (1998) makes reference to the idea of, "where" learners study, the use of resources and the lack of control over surroundings all of which influence their performance (p. 75). All the afore-mentioned study skills form a continuous plan.

2.4. Study skills areas

The study skills discussed are interdependent, and interlinked to form a complete plan for achieving success. This opinion is shared by Hagedorn, Sagher and Siadat (2000, p. 135). All the skills are dependent on time management skills because planning the use of time would influence the manner in which the learner uses organizational, reflection and consistency skills effectively.

These skills also complement each other to form a complete guide. The reinforcing nature of these skills emphasises that fact. Figure 1 below is an illustration of this process. Reflecting on daily work enables learners to identify problems and to rectify mistakes. The timetable would enable learners to set goals and to plan for tests and exams as well. This would also assist learners in becoming more consistent when studying because they will be able to see the limited time available and compare it to the workload they have, enabling them to pace themselves. The ideas discussed can be diagrammatically depicted as the following figure demonstrates.

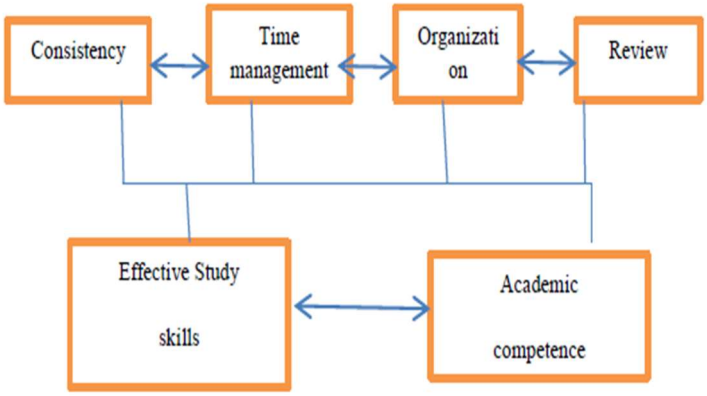

Figure 1: Study skills application

2.5. Study skills application

What is ideal is that study skills in mathematics are taught to learners from as early as primary school (Grade 7, the GET phase). Gall, Gall, Jacobsen and Bullock (1990) argue that learners in this phase generally accept guidance and instruction well, giving them sufficient time to "practice and refine their skills" (p. 42). Learners are thus better able to learn study skills and to apply them in preparation for high school and university life. Kiewra (2002) perceives that good study-strategy instructors must be able to embed "strategy instruction into content teaching" (p. 71).

Gall, Gall, Jacobsen and Bullock (1990) define this infusion approach "as the alternative to a separate study skills course" which gives learners instruction in their mathematics class (p. 47). They further note that there seems to be the disadvantage of "extensive planning, training and coordination of teachers" (p. 47). In the South African context, where teachers are overburdened with work and overcrowded classes, teaching learners study skills in class already seems to add to their teachers' burdens. Teachers may therefore see study skills instruction as extra work and ignore it or do it unenthusiastically. Research indicates however, that teaching learners "how to learn" is just as imperative as teaching them "what to learn" (Hagedorn, Sagher & Siadat, 2000, p. 134). Therefore, while it is required that learners master the content of mathematics, it is nonetheless crucial that they acquire the ability to apply study skills effectively, is crucial for academic competency.

2.6. Feedback

Providing feedback to learners in the class, after tests, tasks and homework have been done, forms an integral part of teaching and learning. Hattie and Timperley (2007) refer to feedback

as an “agent” providing information “regarding one’s performance or understanding” (p. 81). According to Hattie and Timperley (2007), feedback includes the following – the provision of correct information or, a book which provides information; parental “encouragement” and a learner looking in a book to “evaluate” answers (p. 81). In other words, feedback takes place when rectifying information, looking for information in a book, parent “encouragement” and the evaluation of answers in books. There are many “agents” involved in the feedback process such as teachers, learners, parents, peers and resources.

Feedback, argues Hattie and Timperley (2007), is not effective in a “vacuum” and should be done in the context of learning (p. 82). They further add that feedback is that which happens after teaching and the learner responds to instructions – it is thus the information “provided regarding” certain “aspect(s)” of the “task performance” of the learner (Hattie & Timperley, 2007. p. 82). Shute (2008) distinguishes between “directive and facilitative” feedback (p.157). Directive feedback is the belief of Shute (2008) of that information given to learners so that they may rectify or revise work where necessary. Formative feedback by contrast, Shute (2008) argues, is less specific and provides learners with “comments and suggestions” as a guide to their “revision and conceptualisation” (p. 157). Hattie and Timperley (2007) reported that particular feedback strategies are more effective than others.

Studies indicate that when learners receive information concerning a task and in how to do it effectively, the outcome is the highest (Hattie & Timperley, 2007). Shute (2008) distinguishes between three procedures by which formative feedback may be utilized by learners; firstly when a “gap” in performance is identified, by resolving the gap it may motivate learners to “higher levels of effort”. Secondly, it can decrease “struggling or novice” learner’s thinking burden. Thirdly, feedback is useful in providing information for rectifying incorrect “task strategies, procedural errors, or misconceptions” (Ilgen et al., 1979; Mason & Bruning, 2001; Moreno, 2004; Narciss & Huth, 2004, as cited in Shute, 2008).

Hattie and Timperley (2007) further elaborate on the notion of effective feedback as answering three questions from learners and teachers: “where am I going; how am I going; and where to next” (p.86). There are levels at which feedback operates – in performing tasks, in processing the understanding of a given task, in evaluation of “metacognitive” processes and also on private levels (Hattie & Timperley, 2007, p. 86).

2.7. Spiral revision

Spiral revision as theorized by Julie (2013) was done at the start of each intervention session and consisted of previously completed topics in mathematics. Julie's notion of spiral revision which is "… the repeated practic (e) ing of work previously covered." (2013.p. 93) was used in a few lessons. In the same way Cramp and Nardi (2000) refer to "snappies" as "opportunities for revision, instant assessment" of learners' "understanding and linking with" previous knowledge (p. 48). Whereas Cramp and Nardi (2000, p. 48) refer to "snappies" as assisting in "identify(ing) areas" of difficulty, Julie (2013, p. 93) refers to spiral revision as developing "familiarity with solution strategies of mathematical problems". These "repeated practice" sessions of Cramp and Nardi (2000) and Julie (2013) were developed to be done in the mathematics class.

2.8. Conclusion

This chapter discussed the critical terms of the study and elaborated briefly on the origins of studying and learning theories in mathematics education. Spiral revision which was applied in a few intervention lessons was also expounded on. In the subsequent chapter the methodology of the research is considered.

Chapter 3

Methodology

3.1. Introduction

As discussed in Chapter Two, researchers like Gettinger and Seibert, (2003) and Crede and Kuncel (2008) agree that many learners lack effective study skills, a factor identified as one of the reasons for poor performance in mathematics. This chapter describes the research design, sampling, data instruments, data collection and analysis procedures used in the discussion of this thesis that will follow. Chapter Three therefore includes detailed information on the designed intervention designed to examine the effects of the application of a mathematics study skills guide for Grade 10 learners. A case study was used to investigate how learners apply a study skills guide within the teaching of mathematics. This study is described in detail. As case studies are generally classified under qualitative research, the qualitative research design is also described.

While learners' improved academic performance is the ultimate goal world-wide, this research is centred on how learners apply a mathematics study skills guide. Within this project it is crucial to comprehend how learners study mathematics from a learner's rather than a teacher's perspective. If research is able to gather from learners in what manner they study mathematics, it may contribute to learners' resolving their mistakes appropriately. The teacher facilitates learning, while learners are engaged in studying. The importance of gathering information from learners' mathematics study methods, and the subsequent knowledge gained may enable teachers to teach learners more productive mathematics study skills.

Various notions are used to justify low achievement in mathematics. As deliberated on in the previous chapter, learners do not apply study skills effectively, are inconsistent, cram or manage their time inadequately (Kiewra, 2002; Gettinger & Seibert, 2002; Taylor & Mander, 2003; Crede & Kuncel, 2008; Demir, Kilinc & Dogan, 2011). Instructing learners on how to study could enable them to become more skilful at doing mathematics. In the previous chapter several mathematics study skills were identified. These mathematics study skills are captured as a guided intervention, in a study guide aimed at Grade 10 learners. The study guide was specifically designed for mathematics and is not a generic one. In South Africa, Van der Walt and Maree (2007) confirmed that, educators have neglected to teach learners

how to study mathematics. Mathematics study skills were therefore infused into mathematics topics at the time of the intervention. These guided intervention sessions required an in-depth investigation and so a qualitative design was arguably most appropriate. The next sub-section discusses the characteristics of the qualitative approach.

3.2. Qualitative research

The study of "social phenomena" is an expansive approach defined as qualitative research by Marshall and Rossman (2011). The philosophical roots of educational research are traced in three branches: in positivist, interpretivist and in critical forms of inquiry (Merriam, 2002). These include the basic or general qualitative study, phenomenology, grounded theory, case study, and ethnography as qualitative research designs (Merriam, 2002). By contrast, McMillan and Schumacher (2006) distinguish between five modes of inquiry; ethnography, phenomenology, case study, critical studies and grounded theory. This research however, is underpinned by an interpretivist paradigm, which according to Ritchie and Lewis (2003) places the emphasis on the value of human interpretations of their knowledge of their world. Furthermore, Ritchie and Lewis (2003), as well as Marshall and Rossman (2011) underline the importance of the phenomenon studied and researcher interpretations. Understanding the way in which people understand and relate to their social world, and understanding the importance it has for them, is referred to as interpretive qualitative research (Marshall & Rossman, 2011; Merriam, 1998).

The characteristics of interpretive research designs are outlined as follows. In the first instance, a qualitative researcher aims to comprehend the sense individuals have made of their world and their daily practices, and s/he aims to determine how people make sense of their experience (Marshall & Rossman, 2011; Merriam, 1998). Therefore the design used in this study attempts to gain a deeper understanding of the learner's study of mathematics. The distinctive characteristic of qualitative research is embedded in the idea that meaning is socially constructed by individuals in their interaction with their natural environment (Silverman, 2000; Merriam, 2002). Researchers therefore attempt to comprehend the understanding people make of their worlds and their practices (Silverman, 2000; Merriam, 2002). Furthermore, through understanding the process or lived experience, knowledge is gained from an inductive, hypothesis or theory generated method of inquiry (Merriam, 2002; Terre Blanche, & Durrheim, 1999). In the context of broader research that attempts to make sense of peoples' lived experiences this research is interested in the world of the learner in a Grade 10 mathematics class. Merriam's (2002) reference to the qualitative researchers'

interest in understanding "… interpretations …" at specific times as well as the context of the study enhances this research (p. 4).

Silverman (2000) observes that qualitative research tends to rely on lengthy descriptions or narratives more than the statistical tables as used in quantitative research. Qualitative research is therefore largely expressive and makes use of words instead of numbers (Terre Blanche & Durrheim, 1999; Merriam, 1998; Neuman, 2000). Also, this research method is useful for building theories, developing policies, and improving educational practice (Mc Millan & Schumacher, 2006).

In the second instance the researcher is the primary data collector and source of analyses in qualitative research (Merriam, 2002). This means that the researcher becomes the fieldworker attempting to go directly to the subjects' natural settings, which is the best way of collecting data. In the context of this study, the natural setting is the classroom where all data was collected. This advantaged the researcher in that understanding was developed through nonverbal as well as verbal communication. Information is processed immediately, material clarified and summarised, checks with respondents for accurate interpretation followed through, and uncommon unexpected replies were explored (Merriam, 2002). Direct interaction with learners through questioning enabled the researcher to assess the situation and by observing how learners completed specified tasks. During the teaching intervention the researcher was able to assess learners' responses to tasks. These responses from learners enabled the researcher to gauge what feedback was needed. Thus, it became evident that direct interaction with learners is advantageous since it immediately allows the researcher to identify problems experience by learners.

The third distinguishing characteristic of qualitative research is the use of small and specific sample sizes (Terre Blanche & Durrheim, 1999). Quantitative research differs in these respects as it centres on experiments and quantifying greater amounts of data. Interpretations learners made when studying, the researcher as the prime data collector and the small sample size are the characteristics of qualitative research which justify the choice as a research method. In the context of this research, a one stream of a Grade 10 class in a high school is used as the sample or case, while a case study was chosen as a form of inquiry.

