IMPACT OF NATIONAL SENIOR CERTIFICATE EXAMINATION DIAGNOSTIC REPORT ON LEARNER PERFORMANCE IN MATHEMATICS

By

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DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation is my own work, and that all sources I have used have been indicated and acknowledged by means of complete references. It is further declared that this dissertation has not previously been submitted to any University for a degree.

Submitted By

Thabani Chihambakwe

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ABSTRACT

The study sought to determine whether the use of the National Senior Certificate Examination Diagnostic Report (NSCEDR) in an intervention programme would improve the performance of learners in Mathematics. The study utilised a mixed method approach. An action research that employed a quasi-experiment, one group, pre-test and post-test research design was used. A total of 74 grade twelve learners, 46 girls and 28 boys, were selected and participated in an intervention programme for six weeks. Three NSCEDR documents, from 2014 to 2016, were used to determine the topics that were challenging to learners in Mathematics, as well as the errors and misconceptions made by learners in examinations. The topics that were challenging were identified together with their frequency in the three documents. The marks of the learners before and after the intervention programme were compared and analysed. The Statistical Package of Social Sciences (SPSS) and Excel were used to analyse the research data.

The results of the study revealed that the use of the NSCEDR findings in the intervention programme improved the performance of the learners, while the impact was indifferent for boys and girls, and as well as for low performers and high performers. Trigonometry, Euclidean Geometry and Counting Principle were some of the most challenging topics in Grade 12 Mathematics that were identified from the NSCEDR. Based on these results, it was recommended that the NSCEDR should be readily available to all teachers to use, as their use in the classroom improved the performance of the learners.

ACRONYMS AND ABBREVIATIONS

TERM	DEFINITION
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
NSC	National Senior Certificate
NSCEDR	National Senior Certificate Examination Diagnostic report

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

ORIENTATION OF THE STUDY

1.1 Introduction

The performance of learners in Mathematics is a topical issue in most third world countries such as South Africa. Numerous efforts have been made each and every year at school, circuit, district, provincial and national levels to boost matric performance and pass rates in Mathematics. The National Senior Certificate Examination Diagnostic Report (NSCEDR) analysis documents have been used in an attempt to achieve this turnaround.

After the national examinations have been written and marked, the internal moderators and chief markers compile a diagnostic report on the general performance of learners on each question or sub-questions of the Mathematics examination, as well as highlighting some misconceptions and errors committed by the learners. The reports also give suggestions for improvement. The reports are aimed at equipping the teachers, schools, subject advisors and curriculum planners with information on where emphasis and caution must be observed in teaching and learning to improve the performance of the learners, as well as where refinements in teaching and learning must be done.

The analysis of post exams cannot improve the results of the previous year's group but can assist schools in rectifying teaching practice for the following group (Ratcliffe, 2013). The reports act as feedback of the national examination performance of the learners at matric level. Feedback has been found by many authors to have a positive effect on performance (Fyfe & Rittle-Johnson, 2016; Hattie & Timperley, 2007; Lipnevich & Smith, 2009a; Shute, 2007). It is in line with this that the researcher decided to investigate how the matric Mathematics students performed for the past three years, given the availability of the reports for the previous years to improve the feedback methods used by the subject teachers. The research focused on the impact of the NSCEDR on the performance of learners in Mathematics. The research also sought to determine the topics or aspects of a topic where students underperform so as to alert respective stakeholders to employ different methods to help with the conceptualisation of the topic or aspect of a topic.

With the current performance of learners in the South African national examinations in Mathematics, interventions and refinements need to be employed effectively to help improve the attainment of better results. The researcher, as a mathematics teacher, therefore decided to refine her teaching methods, and made use of the guidelines and strategies suggested in the NSCEDR in an intervention programme to establish the impact of the utilisation of the findings on learner performance and whether or not it affected the learners differently according to gender and performance level.