3.3. Case study as a form of inquiry

Case studies are preferential according to Yin (1984, cited in Brown, 2008) when "why" or "how" questions are posed and the researcher has limited control over events (p. 5). This

makes a case study a preferred method of inquiry for this research. The purpose of case studies is the presentation of the case so that the practitioners and policy makers can use the knowledge gained from the experience (Stake, 1994, cited in Brown, 2008). Mc Millan and Schumacher (2006), state that case studies scrutinize "bounded system (s)", also known as a case, over a span of time (p. 26). Stake (1994, as cited in Brown, 2008) acknowledges that a case is a "system with boundaries" in which certain features exist (p.7). Brown (2008, p. 9) and Creswell (2003, p. 99) conclude that a case study is "bounded", its findings can seldom be "generalized", and this gives researchers a noteworthy understanding of events. A case study provides in-depth understanding of practices or issues and facilitates educated assumptions. The ideal of case studies is rich, descriptive analyses of an occurrence. Merriam (2002) further refers to the notion of a descriptive case study as being comprehensive and very precise in its reporting of the findings, thereby demonstrating the complexity of the circumstances. A case study focuses on one "phenomenon" which may consist of one administrator, one class in a school, one policy, or concept, which comprises the unit of analysis. In this study, the case is a Grade 10 mathematics class.

3.4. Sample

A distinction is made between probability and non-probability sampling methods in social research (Ritchie & Lewis, 2003; McMillan & Schumacher, 2010). Qualitative research makes use of three categories of non-probability sampling: convenience, purposeful and quota sampling (McMillan & Schumacher, 2010). This research employs a convenience sample which will be discussed further in this chapter.

As outlined before, the case in this study is a grade 10-class in a high school – Sandvale High School is one of 10 schools participating in the Local Evidence-Driven Improvement of Mathematics Teaching and Learning Initiative (LEDIMTALI) project at the University of the Western Cape (UWC), South Africa. This is a convenience sample or as McMillan & Schumacher (2010) would observe, "available sampling" – defined as being easily accessible or practical (p.137). Sandvale High School was easily accessible to me as a researcher as it is a participating school in the LEDIMTALI Project which was launched on 8 March 2012. A selection of schools in the project was made on the premise that they are situated within a radius of 25km of UWC. Sandvale High School is situated in a township consisting of predominantly low income workers and unemployed people dependent on government social grants. Ten to twenty percent of the learners are dependent on social grants and these learners

are thus partially or fully exempted from paying school fees, an important source of income for many schools in South Africa.

Sandvale High School has a total of 1151 learners and 33 educators. There are two Grade 10 Mathematics classes at Sandvale, consisting of 42 and 25 learners respectively. The Grade 10 class with 42 learners was the preferred choice for the research case as a large class size reflects the norm in South African high schools. Two learners dropped out of school after the first quarter. During the intervention there was an average of 3 learners absent per day. This Grade 10 class consists of learners in different achievement levels of excellent, average and weak performance (levels 1-7). As learners in classes have mixed abilities the research findings will be more realistic since learners work at their own pace and ability. The learners are of mixed genders – with 20 girls and 20 boys-aged between 14 and 16 years old.

3.5. Data collection and instruments

Terre Blanche and Durrheim (1999) define data as the "basic material" researchers work with (p. 45). In qualitative case studies methods of data collection generally combine interviews and observations as data collection methods (Silverman, 2000). Marshall and Rossman (2006) distinguish between four qualitative data collection methods: observations, interviews, direct participation in the setting, and analysis of documents and cultural materials. Wilson and Fox (2009) suggest that there are no fixed rules, rather multi-methods of data collection in classroom-based research which are both advantageous and time consuming. An additional advantage to using multiple data sources is that it assists the researcher in understanding other perspectives of the situation (Merriam, 2002; Bowen, 2009).

In this study data was collected from study participants using a semi-structured questionnaire, informal conversation, unstructured interviews and journals.

3.5.1. Interviews

An interview as defined by Wilson and Fox (2009) is a conversation between two people. Wilson and Fox (2009) further elaborate that interviews are "communications that aim to consult" interviewees about their opinions and understanding and are used to "gather detailed qualitative descriptions" (p. 88). Interviews constitute important sources of data collection in qualitative research. They involve examining and imploring for detail, thereby providing a complete understanding of the interviewees' points of view (Patton, 1987). Consequently interviews allow the interviewer into the interviewers' world. Patton (1987) further describes in-depth interviewing as the questioning through open-ended questions, whilst listening to and recording responses. Also, additional follow-up questions appropriate to the inquiry may

ensue (Patton, 1987). Marshall and Rossman (2011) further elaborate on in-depth interviewing and include specific forms: ethnographic interviews, phenomenological interviews, focus-group interviews, "life histories, narrative inquiry and digital story-telling" (p. 146). During this research informal conversational interviews were adopted as a method for collecting data. Informal conversational interviews take the form of spontaneous questioning that flows naturally from the interaction between the participant and interviewer (Patton, 1987).

As these interviews are captured via tape recordings, this method enables the capturing of more accurate information (Wilson & Fox, 2009). Furthermore interviews allow for huge amounts of data to be captured in a short span of time (Marshall & Rossman, 2011). An additional strength of the informal conversational interview is that it affords the interviewer the opportunity to adapt to both individuals and to any changes that may occur (Patton. 1987).

However, there are weaknesses to this data collection method as well. The interviewer may lack expertise and skill or may not comprehend answers or segments of the conversation: also this method requires exceptional listening skills (Marshall & Rossman, 2006). Additionally analysing and transcribing the interview data can be time consuming (Marshall & Rossman, 2006; Wilson & Fox, 2009). Wilson and Fox (2009) also allude to the fact that it is difficult to identify children's voices after interviews. In anticipation of this fact the researcher took field notes and used the learner class list as a reference.

Interviews as a method for data collection are justified for the following reasons. The questioning during interviews enabled the researcher to get a clearer perspective of how the learner's study – prior to study skills instruction. An informal conversational interview put learners at ease and assisted in creating a situation of trust. The researcher was guided by the initial conceptual framework of the proposal in the choice of data collection methods and thus began by uncovering participants' perspectives (Marshall & Rossman, 2011).

Recordings of the interviews have been transcribed and translated from Afrikaans into English. Transcribing learners' spoken words may have been hampered by the fact that when we speak, we speak without obvious punctuation (Marshall & Rossman, 2006). There is a difference between speaking and writing. However, "visual cues" such as facial expressions indicating the interviewees' state of mind are lost when we transcribe interviews (Marshall &

Rossman, 2006, p. 110). Furthermore meaning may be lost in translation as well. It is therefore advisable to make detailed notes during interviews in a personal journal.

3.5.2. Journals

As part of a qualitative data collection method researchers often supplement observations and interviews with documents as a qualitative data collection method (Wilson, 2009; Marshall & Rossman, 2006). Journals, or otherwise referred to as diaries, are another form of data collection in the method used in this research. Janesick (1999) refers to journal writing as having the purpose of enhancing the writing of the researcher as well as that of participants, through a process of reflection, within qualitative research. As Merriam (2002) states, documents may give researchers "insight and clues into the phenomenon" (p.13). Bowen (2009) and Wilson (2009) allude to the fact that document analysis is a procedure involving the systematic reviewing or evaluating of documents. Bowen concludes that these documents consist of recorded words and images, which exclude the researcher's intervention. So these journals are documents produced by learners and reflect their personal thinking, and not that of the researcher. Learners were therefore requested to keep journals daily. Learners were requested to do three mathematics questions recording the time spent on these questions in their journals. Wilson (2009) and Marshall and Rossman (2006) agree that the collection and analysis of documents of daily events is a discreet manner by which to attain participants' values and their personal ideas. Also, respondents are able to express thoughts, observations or impressions which they may not normally expose (Wilson, 2009). Journals constitute part of this category of document and data collection tool.

Janesick (1999) asserts that journal writing is a powerful qualitative research tool which assists in the triangulation of data. Stevens et al (2010) however contend that journals produces reflection on practices. Dewey (1958, cited in Stevens et al, 2010) view reflection as the "foundation of learning" (p. 351). This practice of reflecting is one of the reasons for using journals in this study. Learners are able to reflect on their mathematics and how they apply their study skills. These journals establish greater validity in the research and include the whole class, not just a small group of learners. In these journals learners record their daily experiences concerning the study of mathematics as well as exercises given during the lessons and at home. Wilson (2009) warns that journals or diaries are time-consuming and may be experienced by some participants as an overwhelming assignment.

3.5.3. Questionnaires

Questionnaires normally consist of a list of questions with "structured response categories" and may consist of open-ended questions as well, as was the case in this instance (Marshall, & Rossman, 2006, p. 125). In this research questionnaires constitute the final data collection method employed. This approach is supported by Marshall and Rossman's (2006) reference to learning about the "characteristics, attitudes and beliefs" of the participants (p. 125). Marshall and Rossman (2006) also allude to the fact that researchers rely on the participants' honesty and accuracy to questions.

Questionnaires were administered after study skills instruction at the end of the research intervention. The questionnaires consist of open-ended and close questions (Appendix 3a). They aimed at acquiring an understanding of how learners applied the study skills guide.

3.5.4. Intervention lessons

Intervention lessons took place from April to May 2015.

The Merriam Webster Dictionary defines intervention as through its verb form 'to intervene': that is "to interfere with something so as to stop, settle, or change [it]" ("intervene," 2016). It further describes an "intervention" as "the act or fact of taking action about something in order to have an effect on its outcome" ("intervene," 2016). The Concise Oxford English Dictionary defines intervention as the "action taken to improve" something (p. 174). The intention was therefore to intervene in the teaching of mathematics in order to teach mathematics study skills simultaneously with mathematics content. In this intervention multiple variables were chosen by the researcher to enhance study skills – time management, organization, review and consistency and feedback. Hattie, Biggs and Purdie (1996) distinguish between three types of interventions: cognitive, metacognitive and affective interventions. While cognitive interventions focus on the development of task-oriented skills, metacognive interventions are focussed on "self management of learning" (Hattie, Biggs & Purdie, 1996, p. 100).

Gersten et al, (2009) in a published guide aimed at learners experiencing difficulty with mathematics, strongly recommends that instruction should be clear and methodical. They further recommend providing "models of proficient problem solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review" (Gersten et al, 2009, p. 6). A detailed description follows of the intervention sessions, as well as further descriptions in Appendix 3b.

Participants received a mathematics study guide (Appendix 2a), a journal, and a worksheet (Appendix 2b), consisting of revision exercises. The mathematics study guide consists of a motivational section, study skills application, prompts to learners concerning journal writing and an example of a study time table illustrating topic organizing.

Each study skills section in the study guide briefly discusses each study skill and is followed by a prompt. The guide consists of the following sections – regular practice, how to manage your time, review of previous work done, and some wise words. Practical examples are also given of real life situations that learners can relate to in sports and in their own studies more generally. Reference is also made of examination- type questions which learners can refer to as examples when studying. The learning outcomes and success criteria of the study guide are also given in order that learners should understand what was expected of them after applying the study guide.

An in-depth discussion with learners followed which related to the mathematics study guide, journal and revision exercises. Participants were also informed that they would be visited every Tuesday until the end of May 2015. There were however times that the researcher went on Thursdays as well. These revision questions were based on the analyses of the March tests of 5 learners who had been interviewed, two being absent at the time of writing the test. The reason I chose these learners was in order to learn whether what was said during the interviews could be confirmed or rejected, an aspect that will be discussed in the follow-up chapter.

The intervention lessons entailed the following:

(a) the doing of three questions on the chalkboard by the researcher,
(b) completing questions from the given worksheet,
(c) completing journal entries,
(d) feedback by researcher to learners on the chalkboard or in journals.

3.6. Ethical considerations

There are ethical issues that need to be well-thought-out when conducting research. Resnik (2010, cited in Hamilton & Corbett- Whittier, 2013) defines ethics as the "norms of conduct" with which acceptable and unacceptable behaviour can be distinguished (p. 64). Mouton (2001) refers to scientific research as a form of human activity, arguing that some forms of conduct are morally acceptable and others are not. The question then is how the apprentice researcher will know what is acceptable and what is not. The answer lies in Mouton's (2001)

"epistemic imperative" as the ultimate goal of research (p. 239). Mouton defines the epistemic imperative as the moral commitment scientists make in the search for truth and knowledge. He elaborates on this definition, arguing that the conduct of scientists is guided by the epistemic imperative which acts as a regulative principle. Scientists are therefore accountable for what they do. Mouton refers to scientists as needing to be socially "responsive" and "responsible" (p. 240). As an apprentice researcher I therefore have to be accountable for my actions, open and aware of the social conditions and cultures prevalent at the school where the research is conducted. Searching for the truth and gaining knowledge in the process is crucial. Hamilton and Corbett-Whittier (2013) argue that we should take cognizance of the fact that we are educators and therefore learners are our first responsibility.