1.2 Background of the study

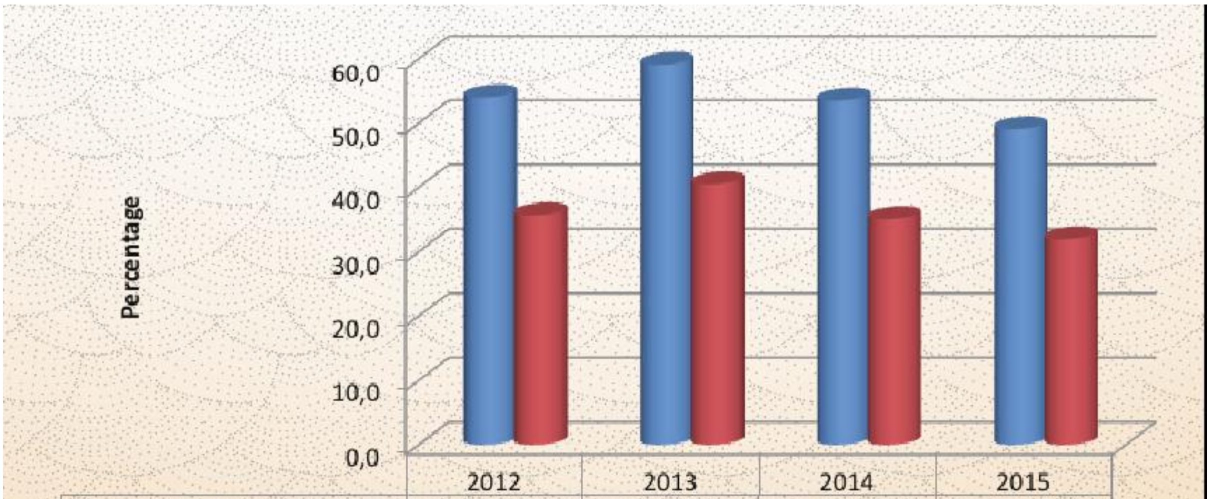
Feedback is crucial in improving one's performance in any learning area. A number of researchers have discovered that feedback affects the performance of a student positively to a greater extent than negatively depending on how the feedback is delivered (Kluger & DeNisi, 1996). There are three different sources of feedback which have both positive and negative effects on individual student's performance (Lipnevich & Smith, 2009a). These include computers, grades and praise as components of feedback.

The results of the National Senior Certificate (NSC) examinations in South Africa are evident of the impact of feedback on the students with reference to Mathematics. Although feedback is given by most stakeholders, like the examiners, subject advisors, the provincial advisors and teachers, through different means, the performance of the students in Mathematics remains very low. Diagnostic reports from the Department of Basic Education (DBE) are distributed each year to schools as feedback on the performance of students for the examinations that have been written. The reports address the misconceptions, errors, and performance of students, as well as giving some guidelines in order to correct misconceptions. This feedback is to be used by teachers to help learners who are to sit for their examinations at a later stage. An article by Ratcliffe (2013) argued that, although there are dedicated managers in schools, they may not have adequate training to analyse the results valuably, and identify the factors causing underperformance, hence the teachers have to use the examiner's report provided to redesign their teaching strategies. The results of an examination are an indication of whether efforts to improve the quality of education are working or not and to show where corrective measures are needed.

Feedback plays a crucial role in motivating learners' performance in any learning area. Many researchers (DeNisi & Kluger, 2000; Fyfe & Rittle-Johnson, 2016; Khachatryan, 2015; Kinzer, Bradley, & Morandi, 2013; Orrell, 2006) have examined how feedback improved the learner's performance when the feedback is directed to the learners' work, however none of the researchers has ever looked at the type of feedback where the information is not about the learner's work but other learners' work. In this case, the feedback is given as a guide to the teacher to use in preparing intervention programmes for the current and following groups of learners in order to support, improve, and correct possible errors and misconceptions based on their predecessor's work. This is possible since there is resemblance to the work done because the curriculum system is the same. The researcher believed that the type of feedback, if utilised fully, would yield very good results in Mathematics because it is not personal but rather general, and therefore, learners would most likely take heed of the feedback information, and use it to their benefit. DeNisi and Kluger (2000) found that interventions providing comparative information about past performances are more likely to yield better positive performances in learners.

The feedback provided by the DBE requires learners to engage with it and apply it in the future (Handley & Williams, 2011). This feedback is more of a facilitative kind of advice. Even if feedback is good, there is a huge gap between receiving it and acting on it by learners Evans (2013). This depended on how the learner perceives and uses it. In other words, feedback must be given in such a way that it motivates learners to see it as relevant, and hence motivate them to want to use it to improve in the subject.

There are different types of feedback, defined by what information is included in the commentary. Muralidharan and Sundararaman (2010) described three types of feedback that included directive, facilitative and feedback specific. Directive feedback indicates to the learner what needs to be corrected and applied. Facilitative feedback involves a report with comments and suggestions to guide the learner in his or her own revision and conceptualisation. This type of feedback is very useful in correcting inappropriate strategies, procedural errors, as well as misconceptions. Finally, feedback specific provides information about certain responses or behaviours over and above their accuracy (Muralidharan & Sundararaman, 2010). Thus, the feedback provided by the DBE is more facilitative than directive as it gives directions and suggestions on how the question could be handled. Researchers like Shute (2007) believe that learners learn best when their teachers give feedback in a facilitative manner, and the feedback is used to help the learners to come up with their own ideas and strategies to improve in the subject.