Denzin (2009) is of the opinion that researchers are obligated to address the ethical decisions shaping their research, including the design, execution and organization of the inquiry. Neuman (2000) refers to five basic norms that guide science. These norms are "universalism, organized scepticism", impartiality, "communalism" and honesty (p. 9). Whether it is the epistemic imperative of Mouton or the five basic norms of Neuman or Denzin, researchers agree that ethics are an important aspect of scientific inquiry. The researcher should be mindful of the extent to which the following might affect the research: "informed consent, deception, confidentiality, anonymity, privacy and caring" (Mc Millan & Schumacher, 2006, p. 333).

All participants involved in the research were informed about the procedure of the research. Their informed consent had to be obtained, as well as the permission of the ethics committee (Mouton, 2001). It is crucial to report to the university ethics board concerning the role of the researcher, access, data collection, storage and reporting (Marshall & Rossman, 2011). In other words here it was imperative that the rights of the learners, who are underage, should be respected and consent from parents or legal guardians obtained (Mouton, 2001). However, if difficulties in gaining consent from parents should occur, the consent from the school as a proxy could be taken for this. In summary the following documents and letters of consent are needed to complete the research: parent consent (Appendix 1a), learner consent (Appendix 1b), school consent (Appendix 1c), WCED consent (Appendix 1d) as well as consent from the University of the Western Cape (Appendix 1e).

Denzin (2009) agrees to incentives for participating, also stating that consent wavers as well as confidentiality agreements pertaining to participants of the research are essential when

conducting research. Therefore, the waving of consent is expressed clearly on all consent forms, during interviews and on questionnaires. A very crucial aspect of the research is that reporting should be accurate, free of plagiarism, accessible and the data or results should be free of falsifications or fabrication (Denzin, 2009). It is also essential that the final data presented should be of such a quality that it could be replicated by any qualified researcher (Denzin, 2009). Detailed descriptions of all aspects during the research are therefore specified at all times.

3.7. Validity and reliability

3.7.1. Validity

Merriam (1995) suggests the following strategies "to strengthen the internal validity of a qualitative study":

- *Triangulation with the use of many investigators, numerous data sources, or multiple methods (as cited from Denzin, 1970; Mathison, 1988).*

- *Participant checks which refer to the data collected from the participants taken back to them in order to confer whether interpretations of data are "plausible, if they ring true".*

- *Peer or colleague review, where colleagues examine the data in order to comment on the emerging findings' plausibility.*

-*Researcher makes a statement of experiences, assumptions and biases at the start of the study enabling the reader a clearer understanding [of] how the data might have been interpreted.*

- *Data should be collected over a long period of time to "ensure an in-depth understanding of the phenomenon".* (p. 54-55).

Terreblanche and Durrheim (1999) agree that validity is defined by the "degree to which the researcher can produce observations that are believable" for all involved in the study as well as the readers (p. 46). The researcher employed triangulation by using many data sources, i.e. interviews, questionnaires as well as the journal entries of learners. The data collected was cross-checked in order to maximize validity. The answers given by learners could therefore either be confirmed or refuted in their journal entries and responses during their interviews. This will be dealt with in the following chapter.

Bowen (2009) refers to the reduction of potential biases that could occur in a single study, through the scrutiny of different methods of data collection enabling "…the researcher [to] corroborate across data sets…" (p. 28).

3.8.2. Reliability

The reliability of a study is focused on whether the researcher's findings will be the same if the study is replicated (Merriam, 1995). She is also of the opinion that the more times the findings of a study are replicated, "the more stable or reliable a phenomenon is thought to be" (p. 55). On the other hand human behaviour is not "static" and therefore interactions change daily. For this reason this study had to keep in mind that the situation in the class may change daily, as well as the behaviour of the learners. Therefore to ensure reliability the researcher had to constantly be aware of what the learners' daily and weekly programmes were so that there would not be any interruptions or disturbances in class. The researcher ensured this by keeping in contact with the class teacher regularly. Learners were reminded daily that their cooperation in class is valued and needed in order to do the research. All the staff members were informed beforehand about the research and asked to respect our privacy. An agreement was made between the researcher and the learners to be truthful about responses concerning the research were made to ensure maximum reliability.

Reliability was to be ensured as the grade 10 class was regarded as a standard high school class in South Africa – in other words an average number of 35 learners, mixed genders, different religions and cultures, as well as the age of the learners, were factors considered to be representative of the average grade 10 class. It is with these in mind that the grade 10 class was chosen for the research.

Bowen (2009) also advises that detailed information regarding the way in which the study is conducted should be given in the research report. A detailed description would thus ensure reliability and could be replicated easily with this information. Bowen (2009) also makes reference to "…trustworthiness techniques…" to ensure that the process of developing theory would be "…visible and verifiable" (p. 38).

In the following chapter a detailed description captures learner responses during interviews, in journal entries and through questionnaires. Reliability could thus be ensured since information could easily be replicated for further research.

3.9. Conclusion

This research was therefore a qualitative case study, employing interviews, journal entries and questionnaires. Ethical considerations concerning the research were closely adhered to. Interviews have been transcribed, as well as the data collected from journals and questionnaires. The presentation of data is given in the next chapter.

Chapter 4

Data analysis and results

4.1. Introduction

McMillan and Schumacher (2006), state that qualitative data analysis is primarily a process that is inductive, organizing data into categories and patterns. Data analysis and interpretation comprise of the "creative insight, disciplined study" and vigilant attention to the purposes of evaluation (Strauss & Corbin, 1990, p. 144). Furthermore, qualitative research is interpretive where the researcher assesses descriptions of the situation or themes, capturing the major categories of information (Creswell, 2005). Strauss and Corbin (1990) argue that analysis and interpretation are conceptually different. While analysis is the "process of bringing order to the data" – organizing raw data into patterns, categories and descriptive units, interpretation involves "attaching meaning and significance to the analysis, explaining descriptive patterns, and looking for relationships and linkages among descriptive dimensions (Strauss & Corbin, 1990, p. 144). Case studies apply multiple methods of data collection and analysis techniques, which provide the researcher with data triangulation opportunities, with the advantage of strengthening the research findings and conclusions (Demetriou, in Wilson, 2009, p. 209).

There is not a correct way of interpreting, analysing and organizing qualitative data (Strauss & Corbin, 1990; McMillan & Schumacher, 2006). McMillan and Schumacher (2006) distinguishes between four analytical styles in qualitative research – technical and quasi-statistical style, template analysis style, editing analysis style and the immersion or crystallization style. McMillan and Schumacher (2006) outline these styles in the following ways:

- Technical and quasi-statistical style categories are decided upon in advance; categories are therefore "predetermined and rigid".

- Template analysis applies resulting codes and categories; revising these throughout data analysis. Initial codes and categories may derive from the research question, interview guide, or data which the researcher may choose to preserve for the final analysis.

- Editing analysis is the search for "parts to illustrate categories of meaning" in the data. Codes are rarely used; instead the researcher makes use of descriptive memos in order to

illustrate the most important interpretations.

- The immersion or crystallization style is where the researcher "collapses coding, categories" and searches for patterns while immersing into the data – the researcher reads and examines the data in detail. Crystallization is the tendency of the researcher to gain maximum experience, leading intensive reflexive analyses concurrently. "Patterns are identified by iterative reflection" (p.365-366).

The template analysis was applied in order to identify codes and catogaries. The data was re-examined and revised continuously keeping in mind the research question. Interview responses and data received from journals were analysed and coded and catogorised.

4.2. Case analysis

Case studies have currently increased in popularity in areas of educational evaluation and instruction with the purpose of developing "critical thinking, skills and knowledge" (Stake, 1995, in Wilson, 2009, p. 210). Demetriou elaborates:

"Students can learn more effectively when actively involved in the learning process, and the case study approach is one way in which such active learning strategies can be implemented." (as cited in Wilson*, 2009, p. 210).*

A qualitative case study first "pulls together the data" and then writes up "a discrete holistic case study" (Strauss & Corbin, 1990, p. 147). Demetriou (in Wilson, 2009) confirms this notion. Data of case studies consists of all the raw data accumulated – including interviews, observations, questionnaires and journals.

4.3. Inductive analysis

Strauss and Corbin (1990), and McMillan and Schumacher (2006) agree that inductive analysis is a process of generating patterns, categories and themes of analysis that emerge from the data, instead of having been decided on before the data collection and analysis procedures. Creswell (2005) by contrast refers to inductive analysis as a process that firstly concentrates on specifics-detailed data, such as transcriptions or interview notes and secondly on the broader – themes and categories.

4.4. Organizing data

The huge amounts of data in qualitative research involve organizing spoken and written information into typed files (Creswell, 2005). In qualitative studies the researcher is guided by initial concepts and is likely to develop or modifying an ever-changing understanding

during data collection and analysis (Marshall & Rossman, 2011).

As a point of departure, I used a template consisting of the concepts identified in the literature. These constructs are those which have been identified in the previous chapters, and which learners fail or did while studying mathematics. The results are presented within the data collection methods used in the section that follows.

4.5. Interviews

Collins, Brown and Newman, (1987), Gettinger and Seibert, (2002), Taylor and Mander, (2003), Kiewra, 2002, Crede and Kuncel, (2008) and Demir, Kilinc and Dogan, (2012) argue that having effective study skills is important for academic competence. Research shows that effective study skills are lacking in students at all levels of mathematics education, at both school and tertiary levels. Studying as defined by Gettinger and Seibert (2002) is the application of study skills which requires training and practice. Interview questions were therefore constructed in such a manner as to enable the researcher to establish ways in which learners study mathematics prior to intervention.

Learners were asked: *How do you study mathematics?* They responded that their method of studying was **practise**. One learner articulated this as follows: "I don't actually study maths; I practise it every day." This was confirmed by another learner who stated "I only use maths practise as a method of study," by stating: "I practise with the problems sir gave (homework)". Practise was viewed as 'doing' homework." However, there was also the response that they engaged with problems not related to homework. This was engendered by the practice book that the learners were provided with. Statements such as "I practise with … those in the practise book" were made during the interviews. Learners also articulated what they did when they practised. One learner expressed this as "I look at the sum and close my book and do it myself. The "do it myself" is "I practice in a practice book by writing." showing that learners were, through writing, constructing their solutions when they were practising. In addition to the sources provided by the teacher, some learners used other sources. Statements such as "I also practise with old class tests that we did," and "I take other examples we didn't do in class" attest to this. Not all learners used resources beyond the textbook or the problems provided for practice in the practice book. An example of this is "I don't use old question papers or Mindset."

Statements made by learners also indicated that they viewed studying as a mechanism that **"refreshed their memories".** An expression such as "I go through my workbook." refers to

familiarizing themselves with previous work done. Confirmation from another learner was conveyed in the statement: "I will go through my previous work that was done in class." The same learner further elaborates that when finding difficulty with a question "If I should get stuck… go back to my classwork book and go through the work again" – thereby repeating the idea of refreshing. Reference was also made to "… look in my book." when doing questions. This is affirmed by another learner who stated "I look at the question…" indicating that the learner first looks at the solution of a problem in the textbook or classwork book before proceeding to answer a question.

The "refreshing of memory" also came through when learners were questioned studying for tests and examinations using the question – *"Is there a difference between how you study for a test and an exam**?"*** One learner, for example, affirmed the "refreshing memory" notion by stating "I practise to refresh my memory."

Inherent in learners' responses was the idea of **repetition** as a method they use to study mathematics. Statements such as "I repeat it until I get it right," and "Then I repeat the question." attest to this.

Time management is considered by researchers as an important aspect of study skills (Kiewra, 2002; Gettinger & Seibert, 2002; Taylor & Mander, 2003; Crede & Kuncel, 2008; Demir, Kilinc & Dogan, 2012). Learners were probed about their time management skills by my asking them "*How much time do you spend doing mathematics every day?*" Some of the responses point in the direction of the amount of time they spent doing mathematics. Typical of responses relating to the amount of time spent on doing mathematics was: "An hour or an hour and a half", "…one hour for maths…" and "every day." Learners made reference to "chores", "homework" and "other subjects" as limiting the time they can spend with mathematics. Narratives such as "I do not spend enough time with my work. When I get home from school, I still have chores to do and homework, and it's a lot of work. And then it's late." and "When I get home I still have chores to do and my homework, and that's a lot. And then it's late." as well as "Depending on how many exercises I have to do. We get exercises every day. So I first do my homework." affirm this fact.

They were then asked: *"Do you have a program written down that you follow every day?"* as a way of probing them about managing their time. Responses confirmed that learners have a plan in place with statements such as "I didn't first have one, but now I do." and "Mine is pasted on my door." Also, reference was made to a general plan for all subjects in a statement

"Yes I plan all my subjects." To probe the question was posed: *Do you follow this program?* Three learners admitted to following their study program. "Yes it's a routine." was one of the strongest affirmations made.

The manner in which learners planned their time was explored by the question "*Do you have a study program for the March examination?"* Responses ranged from no response, to intentions to plan a study program, to already having a functional plan in place. Statements such as "I must still make one." and "I haven't for next week (March exam); only this week." indicate that some learners fail to plan a study timetable, while one learner elected not to respond to the question. Mention was made of planned study times throughout the year, in the response "Today is study timetable (a week before the exam), and the other planning falls away and I just concentrate on my study timetable." Another learner admitted to studying being dependent on the examination timetable. This was affirmed by the account "I always study a week or 2 before the exam, depending on when we get the exam timetable." "Yes. I have one planned now and I'm ready." further illustrates that learners procrastinate and wait for the start of examinations, before planning to study. This evidence confirms the notion of **inconsistency in studying** by Hagedorn, Sagher and Siadat (2000), Gettinger and Seibert (2002) and Crede and Kuncel (2008).

"When you get a lengthy project or task, how will you go about doing it in time?" was another question posed to learners to probe for **planning skills**. Statements such as "I will do it every day for 2 hours and then do my homework." and "I go to the library and go on the internet in order to complete it. About twice a week until it's done." also "I will first ask sir to explain to me and then do it at home. Over a period of 3 days, not longer than 3 days. I will do it immediately."; "I will take some of my study time to complete it, and continue to study once it's done." Narratives such as "I will do it every day for 2 hours…" , "About twice a week until it's done." and "Over a period of 3 days, not longer than 3 days. I will do it immediately." indicate that learners plan to do their projects and tasks over a period of time until completed. A response concerning the use of study time to complete it is attested to by the statement: "I will take some of my study time to complete it…"

4.6. Responses of learners in their journals.

As noted in the previous chapter, there were 40 learners at the end of the intervention lessons. Seventeen of the learners handed in their journals. One learner admitted to never working, another explained that his journal was lost and the others either forgot theirs at home or chose

not to hand it in. In this section the direct quotations in Afrikaans (with their English translations) are added in some instances in order to emphasize what learners said.

In the study guide learners were asked to write a response in their journals to the following question: *How do you feel about the study guide and doing the two questions daily?* in their journals. This question was posed to learners in order to get a sense of how they applied the study guide and the two daily mathematics questions. Learners felt the study guide and questions helped them to "**understand**", **"remember"** and "**improve"** their mathematics. Statements like:

"It helped me a lot with things I did not understand or I struggled with." and "The questions help me to improve my mathematics." also "I think the questions are a good idea because it enables you to understand and remember your work better."

One learner attested to the fact that "The study guide helped me to **study more**." while another learner stated that "(The) Study guide helped me to **manage** and regulate my **time** better." The time management skill can also be attested to with the statement "(The) Study guide helped me to manage and regulate my **time** better." The notion of **organization** was referred to by a learner in the statement "The study guide has helped me a lot to organize my work and to make time for everything"

One learner referred to the journal thus "it helps me to do revision of old work so that I will not forget."["…dit help my om oor my ou werk te hersien en dat ek dit nie sal vergeet."] which attests to the revision or the **"review of previous work done"** notion. This was acknowledged by another learner who stated "I think the purpose of the book was revision of my work in the past. I find the revision full of action as I go back to my previous work."["Ek dink die doel van die boekie (joernaal) was om vir my te hersien ons werk in die verlede. Ek vind die hersiening aksievol en dit laat my terug gaan na my vorige werk.].

Further reference was also made of "with a few questions I got stuck and had to look in my textbook…" ["by sommige somme het ek vas gehaak en in my handboek moet kyk"] These indicated that the learners **review** the work by using the textbook in use when solving problems.

Learners were requested to draw up their own study program to suit their personal needs as suggested by Gettinger and Seibert (2002), and Taylor and Mander (2003). Preferably learners should plan their own study schedules as this is more conducive to effective

studying. Learners had different ways of planning their study guide; ranging from one hour daily to having different allotted times daily. Daily study times varied from one hour, thirty minutes, one and a half hours to two hours daily. There were a few learners who did not plan a study timetable, which could attest to the fact that they either do not study or they are not planning their mathematics study. Figure 2 illustrates a learners' study timetable which includes **revision**, **practising** questions and studying times. This learner included the extramural activities on the timetable as well, indicating the time spent on all activities.

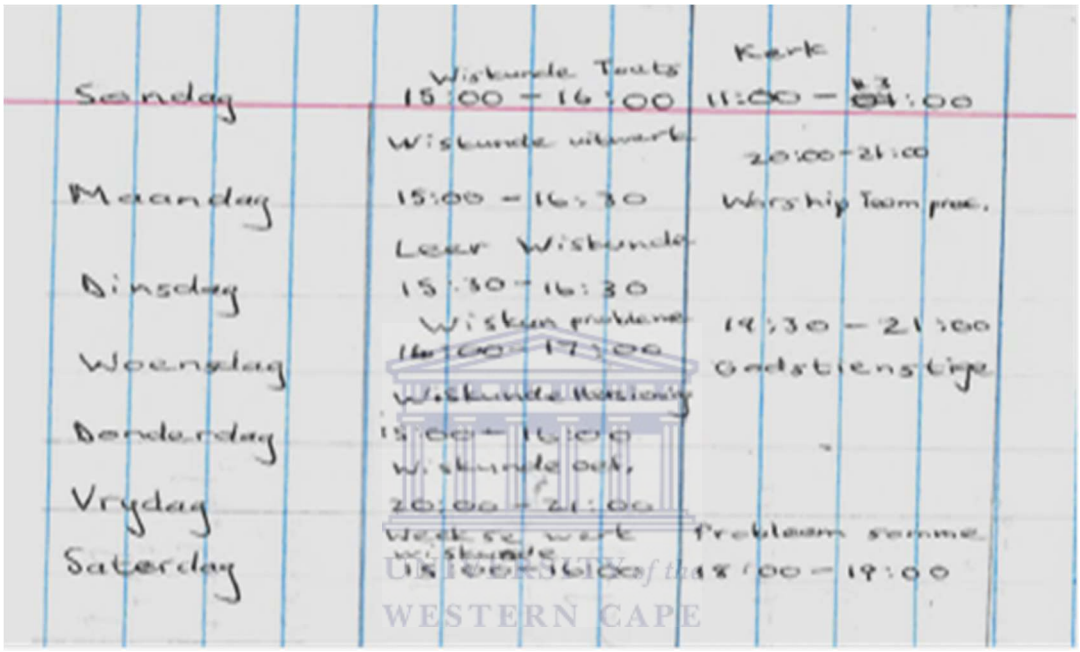

Figure 2: Time table of learner in journal

Learners also did their daily questions in the journal, recording the time spent daily and the date. Again there were those learners who did not complete any questions and others who did a few questions randomly. The request to learners was to choose one question from each Set, A, B or C. There were learners who did the questions and preferred to complete Set A and then B and so on. These learners therefore completed the easier ones, products, first. This can be confirmed by a learner who said the following: "I think this (study guide) helped because I did very bad in mathematics in the first quarter. I told myself that I would find something to help me do better this quarter. Luckily this journal came to my rescue. Although I am struggling a little with factorization and simplification I enjoy it a lot to work with products, as Miss can see. I hope and believe I wil do better this quarter." Also, another learner confesses that "The questions were easy and at certain ones where I struggled I looked in my

textbook." Data from questionnaires revealed the following statement from a learner, confirming the fact that they found certain questions easier after intervention. Previously the learner says that "I struggled with certain questions." But later "I find most of the questions easier." Figure 3 and Figure 4 are examples of two learners' work in their journals.

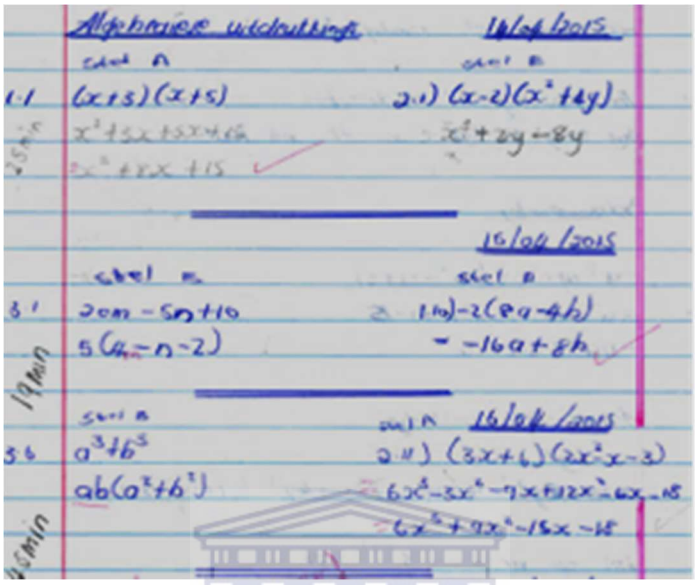

Figure 3: Indicating time spent daily on questions

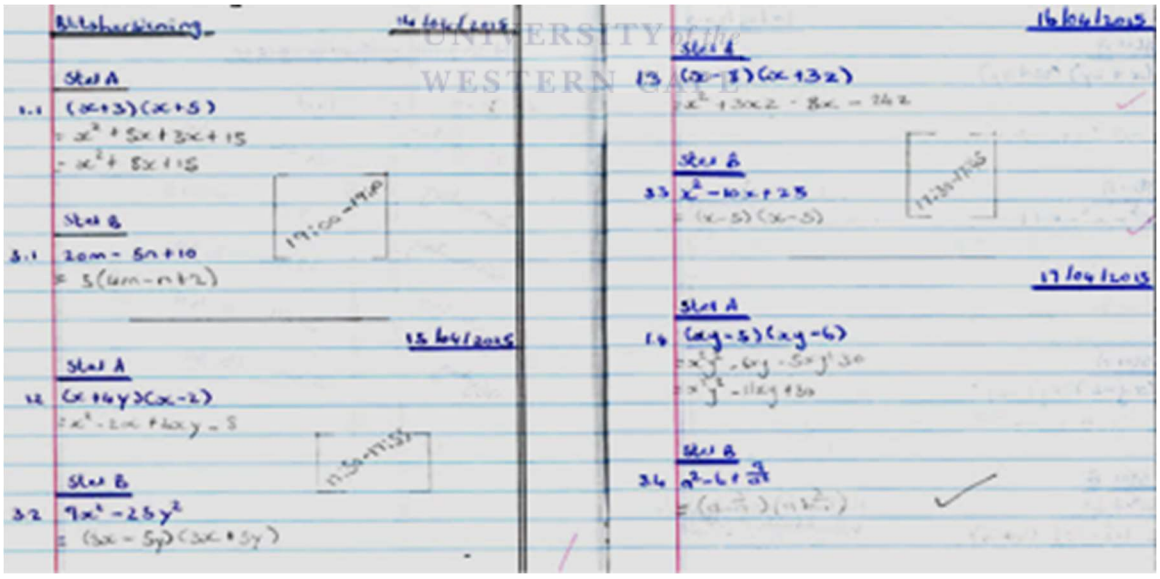

Figure 4: Indicating time spent daily on questions.

Most learners found this set of questions easy, as illustrated in their journals and others progressed as time passed. When learners were asked during interviews "*What problems are you having with mathematics?"*, one learner responded in the following way, "I find it difficult to do the calculations of problems. I struggle with some of the problems especially

factorization, irrational numbers and products." Another learner found difficulty with "The negative and positive (signs) and factorization." Some learners, however, only did the two spiral revision questions done in class. Most learners steered away from doing factorization, while those who already knew how to factorize, and completed the questions. Others who attempted to do a question or two either omitted the answers (see Figure 6) or made errors. Errors were either explained again on the chalk board or I gave feedback during the session in the learners' books or to them personally. The Figure 5 below illustrates some of the feedback given to learners.