	2012	2013	2014	2015
% achieved at 30% and above	54,0	59,1	53,5	49,1
% achieved at 40% and above	35,7	40,5	35,1	31,9

Figure 1.1: Overall achievement rates in Mathematics NSCEDR 2015 (DBE, 2015)

In figure 1.1 above, it is clear that few learners are achieving above 30% in their Mathematics and this is a cause of concern given the low pass percentage and the percentage frequencies become much smaller as the cut off mark increases. Considering the minimum pass mark of 30%, according to the Curriculum and Assessment Policy Statement (CAPS) document from the Department of Basic Education (DBE), something has to be done to improve the performance of learners in Mathematics. Thus, the NSCEDR has been created to provide supportive strategies and to highlight misconceptions, which can be corrected through different interventions by the teachers, to help refine teaching methods and focus on improving the learners' performance in Mathematics. The researcher will focus on all the learners and will create remedial classes in small groups to establish if the NSCEDR will have an impact on their performance and hence improve the performance in Mathematics. The general performance of the learners in the final examinations and the concern of the researcher are clearly displayed by the figures 2.1 to 2.6 extracted from the 2014 to 2016 NSCEDR. Figures 2.1 to 2.6 show the average percentage performance per question and how the sample of learners performed per topic. The average performance in some of the topics leaves a lot to be desired. This information will help Mathematics teachers to focus more on the difficult topics, with whatever intervention necessary, to help improve the performance of the learners. Thus, with the information provided by the NSCEDR, a teacher should be able to redesign his/her teaching approaches, and use effective intervention programmes to improve the learners' performance. The researcher will make use of the NSCEDR to refine her teaching and schedule intervention and remedial programmes to establish the impact of the reports. While many researchers have discussed the importance of feedback in improving learner performance in different subjects, the researcher would like to focus on feedback from the NSCEDR and find out whether they will have an impact on learner performance.

1.3 Problem statement

The performance of matric learners in Mathematics in previous years is unacceptably low yet very important. With the help of an in-depth analysis of the performance of the learners in the previous three years since the introduction of the CAPS curriculum, the researcher wished to determine whether interventions, using feedback provided by DBE in the form of the NSCEDR, would impact positively or not on learner performance in Mathematics. This study attempted to address the following research questions:

1.3.1 Which topics, and aspects of a topic, are challenging to students?

1.3.2 To what extent does the use of the NSCEDR improve performance in Mathematics?

1.3.3 To what extent does the NSCEDR impact on low performers and high performers?

1.3.4 To what extent does the NSCEDR impact on gender?

1.4 Objectives

The research aimed to determine whether or not the findings of the NSCEDR, when implemented in an intervention programme would improve the performance of learners in Mathematics. The objectives that were set to assist in accomplishing the aims of the study were as follows:

1.4.1 To determine the topics and aspects of topics that are challenging to learners.

1.4.2 To establish the impact of the NSCEDR on learner performance by comparing marks obtained in Grade eleven final examinations with those obtained in Grade twelve September examinations.

1.4.3 To determine whether there is any difference in performance between low performers and high performers as a function of the NSCEDR.

1.4.4 To establish whether there is any gender difference in Mathematics performance as a function of the NSCEDR.

1.5 Hypotheses

A hypothesis is a calculated guess or assumption about the relationship between two or more variables that require to be examined. In this study the following hypotheses relative to the objectives of the study are:

1.5.1 There are some topics that are more challenging to learners.

1.5.2 The use of the NSCEDR in intervention programme impact positively on the performance of the learners.

1.5.3 There is no difference in performance of low performers and high performers as a function of the NSCEDR.

1.5.4 There is no difference in performance between boys and girls as a function of the NSCEDR.

1.6 Operational definition of terms

Impact

In this research, impact will refer to the differential performance of learners, with or without the effect of the NSCEDR implementation.

NSCEDR

NSCEDR is an abbreviation for National Senior Certificate Examination Diagnostic Report. It is an official document, produced by the Department of Basic Education, which contains an analysis of learner performance in 11 Grade 12 exit examination subjects, of which Mathematics is one of them. The analysis is done per subject, per paper, and per question and sub-question. The NSCEDR also highlights misconceptions and errors, and provides suggestions for remediation.

Matric

Matric is short for matriculation. In this study matric will be taken to mean the final year of high school or Grade 12 in South Africa.