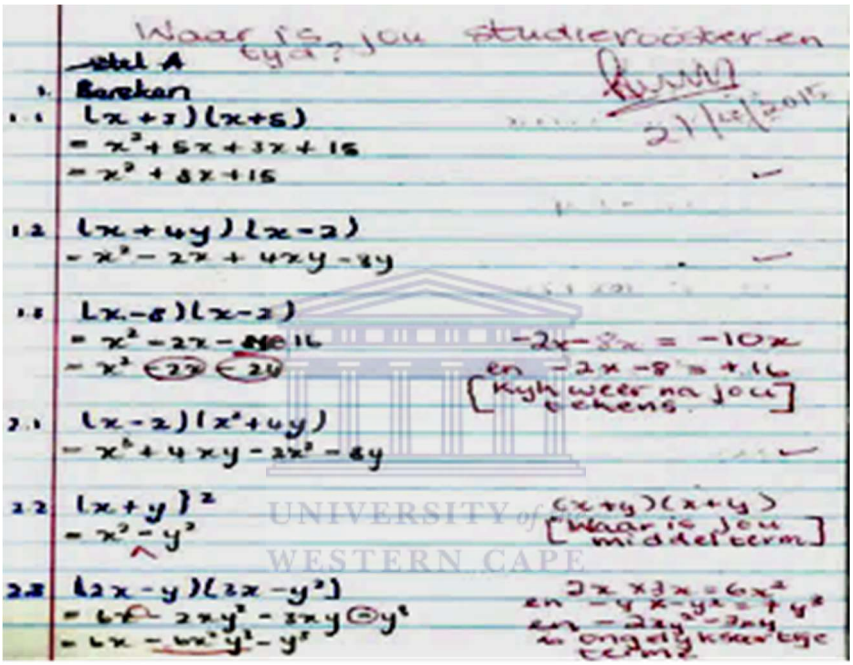

Figure 5: Feedback to learners of errors made

This same learner made fewer errors on the next page in the journal-indicating progress made. The Figures 5 and 6 show this progress.

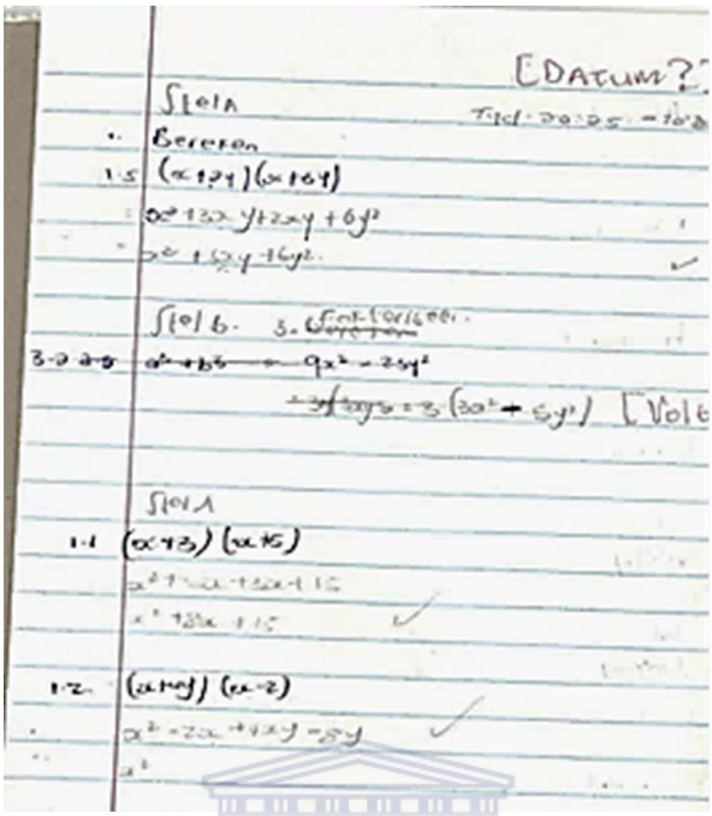

Figure 6: Progress made by learner, as well as omitting factorization

4.7. Results from questionnaires

The question *"How did you study mathematics before using the study guide and with the study guide?"* was posed to learners in the questionnaire. A few learners admit to not changing the way they study with statements such as "Do the same." and "It didn't really make a difference" also " I **practised** a lot on my own and don't really need it." Some of the learners felt that the study guide was a great help and brought about **change in the way they studied mathematics**. A learner relates that previously "I struggled with certain questions." and now "I find most of the questions easier." Others expressed that their **time management skills changed**, stating "(I) never had a fixed time to study. Studied when I felt like it," and now "(I) Have a fixed time to study. (I) Study every day exactly for an hour or more."

One learner responded "… I just paged through my book." whereas now "I refer to previous work done in my book and exercises we did in class." The reference of the learner to "previous work done in my book and exercises we did in class." confirms the leaning to **"refreshing their memory"**. Other learners make reference to their **time management skills** by narrating the following: "(I) Just looked through. Now and then I did a few questions.' whereas afterwards "I did two questions every day and sit with my mathematics book every

day. I spend more time with mathematics since I received the study guide." This attested to the idea of learners **"spending more time"** with mathematics than what they had done before, using the study guide. Responses such as, "[I] studied what the teacher told the class to do." changed to "[I] go through my work every day and do a few examples." Other responses were "[I] didn't manage my time properly. Wasn't completely organized." which changed to "Time restrictions for myself. Setting a study timetable for mathematics was another response which could be confirmed by "A time table to do mathematics." The learners changed the way they studied as these narratives indicate.

A few learners relate that they studied the day before the examination or test, which confirms that learners are not **consistent** in studying mathematics, a point shared by Gettinger and Seibert, 2002 and Hagedorn, Sagher and Siadat, 2000. Statements like: "I studied the day before the exams." and now "(Do) work every day." "(I) Do questions every day and remember the methods." were given by learners.

One learner previously just "Paid attention in class" as a way of studying. This by implication means that the learner never studied at home. One learner confessed to previously "I never worked. Didn't do homework," but later "I did mathematics exercises and went through my work twice a week for two hours." This learner confesses to "never work(ing)" and not "doing homework" before the intervention sessions. During the intervention period the learner "did exercises" and "went through my work twice a week for two hours". Previously, a learner claimed "(I) couldn't focus to study." but now "(I) **focused** very well to study." Having the ability to focus when studying, was clearly an important factor for this learner. One learner responded *"*Did not really use it a lot*."* referring to not using the study guide much. A learner relates that **"Questions became easier."** whereas previously "I found it difficult." The two daily questions the learner did, aided in making mathematics "easier". A learner responded "(I) did unnecessary questions.", but now "(I) choose specific questions and similar ones." The study guide "helped" a learner who said "I do two or three questions every afternoon and it **helped me to understand** the formulas better than I did before." One learner attested to the following "Everything was a mess. There was a lot of work that was **disorganized**. A lot of work was unfinished." now "Everything fell in place. (I) understand a lot more." This further indicates the **organization skill** was applied when studying mathematics as learners indicated in their journals and in interviews.

4.8. High-stakes assessment data

The results were also chosen of their March control test and that of the June examination were chosen for assessment to gauge the progress of learners. One learner was absent for the March test and two learners had left school by that time. The test consisted of similar topics done during the first term. These topics are products, factorization and fractions. Other topics were omitted from analysis as these topic were either not similar to those in the June examination, or had not been covered in the March test. The March 2015 assessment was done before intervention and the results are given in Table 1. The March 2015 test is given in Table 1.The June 2015 assessment marks of the class were taken (Table 2) of the same topics as that in the March test in order to compare the learners' results. Results were analysed per question in both the March and June high stakes assessments.

Table 1

Sandvale High School March 2015 Assessment data

Question Mark allocation	Average Percentage (Number of learners = 42)
2. Calculate the products in the following: 2.1. (a + 3) (a – 3) /4/	79
2.2.$(2ax - b)^2$ /3/	64
2.3. (2ax – b)(2ax + b) /2/	69
2.4.$-(x-7)(x+7)$ /3/	49
2.5. $3(a-2)(a+5)-2(a-2)^2$ /8/	33
3. Factorize the following: 3.1.$4pq^2 - 8pq - 12p^2q$ /2/	56
3.2.$ac - cd - ab^2 + b^2d$ /5/	38
3.3.$25x^2 - q^2$ /2/	58
3.4.$8a^2 - 2a - 1$ /2/	19
3.5.$8b^4 - 27bc^3$ /4/	9
Total average %	47

Table 2

Sandvale High School June 2015 Assessment data

Question	Mark allocation	Average Percentage (Number of learners = 40)
1.1.Find the products in the following and simplify as far as possible:		77
1.1.1 $(2x+1)(3x-4)$	/3/	
1.1.2 $(a+2b^2)(a-2b^2)$	/2/	88
1.1.3. $(2x-\frac{1}{4})^2$	/3/	43
1.1.4. $(5a+2)(25x^2-10a+4)$	/2/	75
1.1.5. $x(3x+3)-3(x-1)(x+2)$	/4/	44
2.1. Factorize completely:		64
2.1.2. $25-36x^2$	/2/	
2.1.3. $(x-2y)-ax+2ay$	/3/	53
2.1.4. x^3-2x^2+x	/3/	26
2.1.5. $24x^3y-648y$	/3/	20
Total average %		49

The average for these specified topics for March 2015 is 47%, while that for June 2015 is 49% – an increase of 2%. During interviews, when asked whether they studied the same for tests and examinations responses from learners were “Yes. Exactly the same.” Where some replied that they studied the same, another learner gave this response: “I will give more when

writing exams." This learner makes reference to the notion of "give(ing) more" when writing examinations. Although the results do reflect the learner "give[ing] more", the amount of work covered in the June examination is much more than that covered in the March test.

4.9. Conclusion

In conclusion the data shows that learners did revision, repetition of questions and refreshed their memories as study methods before the intervention sessions. Many learners also applied the study skills of planning and time management while studying. Although, there is evidence of learners who did not apply these skills prior to intervention, they admitted to changing the way they studied mathematics. A brief summary of the major findings that emanated from the analysis of the three data sources follows.

Whereas other learners admitted to having studied mathematics before the intervention by practising questions, they felt no need for the study guide. Practising is thus still the only method of studying for some learners. Learners confirmed that the questions they had to do in their journals help them to understand, improve and remember their work better.

"Refreshing their memory" was conceived of by learners as a study skill – when looking in their books and also when practising mathematics. Whereas learners practised and refreshed their memories before intervention, learners stated that they **"looked at previous work done"** after intervention. In other words, learners changed their way of studying mathematics from "just paging through" to "looking at previous work done". The amount of time spent doing mathematics depended on chores, homework and the amount of other exercise they had to do. **Time management** skills were applied by a few learners before intervention while others admitted to not spending enough time with their work and not managing their time well. After intervention learners changed the way they managed their time. They made mention of **planning** their work and having a study time table, while there were those who admitted to not having had one before intervention.

Learners also attested that the study guide helped them to manage their time better, **organize** their work and to study more. Previously learners had felt they were disorganized and their huge amounts of work were a mess and unfinished. After intervention they felt that everything fell into place. Being more organized assisted learners to understand their work better.

Evidence revealed that although some of the learners had an existing study time table, others

continued to not make use of one. Planning their work for some learners was thus non-existent. This corresponds with the notion of **inconsistency** in studying mathematics. Time management and consistency in mathematics are study skills which assist learners to become effective 'studiers'. In the next chapter the findings and recommendations for further studies will be discussed.

Chapter 5

Findings, recommendations and conclusion

5.1. Introduction

The purpose of the research was to determine how learners applied a study skills module in grade 10 mathematics class. A case study was used to investigate how learners applied a study skills guide during the teaching of mathematics. The question is whether the learners in a grade 10 mathematics class applied study skills guide regularly and effectively. Furthermore, the aim was to ascertain whether learners apply all study skills in conjunction with one another or in isolation.

Research indicates that ineffective study skills generally become evident after primary school – amongst teenagers and older learners – due to the need for increased self-regulating textbook study during these years (Gettinger & Seibert, 2002). In other words learners in high school are required to use their textbooks for study purposes more, and therefore require effective study skills to accomplish this. In the foregoing chapter discussions concerns findings as these relate to the aforementioned research questions. Associated recommendations for future research and implications are also deliberated upon in this chapter.

5.2. How learners applied the study skills module

Applying and acquiring study skills constitutes studying as defined by Gettinger and Seibert (2002). The study skills guide gave learners the insight into different ways in which to study mathematics by applying study skills effectively. The researcher guided learners in how to go about these applications. The study guide emphasized doing spiral revision of previously completed topics and it was expected that learners would buy into this idea. However, the data showed that learners were disadvantaged in doing spiral revision due to chores, extra-mural activities and homework – before they could study mathematics. Another factor that hampered studying mathematics was perceiving doing homework as studying. Reference was also made to the difficulty experienced in remembering the mathematics methods. Arguably this indicates that learners did not study mathematics consistently; a consistent study program has positive results (Gettinger & Seibert, 2002). Also, the general response in questionnaires after intervention was considered to involve spending more time with their work and gaining a better understanding. However, evidence in journals showed that many learners did not attempt any questions or only did a few questions during the six week intervention period. Also, a number of learners forgot their journals at home, which made the session challenging

for the researcher. This also meant that these learners did not do any of the questions in their journals on those days. Omitting questions also occurred as learners either did not attempt questions or preferred to do other questions. As an experienced educator, I have come across similar situations many times. My experience of learners being inconsistent and disorganized is also borne out of these situations. This has cautioned me to be unbiased during the research.

These lifelong study skills of time management, consistency, practising, organizing and feedback are there to assist learners after school as well. The evidence shows that learners do not apply all the mathematics study skills effectively and consistently together. They either apply a skill selectively or inconsistently or fail to apply any skills and continue to study as they previously did. This finding is shared by previous research; it is noted for its negative effect on academic competence.

5.2.1. Learners utilized looking back

Looking back at previous work done was a study skill utilized by learners to study mathematics. When learners got stuck while doing questions, they looked in their textbooks, practice exercise books and classwork books. Gettinger and Seibert (2002) put forth that low academic achievers do not show any evidence of employing "looking back" strategies when they encounter problems (p. 352). Weinstein (1999) and Kiewra (2002) suggest that learners look back or review their work. Gubbels (1999, as cited in Kiewra, 2002) reported that students review their work through "rehearsal-type strategies, such as repeating or rewriting information verbatim (p. 75). Evidence indicates that looking through the days' work, doing homework and practising are considered as "review[ing]" by learners (Kiewra, 2002, p. 75). However, Craik and Watkins (1973, as cited in Kiewra, 2002) and Gettinger and Seibert (2002) argue that studying employing rehearsal skills are ineffective. This is because little content is "processed" and therefore such practice is especially not effective for learners in high school, being more suitable for learners in primary school when memorizing multiplication tables (Gettinger & Seibert, 2002, p. 355). Mayer (1984, 1996) noted that learners should "relate "to what they are learning (as cited in Kiewra, 2002, p.75). It is therefore essential that learners think about what and how they are studying. As evidence from narratives revealed learners changed how they studied; they began thinking about how to remember and apply the mathematics study skills.

5.3. Practicing of and training in study skills

The grade 10 mathematics study skills guide was constructed for these learners as it covered

the mathematics topics they had already completed in the first quarter. Evidence suggested that certain learners practised mathematics by doing homework; others only used practice questions in their books and admitted to not needing additional study skills. Learners viewed practice as repetition of questions previously done. They felt they made progress, even those who did not practise consistently. There were those who admitted to not doing anything and one who admitted to not liking mathematics. The high-stakes assessments, however, revealed an increase of 2% in the average scores from March to June 2015. Learners had to be trained within six weeks, which is six days only, to master the study skills. This may also be the reason why only 17 learners chose to hand in their journals – the time was not sufficient for learners to practise and learn how to study mathematics.

This case study aimed at identifying how learners studied mathematics; it was intended to assist educators as well as learners. For training learners to apply the study skills daily the time was insufficient; more time is needed to practise these skills. However as previously discussed, making learners aware of these skills is a notion which is as important as teaching subject content. Evidence from questionnaires also indicated that not all the learners practiced these study skills. Evidence however, indicated that some learners admitted to changing the way they studied mathematics.

Evidence from the study shows that learners lack effective study skills and the skills that some learners do possess are applied in isolation. Also, the fact that only 17 learners' journals were handed in and many learners confessed to not doing any work indicates that learners are not motivated to study. Before the intervention, learners relied on revision in the form of repetition and refreshing their memories. The purpose of the intervention was not only to discover how learners apply study skills, but to enhance study skills. Evidence from data did reveal that learners understood and remembered mathematics better. Also, evidence indicated that the mathematics study guide helped learners to remember formulae more easily. This is a particular aspect of mathematics that learners continually struggle with – remembering where and how to apply formulas.

Evidence also indicates that learners' changed the way they did mathematics; where they studied more and spent more time doing mathematics. Other behaviours that changed involved their managing and regulating their time when doing mathematics. Evidence suggests an increased awareness and better application of time management, although some learners had already possessed this skill. Learners' organization skills were improved as

evidence revealed from narratives, responses in journals and questionnaires. Only the learners' accounts could be accepted as truthful, since they were instructed to be honest and candid in their responses to questions.

When learners got stuck while doing questions they referred to previous work in their books. Not only did learners apply the review skill, but they gave feedback to themselves on their progress. Learners were able to gauge their progress through feedback from self, peers and the teacher researcher. During intervention lessons feedback was given after learners had completed two or three questions. Further explanations were given and errors made by learners were illustrated and highlighted. The notion of Shute (2008) concerning feedback is arguably present in many aspects of the research. The learners received feedback from the researcher in the form of directive feedback.

Eaton and Bell (2006) report that when teachers correct responses and give feedback this enables teachers to allow learners to advance in their thinking. Hagedorn, Sagher and Siadat (2000) provided certain component in their research and the outcomes; one component was feedback which enabled learners "to learn from their mistakes" (p.141). Shute (2008) defines directive feedback as that information provided to learners to rectify or revise information where necessary. Directive feedback was provided verbally during teaching and formative feedback in written form in learner's journals. Formative feedback as Shute (2008) suggests, is less specific and provides learners with "comments and suggestions" as a guide to their "revision and conceptualization" (p. 157). In this context I would therefore argue that the prompts and examples in the mathematics study guide also constitute formative feedback – while also providing alternative skills to study mathematics effectively (Hattie & Timperley, 2007).

The aim was not only to teach the mathematics content, but to illustrate how learners should review their own errors. In a similar intervention in the CAME Project, the aim was to improve learners' cognitive development so that they would "(approach) their mathematics learning in a reflective" manner (Eaton & Bell, 2006, p. 2). Omitting factorization was also evident from journals. This question in the June Examination 2015 indicated the lowest average of all the questions analysed – 20%. Question 2.1.5. $24x^3y - 648y$ with a mark allocation of 3. Doing mathematics consistently was evident from a few learners, while there was still inconsistency in others who crammed the night before examinations. Some however, put more effort into High-stakes assessments. Then there were also those who studied as

before and did not change their behaviour as they felt they had no need to. Thinking skills according to Gettinger and Seibert (2002) are needed to assist learners to participate in suitable thinking appropriately about information required to study. Gettinger and Seibert (2002) further elaborate that studying is improved when information is meaningful and connected to present information.

Resources such as textbooks, a practice book and classwork book were used by a few learners to do revision and review previous work done. Question papers from previous examinations were not used as a mathematics resource. As a result exposure to different types of mathematics questions was limited. Previous question papers acquaint learners with numerous types of questions in mathematics topics.

This research consisted of teaching and learning how to learn. The teacher researcher clearly indicated the lesson outcomes on the chalkboard. The goal was that learners clearly understand what was expected of them and what was being done during that time. During the first weeks spiral revision of previous work was done in the first ten minutes of the period. The latter part of the intervention sessions were designed around timed sessions of ten minutes at the start of each period. Timing learners to do questions gave them opportunities to practise their mathematical knowledge and to prepare for tests and examinations. Learners are able to assess their progress during these timed sessions. Many learners tend to become anxious and practising assisted learners to gauge their time while doing questions and reviewing their work. Furthermore, learners become more at ease in these timed sessions with more practice.

5.4. Recommendations for further research

The classroom intervention lasted 6 weeks and was done from 14 April to 19 May 2015. In South Africa we have a few public holidays in April and May and learners were therefore on break on these days. The intervention sessions consisted of one lesson per week of 30 minutes. In total the amount of time spent infusing study skills in the grade 10 mathematics class was three hours. The time allotted to the mathematics lessons infusing study skills should be lengthened and ideally should be done on a regular basis so that learners may practise the mathematics study skills effectively together (Stensvold & Wilson, 1990, as cited in Gettinger & Seibert, 2002). The greater the amount of time learners are exposed to the study skills the greater the academic competency, as research literature indicates. I would also suggest that learners supply their own questions in order that they would become more

involved in their own learning as suggested in the CAME (Eaton & Bell, 2006) Project. Alternatively the subject teacher should be trained to teach learners the application of study skills in class. When the teacher is more involved in the application of the study skills the chances are better of continued application and training. Training teachers would be beneficial to both the teacher and the learner. The teacher should if at all possible take more time to give feedback to learners. This poses a challenge in practice where the teaching and learning context involves forty learners; lessons therefore have to be well planned and organized to give feedback to learners effectively. Research indicates that instructing small groups is recommended in order to provide effective feedback to learners. This requires more time from teachers which is problematic. Teachers already struggle to complete the mathematics content as set out by the Department of Basic Education. If well-planned learning materials and study guides are supplied readily to educators it would make teaching and learning easier.

The Grade 10 mathematics study guide should be revised and adapted to all the topics in the curriculum. Algebra, geometry, graphs, analytical geometry, trigonometry, data and probability are the sections in which the study guides should be divided into. This format would also assist learners to organize their work into smaller chunks– making studying easier as research indicates. Learners would also get sufficient time to practise the mathematics study skills, while the teachers would be able to provide instruction.

If the six-week intervention yielded an average increase of 2%, then an intervention during a school year would be much higher. Learners who require 2% in order to progress would then benefit from these interventions. Preferably teaching should infuse all the mathematics study skills as well as the spiral revision of ten minutes which takes place at the start of a lesson. Research show that previously, cognitive study skills were taught separately, but recently the emphasis has shifted to entrenching these skills in specific contexts (Hattie, Biggs & Purdie, 1996). Study skills instruction should be illustrated when doing different tasks and topics. Lessons should indicate the specific outcomes of the lessons as well as the critical outcomes. Learners should be able to understand clearly what is expected of them and the goal that is to be achieved. The teaching and learning environments, the classrooms, should be conducive to study skills instruction. These teaching programs should also start gradually and in primary school. This would ensure that when learners reach high school they are more effective ‘studiers’. Infusing study skills while teaching mathematics would need motivation and consensus from both teacher and learner. Learning can only occur when both parties are

willing to participate.

Further research in schools, universities and tertiary institutions is needed. Mathematics is a subject which is challenging to many learners and one in which many do not excel. Since mathematics is considered a gateway subject there is a great need to improve performance in mathematics in South Africa. The economic climate and high unemployment further necessitates that there are graduates in fields of engineering, finance, medicine and the sciences. Training mathematics student teachers is needed to ensure that the next generation of learners becomes more effective 'studiers'. Also, training student teachers effective mathematics study skills would assist them in their own studies.

Research projects such as CAME and LEDIMTALI could train facilitators and adopt the top-down principle. Dividing regions into areas and thereby making a facilitator responsible to do training at schools in each area. Smaller training groups should meet with others and share ideas and find solutions to problems experienced. However, if the Grade 10 mathematics study guide can be improved on, this could be shared with the education department. The mathematics study guide can also be adapted to other grades. Professional development of teachers would be advantageous to both teachers and learners. Resources such as lessons, notes, training videos, and other forms of support would assist teachers in the teaching and training of mathematics study skills.

The teacher researcher should involve the parents and guardians in encouraging and motivating learners to study mathematics. Motivating learners and gaining support from parents are considered by Gettinger and Seibert (2002) to enhance academic performance through effective study skills. Hattie and Timperley (2007) make reference to feedback as the encouragement from parents. The "agent" being the parent and the encouragement or "corrective information" provided is argued as feedback (Hattie & Timperley, 2007, p. 81).

Shute (2008) argues that feedback is the "information communicated to the learner that is intended to modify his or her thinking or behaviour for the purpose of improving learning." (p. 154). Azevedo and Bernard (1995), Bangert- Drowns, Kulik, Kulik and Morgan (1991), and others (cited in Shute, 2008) view feedback as vital for skills acquisition and improving knowledge. Furthermore, feedback is described as a motivating factor for learners.