1.7 Intended contribution to the body of knowledge

It is anticipated that the findings of this study would assist Mathematics teachers to value and use the NSCEDR to improve the learners' performance in matric examinations. The outlining of the most challenging topics and aspects is intended to give a wake-up call on teachers, curriculum developers and authors of Mathematics textbooks to reflect on the content and find better ways of improving comprehension of the topics and aspects. Very few countries produce documents like the NSCEDR, therefore the positive impact of the document especially in Mathematics performance could encourage other nations to produce similar documents for the betterment of the learners. Lastly the research will encourage teachers to be lifelong learners and researchers and keep improving their teaching strategies.

1.8 Research methodology

Research methodology is a systematics process of collecting, analysing and interpreting information to aid understanding of a phenomenon under study (Leedy & Ormrod, 2013). This research employed both quantitative and qualitative methods to collect and analyse data. An intervention programme using strategies and guidelines from the NSCEDR was administered to all the learners by the researcher to prepare the learners for the upcoming NSC examinations. Pre-test and post-test marks of learners were used to determine whether or not the intervention programme improved the performance of the learners hence determining the impact of the NSCEDR. The NSCEDR documents from 2014 to 2016 were used to evaluate its question by question analysis and comments, to determine the topics and aspects of the topics that were challenging to learners.

1.9 Paradigm

The research used pre-test and post-test achievement tests to establish the impact of the NSCEDR. The data were obtained through observation and measurement, hence this research was underpinned by the positivist theory of learning.

1.10 Research design

An action research employing a quasi-experiment one group pre-test post-test design was used. The quasi-experiment involving only one group of participants was used whereby each participant wrote two standardised tests, the pre-test and the post-test. A pre-test was written before the intervention programme. Figure 3.1 showed the outline of the research design used. An intervention programme was carried out to determine whether or not there was any change in performance of the learners by comparing the pre-test marks with the post-test marks after the intervention. The researcher focused only on Grade 12 learners for 2017 and the intervention programme was employed to all the learners in the sample.

1.11 Sampling design

The population for the study were the Grade 12 learners of 2017. Convenient sampling was used to select the school and the participants for the research. The choice of the sampling design was selected as this would enable the researcher to carry out the intervention programme without any inconveniences as well as enabling the gathering and analysis of data to be faster and cheaper. On the other hand, since the researcher was the one to carry out the intervention programme the choice of the sampling design was selected to avoid offsetting the running of the whole school. The sample consisted of 74 Grade 12 learners of which 28 were boys and 46 were girls.

1.12 Research instrument

The NSCEDR documents and Grade 12 marked scripts were used to identify challenging topics and the aspects of the topics. The standardised tests and marked scripts for Grade 11, 2016 end of year examinations, and for Grade 12 September 2017 examination were used. The validity of the standardised tests was assumed to be high given that the tests were set and moderated by experts in Mathematics from the KwaZulu-Natal Department of Education.

1.13 Analysis of data

1.13.1 A diagnostic analysis of the Grade 12 marked scripts and the question by question analysis of 2014-2016 NSC examinations were used to identify the challenging topics and aspects.

1.13.2 A correlation of the marks obtained in the grade 11 end of year examination (pre-test) to the Grade 12 September examinations (post-test) were used to determine the impact of the NSCEDR. A paired t-test was also used to establish whether the use of the NSCEDR improved the learners' performance in Mathematics and the direction of the impact. Summary statistics were used to summarise the scores obtained in the two tests.

1.13.3 An Independent t-test was used to determine if there was any differential impact of the NSCEDR on low performers and high performers.

1.13.4 A student t-test for independence was used to determine if there was any differential performance of learners as a function of the NSCEDR on gender.

1.14 Description of procedure

1.14.1 The NSCEDR were requested from the school principal, and other reports were downloaded from the Department of Basic Education website.

1.14.2 The analysis reports on the NSC Mathematics examinations as well as the diagnostic analysis of the September examination were used, and reports on the performance of learners on different topics and subtopics were noted and analysed.

1.14.3 Descriptive tables of analysis were created to better represent the information obtained from the reports.

1.14.4 Relative percentage performance of learners per topic and subtopic were tabulated in relation to the year.

1.14.5 The learners were taught using the guidelines from the NSCEDR and feedback was given timeously to individuals or to groups. Remedial classes of one hour per week after school and 4 hours every Saturday fortnightly were conducted as an intervention strategy.

1.14.6 Marks of the learners were collected and analysed using SPSS and Excel.

1.14.7 The results from SPSS and Excel were interpreted and discussed.

1.15 Ethical and safety issues

There are a number of different issues that needed to be considered to achieve the intended goals of the research. According to Breakwell, Hammond, Fife-Schaw, and Smith (2006), the researcher should consider the welfare of the participants in any study. The participants in any study have to be protected from any harm, physically or mentally. The rights and dignity of the participants have to be respected by the researcher. The researcher ensured that the data were reported honestly without fabrication to show respect to participants, and to people who would read the research. Any information obtained from other researchers was acknowledged and references given correctly. Since all research raises ethical issues the researcher sought for ethical clearance from the University of Zululand ethical committee which was granted. Learners' parents and guardians were made aware of the revision programme scheduled during break times through a letter signed by the school principal and consent forms given out to them and the learners. As this was an additional schedule for the normal extra classes schedule set at the beginning of the year with the parents and educators the risks for the use of 30 minutes during break time were minimal and learners and parents supported the idea. This research involved obtaining marks from learners, after being taught in a normal classroom setting hence the learners were informed that their mathematics marks for the September trial examinations and their grade 11 mathematics end of year examinations were going to be used by the teacher in the research project and that their names were not going to be disclosed in the research but rather codes would be used. The principal as well as other teachers were also made aware of the additional time scheduled for interaction with the learners and approved of it. In the rolling out of the programme all the learners taught by the researcher were considered and given the same treatment. The learners were also told that their participation was voluntary and anytime they felt they wanted to be out they were freed from doing so.

The researcher sought the consent of the learners, parents/guardians and the principal of the sampled school to conduct the research. The learners taught by the researcher were treated equally, that is they were subjected under the same learning conditions in terms of time for intervention. As the research also involved using free, secondary data that could be accessed by the public at any time, the researcher undertook to abide by the general rules set out by the University. The researcher made sure that the dignity, safety and integrity of those who compiled the NSCEDR as well as the participants was respected. Where the researcher discussed any of the objectives of the research with anybody, the researcher undertook to respect the anonymity and confidentiality of the individuals. The researcher ensured that the quality and integrity of the report was not fabricated or falsified. The researcher made sure that any other relevant information obtained from any other sources was acknowledged to avoid plagiarism. The researcher worked independently and produced the research on her own, except for normal supervision and fellow students' assistance. The results of the standardised tests were made available to the learners under study particularly the ones after the intervention. The results of the study would be made available to the participants, the parents as well as the Principal should they wish to know and read about them.

The research was not aimed to do any harm to anyone as it only sought to use the NSCEDR to improve the learners' performance in Mathematics. A participant who wished to stop participating in the intervention programme was free to do so without any prejudice nor being forced to continue participating.

1.16 Resources

The researcher did not receive any financial support for carrying out the research, however has applied for funds from the University's post graduate project fund. Funds were required for accessing the library from home (internet), stationary, printing, binding, and editing, as well as duplication of the copies of the research report.

1.17 Intellectual property

Besides the usual copyright issues, the researcher did not anticipate any intellectual property rights out of this research except for the copyright issues that would be dealt with by the University when there is need in future.

1.18 Harvesting the research

A research report in the form of a dissertation was completed and submitted for examination by both internal and external experts. The research topic, the analysis of the data, and the results there from, make it possible to publish at least an article from the research. The researcher would also seek to present her findings in conferences both locally and internationally.

1.19 Plan of the study

The research document is made up of five chapters including a summary of each chapter. In brief, the chapters are as follows:

1.19.1 Chapter 1: Orientation of the study

This chapter dealt with the orientation of the study. The main focus was on how the research was conducted. The chapter outlined the motivation behind the research and the goals of the study that the researcher wished to achieve. The research questions, objectives, hypotheses, the value of the study, resources required, intellectual property rights and ethical considerations were explained in this chapter.

1.19.2 Chapter 2: Literature review

This chapter focused on the theoretical framework of the study. A thorough examination of the theory and literature relevant to the topic was done. The chapter emphasis was on the key issues related to the topic. In this chapter the focal point was to make use of the feedback provided by DBE to improve the performance of the learners in Mathematics. It was therefore important to examine error analysis and feedback impact on learner performance.

1.19.3 Chapter 3: Research methodology

The research methodology and design used in this study was discussed in this chapter. The population and the sampled participants are indicated in the study as well as the rationale for selecting some techniques for the study.

1.19.4 Chapter 4: Data presentation and analysis of results

This chapter presented and analysed the results data using information obtained from document analysis and marks of the learners from pre- and post- test standardised test. The results were also interpreted in this chapter.

1.19.5 Chapter 5: Discussion of findings, conclusion and recommendations

This chapter gave a summary of the results. Recommendations were made to Mathematics classroom practitioners, curriculum developers and assessors on how the performance of the learners in Mathematics may be improved.