In a study conducted in Northern Ireland in 1993, that is, the CAME Project, the goal was to speed up the cognitive development of learners in their first two years of high school (Shayer

&Adhami, 2006). In that mathematics intervention learners received instruction for approximately half an hour every second week (Eaton & Bell, 2006), while in this study learners received instruction for about half an hour once a week for the duration of six weeks. The CAME Project suggests an intervention that spans a period of two years (Eaton & Bell, 2006). Whereas the CAME lesson characteristically applied group work this intervention employed a study guide and was thus individualistic in nature. However, learners in this study naturally interacted with their peers and asked for assistance from them when they got stuck as the evidence indicates. The CAME project emphasized the "thinking process and the sharing of ideas rather than the specific knowledge or skills themselves" (Eaton & Bell, 2006, p.3). By contrast this study focused on teaching learners how to study mathematics; it incorporated content, study skills and procedures in mathematics. CAME teachers gave learners problem-solving type questions, while this study focused on topics which had already been completed previously. The CAME study showed that learners did not have exceptionally improved scores in the high-stakes English General Certificate of Secondary Education (GCSE) examination.

I therefore recommend a one lesson-a-week engagement with a mathematics study guide containing topics related to previous done work as well as higher level questions. The format of the intervention lessons done in this study should be started from the beginning of the year. These study guides should incorporate all topics of mathematics as set out by the Department of Education as well as the study skills. Additionally the questions – together with higher level questions – should be added to the study guide. This would enable learners of different levels to work at their own pace while studying mathematics.

5.5. Conclusion

Mathematics study skills in South Africa are generally unknown and not well researched. It is my opinion that a lot more research be done in this area. This case study specifically applied mathematics study skills in Algebra topics. Further research should be done on geometry and trigonometry. Research indicates a greater success with interventions which affect behaviour when compared with those which affected performance. Also, this study showed a greater effect on study skills application than on performance. Although ultimately teaching and learning is aimed at specifically increased performance, effectively improving the way learners study is as important for long-term purposes. Research shows greater success ininterventions in which numerous skills were applied rather than only a single skill.

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Acronyms

CAME- Cognitive Acceleration in Mathematics Education

CAPS- Curriculum and Assessment Policy Statement

DBE – Department of Basic Education

FET- Further Education and Training

GET- General Education and Training

LEDIMTALI- Local Evidence Driven Improvement Mathematics Teaching and Learning Initiative

NSC-National Senior Certificate

UNESCO- United Nations Education, Science and Cultural Organisation

WCED- Western Cape Education Department

Appendices

Appendix 1a: Consent from parent/guardian

5 January 2015

Letter of Consent

Dear Parent/ Guardian

I am currently busy with my Master's degree at the University of the Western Cape, Department of Science and Mathematics Education. My topic is: A case study of how Grade 10 learners apply a study skills module in a mathematics class. The focus of the study is to infuse study skills in mathematics lessons as an intervention.

The consent form herewith asks for your permission for (learner Name and Surname)……. to complete the questionnaire, journal and to be part of the interview process. This will support me with the data collection process for the study. **All information will be anonymous and no names will be mentioned in any reports or discussion documents.**

Should you give permission for your child to take part in this research, I will have the opportunity to ask questions related to this study. He/She may refuse to answer any questions that you are not comfortable with.

You will be aware that this interview might result in research which may be published, but your name will **not** be used.

Date: ……

Parent/Guardian Name:……

Parent/Guardian Signature:……

Researcher/Interviewer Name: Ms. F. Arnold……

Researcher/ Interviewer Signature:…

If you have any questions concerning this research, free to call Ms. F. Arnold at (021) 9592229, or my supervisor, Prof. C. Julie at (021) 9592861 or Prof. M. Mbekwa at (021) 9592957

Appendix 1b: Consent from participant

Letter of Consent
Dear Participant

Project details and information

I am currently busy with my Masters research at the University of the Western Cape, Faculty of Education. **My topic is: A case study of how learners apply a study skills module in a Grade 10 Mathematics class**.

The aim of the study is: to teach a study skills module in topics of the mathematics curriculum. Data will be gathered by means of a semi-structured questionnaire and journals administered to a sample of 35 respondents. In addition, data will be gathered from journals as well as from semi-structured focus group interviews with learners.

Consent

Should you agree to take part in this research, you will be asked to sign this letter of consent. Two copies are required, one for our records and one for your records.

You will be aware that data collected during this research might result in research which may be published, but your name will **not** be used.

You may also refuse to answer any questions that you are not comfortable with.

You may withdraw from this study at any time.

Date: ……

Participant Name: ……

Participant Signature: ……

Researcher Name: ……..

Researcher Signature: ……

If you have any questions concerning this research, free to contact call Ms F. Arnold at (021) 9592229 or my supervisor, Prof C. Julie at (021) 9592861.

Appendix 1c: Consent from principal and SGB

5 January 2015

Letter of Consent

Dear Principal and Members of the SGB

I am currently busy with my Master's degree at the University of the Western Cape, Department of Science and Mathematics Education. My topic is: A case study of how Grade 10 learners apply a study skills module in a mathematics class. The focus of the study is to infuse study skills in mathematics lessons as an intervention.

The consent form herewith asks for your permission of learner to complete the questionnaire, journal and to be part of the interview process. This will support me with the data collection process for the study. **All information will be anonymous and no names will be mentioned in any reports or discussion documents.**

Should you give permission for learner to take part in this research, I will have the opportunity to ask questions related to this study. He/She may refuse to answer any questions that you are not comfortable with.

You will be aware that this interview might result in research which may be published, but your name will **not** be used.

Date: ……

Principal Name:……

Principal Signature:……

SGB Member Name…….. Signature……..

SGB Member Name……Signature……

Researcher/Interviewer Name:……..

Researcher/ Interviewer Signature: ……

If you have any questions concerning this research, free to call Ms. F. Arnold at (021) 9592229, or my supervisor, Prof. C. Julie at (021) 9592861 or Prof. M. Mbekwa at (021) 9592957

Appendix 2a: Study guide

WISKUNDE STUDIE GIDS

Graad 10

Practice makes perfect

In hierdie gids sal jy leer om:

*Wiskunde gereeld te beplan;
*tyd effektief te gebruik;
*konstant en gereeld te studeer;
* effektief te studeer deur gereeld oor vorige werk te gaan en so probleme te kan reg maak.

1 Gereelde oefen

"Practice makes perfect". As jy sukses wil behaal in wiskunde het jy soveel moonlik oefening nodig, en op'n gereelde basis.

- ❖ Skryf in jou joernaal hoe jy wiskunde oefen. Skryf 'n volle verduideliking om te wys wat jy doen.

Daar is baie sukses stories wat almal wys dat harde werk en toewyding aanleiding gee tot sukses.

'n Goeie manier om 'n wiskunde probleem op te los, soos die vergelyking $4^{2x} \times 8^{x-1} = 32$ is deur die volgende stappe te volg:

Stap 1: lees die probleem en verstaan wat gevra word (verstaan jy die terme?).

Stap 2: lees deur elke stap wat jou onderwyser as voorbeeld gedoen het of verwys na jou handboek.

Stap 3: doen self die probleem sodat jy beter kan verstaan.

Stap 4: verduidelik die probleem of 'n soortgelyke probleem hardop. Vra jouself hoekom jy elke stap doen soos jy aanhou met oefen. Maak gebruik van vrae soos wat, waneer en hoekom tipe vrae.

Waneer jy probleme soveel as moontlik oefen, dan sal jy later dit op jou gemak kan doen. Op dieselfde manier het Usain Bolt die 4 X 100m aflos met sy spanmaats so moeiteloos gehardloop. Hy oefen vir lang ure elke dag. Die Jamaika span het die aflos gewen en 'n nuwe wereld record opgeteken. Daar is 'n negatiewe sy omtrent hierdie storie ook. Toe hy nie gereeld geoefen het nie, het Usain Bolt tydens 'n byeenkoms verloor.

Die vraag wat jy aan jouself moet vra is, wat wil jy bereik en so doelwitte vir jouself stel. Skryf neer jou doelwitte en plak dit waar jy dit kan sien, soos jou dagboek.

❖ Skryf in jou joernaal jou doelwitte vir wiskunde.

2 Bestuur jou tyd reg

Besluit reeds vroeg in die jaar hoe jy jou tyd wil spandeer deur'n daalikse, weeklikse en 'n kwartaallikse program op te stel. Op hierdie manier sal jy verseker wees dat al jou werk op tyd sal klaar wees en verhoed dat jy 'n klomp werk die aand voor die eksamen probeer in prop. Deur te veel werk te wil in prop, plaas jy groot druk op jouself en mag lei daartoe dat jy vergeet of "blank" word. Die regte Bestuur van jou tyd is 'n algemene kenmerk van suksesvolle mense. Die bekende Mark Shuttleworth, J.P. Duminy, Messi, Siya Kolisi en talle ander sit 1000de ure harde werk in om die sukses te bereik. Kan jy van nog 'n paar bekende mense dink, wat suksesvol is met wat hulle doen? Die regte bestuur van jou tyd en harde werk is altyd 'n goeie resep vir sukses. Hier onder is 'n voorbeeld van hoe jy jou eie studie rooster kan op trek om jou tyd effektief te bestuur.

Maandag	17:00-18:00			
Dinsdag	15:00-16.30 Rugby	17:15-19:00		
Woensdag		Godsdienstige aktiwiteit	19:30-20:30	
Woensdag		Godsdienstige aktiwiteit	19:30-20:30	
Donderdag		Rugby		21:00-22:00
Vrydag	21:00-22:00			
Saterdag	10:00-12:00			
Sondag		18:15-19:15 Hersien	19:30-20:30 Eksamen oefeninge	

❖ Skryf in jou joernaal jou eie studie rooster. Sluit jou buite-muurse aktiwiteite. Verduidelik ook die beste manier (e) om jou studie tyd te bestuur.

‘n Goeie idee sal wees om to een dag in ‘n week te gebruik waneer jy hersiening doen van al die werk wat vir die week gedoen was.

Op hierdie manier sal jy beter meer werk kan onthou, en jy sal kan identifiseer waar jy vashaak en probleme ondervind. Sodra jy die probleem areas identifiseer het, kan jy maniere vind om dit beter te verstaan.

- ❖ Wat doen jy waneer jy vas haak met ‘n probleem? Skryf in jou joernaal.

3. **Oorsig van werk alreeds gedoen**

Slegs ‘n week nadat ons werk gedoen het, vind ons dat ons vergeet! Hoe kan jy verseker dat jy onthou? Die gereelde oorsig van die week se werk sal verseker dat jy meer sal onthou. Kom ons kyk na die volgende as **voorbeeld:**

Maandag: die volgende werk was gedoen in klas -definieer die trigonometriese verhoudings sin ø, deur gebruik te maak van reghoekige driehoeke.

Inleiding van die teorie van Pythagoras (oorsig van Graad 8).

Oorsig van die optelling en aftrekking van kwadrate.

Dinsdag: Definieer die trigonometriese verhoudings cos ø en tan ø, deur gebruik te maak van reghoekige driehoeke.

Oorsig van werk gedoen op Maandag.

Woensdag: Oorsig van werk gedoen vanaf Maandag en Dinsdag kortliks en let op waar jy meer aandag nodig het. Die makliker tipe eksamen vrae kan ook nou gedoen word. Op hierdie manier verseker jy dat jy gereeld met eksamen vrae oefeninge kry.

Donderdag: Gebruik hierdie dag om soveel moontlik jou probleme wat jy ondervind met die wiskunde uit te stryk.

Vrydag: Toets dag- op hierdie dag werk jy eksamen tipe vrae uit en jy kan selfs jou eie vrae op stel om jou vordering te peil.

- ❖ Dit is slegs een manier hoe om dit te doen. Skryf neer **jou** eie manier. Dui aan waar jy op jou studie vaardighede en die beplanning van jou week kan verbeter.

- ❖ Skryf neer 2 van jou eie voorbeelde van ‘n som wat jy in die klas gedoen het in jou joernaal om te wys hoe jy dit verstaan.(die voorbeelde moet jy self uit dink)
- ❖ Jou eerste kontrole toets is in Maart. Kyk op die kalender en tel hoeveel dae het jy voor jy jou toets skryf. Doen dieselfde met jou Junie eksamen.

❖ Hoe sal jy jou voorberei vir die Maart Kontrole toets?