1.20 Summary

The main aim of this study was to determine the impact of the NSCEDR findings in improving the performance of the learners in Mathematics. Mathematics as one of the very important subject requirement in the economic development of a nation need to be given particular attention in the teaching and learning for learners to understand it and achieve better results. Better methods of delivering the content of Mathematics with understanding need to be explored.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the benefits and the problems associated with NSCEDR findings on learners' errors, misconceptions, and how important the learners' performance is in their final Mathematics examinations, will be highlighted. The chapter will highlight some of the factors affecting learners' performance as found by other researchers. There is, however, very little literature on the use of the findings from the NSCEDR to improve learners' performance, hence most of the literature found is on error analysis and feedback, which resembles the NSCEDR document. The chapter will start by highlighting the importance of Mathematics, followed by an outline of the theoretical framework, and what researchers say about feedback, and thereafter the error analysis as outlined by the NSCEDR will be discussed. Perceptions on Mathematics learning ability, and the difficult topics in high school Mathematics, will be discussed, followed by a review of what researchers say about gender differences on Mathematics achievement.

2.2 Importance of Mathematics

Examinations are very important in the South African education system, and in most other countries. The examinations are used mainly to measure the level of a learner's achievement and determine the learner's next level of education, training and employment. Mathematics among other subjects is considered to be a very important subject, as it opens many doors to different career opportunities if a learner does well. It is viewed as a tool that can be used in everyday life. Nhamburo, Sithole, and Chinamasa (2014) viewed Mathematics as a basic tool in the development of science-based knowledge, such as technology, industry, and even for sound analytical reasoning in daily living in a modern society. Regardless of the importance of Mathematics in learners' future after high school, the failure rate in Mathematics national examinations is alarming. It is for this reason that the researcher decided to employ the findings and recommendations from the NSCEDR in an intervention programme, to see if this could yield better performance, as purported by the NSCEDR document.

Achievement in Mathematics requires different stakeholders to come together, and an understanding of learners' difficult areas in Mathematics and the perceptions of learners about the subject and its content. Teachers need guidance to translate data into useful information, Barneveld van (2008) advocated for teachers to have a clear process, time to acquire skills, and guidance from experts over time. The data provided in the NSCEDR, if interpreted well, could help teachers make informed decisions that could positively affect learners' performance (Lewis, Madison-Harris, Muoneke, & Times). In other words, having diagnostic reports for post examinations available, might not be sufficient enough for teachers, unless they were able to draw meaning from the data and used it to the benefit of the learners. However, teachers using information from reports like the NSCEDR reported greater differentiation of instruction, greater collaboration among staff, increased sense of teacher efficacy and improved identification of learners' learning needs. According to Kellaghan and Greaney (1992), examination information helped in shaping the teachers' instructional practice, though its success was not certain. The success in the effective implementation of the information from examinations depended mostly on the political will of the government to support the effort. It is through the understanding of the learners' needs, and the data available from reports, that the teacher may make decisions that would positively affect learners' performance, however the extent to which the information in the NSCEDR is considered to be of value by different stakeholders is unclear. Using data obtained from previous examination analysis to improve learner achievement, according to Barneveld van (2008), did have some benefits. One of the benefits was that the use of data to drive educational decision making resulted in changes in teacher practice and school culture, however the process was complex and required time, resources, collaboration, support and persistence among all stakeholders. An article by Ratcliffe (2013) argued that even if there were dedicated managers in school, they might not have adequate training to analyse the results valuably and identify factors causing underperformance, hence the NSCEDR would be helpful for teachers to analyse and redefine their teaching strategies.

2.3 Theoretical framework

This study is underpinned by a number of theories among which are cognitive theories, motivation theories, social learning theories and error analysis and problem-solving techniques.

2.3.1 Learning theories

Learning Mathematics manifest itself as a difficult process that requires a learner to be self-motivated and to be able to identify his or her weaknesses and strengths. In learning Mathematics, repetition of concepts and group work are key to performing better. Thorndike's theory of learning postulates that when repetition is done in the absence of feedback, it yields no improvement in learner performance. Vygotsky, a social learning theorist, believed that social interactions and processes in the surroundings are transformed to become the processes within the learner. Interaction with the environment, in this case the NSCEDR, drives mainly the functioning of reflexes and accommodation. Some psychologists, like Bandura (1977), concluded that learners can learn and understand concepts better from mere observing and imitating others (social learning theory). Bandura outlined four cognitive processes of learning, namely attention, retention, reproduction and motivation. The NSCEDR acts as the model as it outlines the misconceptions, and gives suggestions on how to solve a given mathematical problem, while the teacher is the mediator of learning. The outcome of using the NSCEDR through the modelling approach and mediation of the teacher could motivate the learners to take heed of the suggestions and errors committed by their predecessors and avoid or eliminate them, thereby achieving better results in Mathematics examinations.

A learner's learning behaviour can be changed by using reinforcement, punishment and extinction, (Sharma & Sharma, 2003). Giving positive feedback (reward) to a learner motivates the learner intrinsically to do more outstanding work. Thus, the NSCEDR as a form of feedback is a good motivator if learners and teachers work together with it, as it provides guidance and conscientise learners of possible errors and misconceptions (negative reinforcement). The teacher has to complement the NSCEDR by giving feedback timeously, positively, and negatively, to instil the required skills.

The guidelines from the NSCEDR can be used to close the gap between what the learner can achieve alone, and what can be achieved with some help from someone; according to Vygotsky, this is referred to as the zone of proximal development (ZPD). The researcher believes that with assistance from the teacher and the NSCEDR guidelines, the learner is able to master different mathematical concepts and skills required to perform better in examinations. It is in this ZPD that the teacher plays an important part in mediating the conceptual understanding, procedural fluency, strategic competency, adaptive reasoning and productive disposition requirements of any question in Mathematics.

2.3.2 Newman's error analysis

This study was also guided by Newman's error analysis technique and the NSCEDR findings of learners' mathematical work. The NSC Mathematics curriculum involves different topics, of which some require learners to be able to read and understand the question so as to respond to it correctly. Newman's error analysis provided the basis for teacher to understand the learners' levels of errors. The strategies by Newman (1977) consisted of reading, comprehending, transforming, procedure and encoding the question. The researcher would apply Newman's strategy to ascertain that the learners can read and understand the questions, find out how to solve the problem, and write down the answer to the problem during the intervention programme.

2.3.3 Polya's problem solving technique

Problem solving in Mathematics requires a strategic approach to understanding and representing a problem. The researcher applied Polya's problem solving technique in the intervention programme to help learners to develop problem solving skills. Polya outlined four strategies to problem solving to help learners' problem-solving techniques. Polya's techniques, according to Khalo and Bayaga (2015), include understanding of the problem (explore), devising a plan, carrying out the plan (solve), and looking back (check). By following Polya's strategies, the learners were expected to be able to analyse and understand related information, decide on how to solve the problem, look for alternative solutions, and check the correctness of the alternative solution.

2.4 Feedback

Feedback has been outlined by many researchers (DeNisi & Kluger, 2000; Fyfe & Rittle-Johnson, 2016; Hattie & Timperley, 2007; Lipnevich & Smith, 2009b; Shute, 2007) as having more positive effects towards Mathematics achievement than negative, depending on how the feedback is delivered. According to Lipnevich and Smith (2009a), computers, grades and praise are components of feedback that have both positive and negative impacts on an individual learner's performance. The NSCEDR provides the kind of feedback that DeNisi and Kluger (2000) found to be more likely to yield better positive performance in learners. The kind of feedback provided by the NSCEDR enables learners and teachers to engage and apply it in the future (Handley & Williams, 2011). Evans (2013) argued that, even if feedback is good, there is a huge gap between receiving and acting on it by learners, as well as teachers, according to how the teacher and the learners perceive and use it. Thus, feedback must be given to learners in such a way that it motivates the learners to see it as imperative and relevant to use, to improve their performance in the subject. Feedback can take different forms, one of which is facilitative feedback which involves a report with comments and suggestions to guide the learner in his or her own revision and conceptualisation. According to Muralidharan and Sundararaman (2010), this type of feedback is very useful in correcting inappropriate strategies, procedural errors and misconceptions. Learners learn best when the teachers give feedback in a facilitative manner, because the feedback helps the learners to come up with their own ideas and strategies to improve in the subject (Shute, 2007). While according to the NSCEDR documents, there should be an improvement in the performance of the learner due to the availability of the report, the trend of the learners' performance from 2014 to 2016 shows otherwise. The performance of the learners from the DBE 2014 to 2016 is given in table 2.1

Table 2.1: Overall achievements rate in Mathematics: NSCEDR 2016

Year	Number Wrote	Number achieved at 30% and above	% achieved at 30% and above	Number achieved at 40% and above	% achieved at 40% and above
2014	225 458	120 523	53.5	79 050	35.1
2015	263 903	129 481	49.1	84 297	31.9
2016	265 810	135 958	51.1	89 084	33.5

(DBE, 2016)

From table 2.1, while the number of examinees increased from 2014 to 2016, the percentage pass rate fluctuated, and appears to be decreasing regardless of the availability of the NSCEDR to inform teachers and all stakeholders in the education of the learners. The pass rate is given by the percentage of learners who achieved 30% and above. It can be said therefore, that it is not only the availability of the NSCEDR documents that could help improve performance, but it is the teacher's duty to engage the learners in reflective activities to help them understand the importance of the data. As a result of sharing data with the very people it impacts the most, learners will better understand the "why" behind the curriculum presented to them (Long, 2016). Long (2016) posited that when data are made an integral part of the classroom experience, a transformational change is possible for learners, teachers, and administrators. As a result, the NSCEDR's availability in schools and to teachers makes it possible to integrate the findings of the reports in the classroom in an attempt to transform the learners' performance in Mathematics.