Appendix 2b: Blits hersieng Gr. 10/1

Blits hersiening Graad 10/1

Algebraiese uitdrukkings- Produkte, faktore en breuke

1. Stel A	Stel B	**Stel C**
1. Bereken: 1.1. $(x+3)(x+5)$ 1.2. $(x+4y)(x-2)$ 1.3. $(x-8)(x+3z)$ 1.4. $(xy-5)(xy-6)$ 1.5. $(x+2y)(x+3x)$ 1.6. $(xy-2)(xy+3z)$ 1.7. $(2x+5y)(4x+3y)$ 1.8. $(5z-6m)(10z-3m)$ 1.9. $3(x+y)$ 1.10.-2(8a – 4b) 2. Bereken; 2.1. $(x-2)(x^2+4y)$ 2.2. $(x+y)^2$ 2.3.$(2x-y)(3x-y^2)$ 2.4. $(5m^2+2n^2)(3m-10)$ 2.5. $(\frac{1}{2}x+\frac{1}{3}x)^2$ 2.6.$\left(\frac{2}{3}y-9x\right)(\frac{2}{3}y+9x)$ 2.7. $\left(\frac{2}{x}+x\right)\left(\frac{3}{x}-x\right)$ 2.8.$(y-\frac{2}{3})(y+\frac{2}{3})$ 2.9. $(2+y)^2$ 2.10. $\left(m+\frac{1}{m}\right)(m^2-1+\frac{1}{m^2})$ 2.11. $(3x+6)(2x^2-x-3)$ 2.12. $(a+b)(a-b)^2$ 2.13. $-5(x+y)(2x+y)$	3. Faktoriseer: 3.1. 20m – 5n + 10 3.2. $(9x^2-25y^2)$ 3.3. $x^2-10x+25$ 3.4. $a^2-6+\frac{9}{a^2}$ 3.5. x^5-x^4-x+1 3.6. a^3+b^3 3.7. $3p^2+15p-108$ 3.8. $x^2+13+\frac{30}{x^2}$ 3.9. $x(a-b)+y(b-a)$ 3.10. $20p^2q+62pq^2-28q^3$ 3.11. $3m^2-5m-2$ 3.12. $\frac{3}{4}-3p^2$	4. Vereenvoudig: 4.1. $\frac{6x^2+9x}{3x}$ 4.2. $\frac{2m}{3n}-\frac{2m^2-3n^2}{6mn}+\frac{3m}{4n}$ 4.3. $\frac{3a^3(2q-3)^2}{6b^6(3-2q)^2}$ 4.4. $\frac{1-y^2}{1-y^3}$ 4.5. $\frac{x^2-2x}{x^2-1}\div\frac{x^2-3x+2}{x^2-xy-2y^2}$ 4.6. $\frac{p^2-2p-3}{p^2-p-2}\times\frac{p-2}{p-3}$ 4.7. $\frac{m}{3}+\frac{3}{4}$ 4.8. $\frac{b}{3}-\frac{2}{b}-\frac{b-4}{2b}$ 4.9. $\frac{1}{x^2-2x+1}-\frac{2}{x-1}$ 4.10. $\frac{a-2}{a+1}+\frac{3}{a^2+2a+1}$

Appendix 3a: Questionnaire

Let Wel: Deelnemers se' identiteite sal anoniem bly. Voltooi alle informasie hier onder:						
Ouderdom:		**Geslag (✓):**	M	V	Vorige graad geslaag :	Naam en Van:

1. Maak 'n lys van probleme wat jy ondervind, indien wel, as jy wiskunde studeer.

Probleme	**Wie help jou met die probleme?**

2. Hoe het jy wiskunde studeer voor jy die studie gids gebruik het en met die studie gids.

Voor studie gids	**Met studie gids**

3. Bestuur jou tyd

3.1. Ek spandeer genoeg tyd met wiskunde.

Ja	Nee

3.2. Die beste tyd waneer ek studeer is die aand voor die eksamen of toets. Ek gebruik hierdie tyd die beste om te studeer.

Altyd	Somtyds	Nooit

3.3. Ek begin reeds lang vooraf met my voorbereiding vir die eksamen.

Altyd	Somtyds	Nooit

4. Beplanning

4.1. Voordat ek begin studeer beplan ek *wat* en *hoeveel* werk ek gaan doen:

Altyd	Somtyds	Nooit

4.2. Ek volg ‘n skedule / program elke dag as ek wiskunde studeer.

Altyd	Somtyds	Nooit

5. Hersien

5.1.Waneer ek studeer, maak ek self opsommings van al die wiskunde wette en formules.

Altyd	Somtyds	Nooit

5.2. Ek hersien en korregeer my foute gereeld in my skryfboek.

Altyd	Somtyds	Nooit

6. Gereelde studie

6.1. Hoe gereeld studeer jy wiskunde? Die aantal tyd wat ek spandeer is:

Net een keer per week	Meer as 1 uur. elke dag	1 uur elke dag	30min.elke dag	Net voor ‘n toets of eksamen	Nooit

6.2. Ek is oortuig daarvan dat as ek elke dag wiskunde studeer dan sal ek my doel bereik.

Ja		Nee	

6.3. Hoe voel jy het die studie gids jou gehelp? Verduidelik

7. Effectiewe studie

Beantwoord die volgende vrae:

7.1. Is daar ‘n verskil hoe jy jou voor berei vir ‘n eksamen en vir ‘n toets? Verduidelik.

7.2. Hoe het die twee vrae wat jy elke dag gedoen het, jou gehelp?

7.3. Wat doen jy waneer jy vashaak met ‘n probleem(som)?Verduidelik

7.5. Wat dink jy omtrent die Dinsdag periodes?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Datum: …….. Handtekening:……

Student Navorser: Me. F. Arnold

Appendix 3b: Intervention lessons

Intervention lessons

Lesson 14-04-2015

An in-depth discussion with learners followed relating to the mathematics study guide, journal and revision exercises. Participants were also informed that they would be visited on every Tuesdays until the end of May 2015. There were however times that I went on Thursdays as well. These revision questions are based on the analyses of the March tests of 5 learners who had been interviewed, two being absent at the time of writing the test. The reason I chose these learners was in order to learn whether what was said during the interviews could be confirmed or rejected. The teacher informed me that the learners were struggling with exponential equations at that time. I then proceeded to explain questions 1 and 2 on page 53 in their textbooks. These are the questions, of which I chose to do one with fractions and one question where the basis had to be similar. In this process I elaborated on the following as well: $\frac{1}{2} = 2^{-1}$; $\frac{1}{4} = 2^{-2}$, and vice versa: $3^{-1} = \frac{1}{3}$; $5^{-1} = \frac{1}{5}$; etc.

Also remember the prime numbers: 2, 3, 5, 7, etc.

This needed to be explained first.

a) $3^x = 9$

b) $\frac{1}{32} = 2^x$

Respondents were requested to do 30 minutes of extra work daily in their journals, recording the time. The first task they had to do was to set up a study timetable that was suited to their needs as prompted in the study guide. Thursday 16 April 2015 I returned to make certain that respondents understood was expected of them.

Participants were asked to do a minimum of two problems daily in their journals, noting the time at the beginning and end of each session. Participants were also instructed to study mathematics daily for a minimum of 30 minutes, excluding homework time. This notion of consistency and time management was exposed to participants in this manner.

During this intervention session I asked participants to refer back to their textbooks and notebooks when they got stuck with a question. Other prompts such: “What should I do now?” or “When do I apply the rule or procedure?” were used as illustration to self-questioning techniques. Kiewra’s (2002) notion of teaching learners to generate why-type

questions as a review strategy after lessons outperformed those who reviewed their work in the normal way by just reading notes. This notion of review was applied in this instance.

Lesson 16-04-2015

During this session I made my instructions clear and questioned learners about any problems they were experiencing. The study skill of reviewing previous work was reaffirmed. This gave me an opportunity to check a few journals and give feedback. Learners were now getting more practice with products, factorization and fractions. The few problems I picked up I intended to address in the next session, especially fractions. Learners were reminded about the two questions they had to do daily in 30 minutes, recording the time in their journals.

Lesson 21-04-2015

Three questions were done on the chalkboard from a different set (A, B or C) each. There were a number of learners who forgot their journals at home which made the session challenging. Spiral revision of work done during the first quarter was done within ten minutes at the beginning of the lesson. Spiral revision, which is "… the repeated practic (e) of work previously covered." (Julie, 2013, p. 93) was implemented in a few lessons during the intervention.

The following questions were done:

3.9. $x\,(a-b)+y\,(b-a)$

4.1. $\frac{6x^2+9x}{3x}$

4.2. $\frac{2m}{3n}-\frac{2m^2-3n^2}{6mn}+\frac{3m}{4n}$

Lesson 23/04/2015

I took this opportunity to speak to the learners and check on their progress and any problems they may be experiencing. Learners were also reminded about reading the study guide and completing the tasks daily.

Lesson 28/04/2015

The day after our public holiday, Freedom Day, and 6 learners were absent and only 4 journals were present for me to look at. We had a look at Set B, 2(vii). What happens if we change the + sign into a - in the following question: $a^2 + 6 + \frac{9}{a^2}$ into $a^2 - 6 + \frac{9}{a^2}$. Learners learnt to look back and review previous work done in their classwork books and textbooks. Most of them got the correct answer. Learners were reminded that their June examination was in only 28 days. Next they were given a task to do in their journals:

Write a paragraph about:

1) What do you do when you struggle with any question?
2) How does the study guide help you?
3) Explain how it helps you to do at least 2 questions every day for 30 minutes?

Lessons 5/05/2015

In this session I made use of charts which I pasted on the black board. On chart 1 the learning intentions were written on:

What am I learning today?

1) How to plan my time.
2) How to look back or review when I struggle with a question.

Chart 2

Rules:

1) You have a timed 10 minutes to complete your questions, with 2 minutes to write down the questions and 8 minutes to complete them.
2) Do your own work.
3) You may refer to your classwork book or textbook.

Questions:

Term 1: Products, Factorization and Exponents:

1. Simplify: $-a(a + 2) - 5(2a^2 - a + 3)$
2. Factorize completely: 2 - $8y^2$
3. Solve for x: $3^{x+1} = 81$

Learners were visibly anxious and eager as well to complete the task. Those who consulted their workbooks soon realised that time was running out fast. When time was up learners were visibly shocked and agitated.

I marked their work while the teacher carried on with his lesson. I gave feedback which was written in their journals next to errors made. The learners that regularly practiced their questions fared better than those who either have not done anything or only did a few.

Lesson 12/05/2015
In this session I repeated the process of the previous session with different questions, but also doing spiral revision of the first term's work.

The following questions were written on the charts and pasted on the chalk board:

Solve for x:

1. $2x^3 = 128$
2. $5(3 – x) + 2 = x + 7$
3. $2x^2 = 6x$

Lesson 19 /05/2015
The following question was pasted on the black board and I gave learners time to solve it:

Solve for x: $x^2 = 16$

I realised in the previous session that there were still learners who had not mastered that question, in other words question 3 from the previous lesson. I walked around and checked on learners asking them and probing why they used certain procedures. I then went on and illustrated 2 ways to solve the question. Learners wrote the answers in their journals or their class work books. Next I handed them a worksheet with algebraic equations.They were reminded to complete at least 2 questions daily and should have completed a minimum of 4 by Thursday when I would check their journals again. There are still learners who forget their journals at home and others who have not yet started on anything. Only a few learners achieved high marks (8/10) while the rest were all below 5.

These timed sessions were designed to illustrate time management during high stakes examinations and tests. The learning outcomes were clearly noted on the blackboard. Participants were allowed to "look back" in their classwork books and textbooks. This enabled participants to practice the skill of reviewing previous work done. This also gave me

an opportunity to establish any difficulties participants still experienced on the topics identified. Many participants had difficulty with finding the specific topics in their classwork books. Many participants were therefore not able to complete all the questions as they ran out of time. In a follow up session I illustrated how to organize their classwork books in order to speed up their search during review and other study sessions.

Lessons were also adapted to the situation as it unfolded. Feedback from learners concerning any difficulties they experienced while solving problems were addressed. The following is one example:

Simplify the following equation below. Learners had difficulty with fractions and factorization which confirmed learner's responses during the interviews.

2.8. $\left(y - \frac{2}{3}\right)(y + \frac{2}{3})$

I went on to illustrate that simplifying products are the opposite of factorization. I encouraged learners to do similar questions. Many learners struggled to multiply the fractions and I illustrated how to use their calculators in order to find the answers. Many learners did not own a scientific calculator in this class. Learners either borrowed calculators from their peers or looked at what their peers were doing.

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