Researchers have obtained conflicting outcomes on the effects of feedback on learning, however Jian-Wei, Yuan-Cheng, and Yuh-Shy (2013) found out that timely diagnostic feedback had better effects on the learner. The research sought to use the feedback from past examinations to improve the performance of learners in Grade 12, however the feedback was given on the learners' intervention work as the programme was developed and implemented, thus the feedback was done timeously as this provided coaching at the right time to prepare the learners for their final examinations.

2.5 Error analysis and classroom intervention

Very little research has been carried out on how to deal with errors, mistakes and misconceptions committed by learners in their everyday Mathematics activities, and in particular in their high school exit examinations. Much of the studies done, according to Heinze (2005), had been on students' mistakes from a diagnostic point of view, and very little, if any, has been done on how to handle and correct them in a Mathematics lesson. Further research (Heinze, 2005; Heinze & Reiss, 2007) aimed to identify the reasons for different, typical students' mistakes, and the development of didactical ideas and material to prevent the mistakes, or to use them as a learning opportunity. This research aimed to use the mistakes identified in the NSC examinations, documented in the NSCEDR, to conscientise students to be aware of such mistakes in Mathematics, so as to improve their performance. There is little research however, on a good way of dealing with these mistakes in a Mathematics lesson.

An action research study by Gningue and Soriano (2013), to determine the extent to which the use of student error analysis improve students' academic performance in Mathematics, was conducted using 54 students. Two groups were formed using a convenience sampling method, in a quasi-experimental design, where both the control and the experimental group were given a baseline assessment. Performance tasks, achievement tests and classroom observations were used to collect data, and the results showed that even though from the pre-test to the post-test, both groups showed an improvement, on average, students in the control group decreased, while experimental group increased in performance from the pre- to the post-test. While the research by Gningue and Soriano (2013) is similar to the researcher' research, the researcher used no grouping, but applied both pre- and post-test, as well as classroom observation, to the whole group to determine whether or not the intervention strategy improved the performance of learners. The researcher used the errors and misconception from the NSCEDR to improve instruction and remedied them according to learners' work in the classroom.

In another study conducted to explore the effectiveness of an instructional intervention programme to develop the number sense of grade seven learners, Markovits and

Sowder (1994) found that, after an instructional intervention programme, a long term change in electing to using strategies that reflected number sense developed in the learners. In accordance with the study aim, the intervention programme was developed to develop learners holistically in the five strands of mathematical proficiency, which would increase the retention and accommodation of information on possible errors, and misconceptions encountered in the writing of Mathematics activities and achievement tests.

2.6 NSCEDR and improvement of classroom teaching

Much research has been done on how to carry out error analysis on learners' work in order to find out what kind of errors and misconceptions are committed by learners on certain topics. An analysis of the responses and errors by Williams and Ryan (2000) on seven and 14 year old children's performance in a Mathematics test was scaled against the children's ability using a Rasch methodology. Williams and Ryan (2000) believed that a report on error analysis provides a starting point for effective diagnostically-designed teaching and learning of Mathematics. It is difficult for teachers to understand their learners' errors and misconceptions in Mathematics, hence the NSCEDR proved useful, however just as Williams and Ryan (2000) noted, many teachers do not use diagnostic methods and do not seem to be aware of their potential to improve classroom practice.

The findings of the error analysis were used to remedy directly the learner's work, however with the NSCEDR, a sample of 100 scripts from each of the 9 provinces in South Africa were analysed for errors, misconceptions and suggestions for remedying them (DBE, 2014). These findings were intended to assist teachers, subject advisors, and all stake holders, to refine their instruction and improve the performance of other learners, and not the ones who committed the mistakes. The researcher therefore is trying to ascertain the value on using outlined general common errors and misconceptions to improve learners' performance in an intervention programme.

The National Senior Certificate examinations in South Africa resemble the high stakes tests in the United States of America. The NSCEDR on the examinations introduced by the Department of Basic Education played an important role in aiding teachers to better align instruction with the content standards of the subject to ensure that learners were taught and tested on the content and skills they were expected to master (Perkins & Wellman, 2008). To show how important diagnostic analysis was Williams and Ryan (2000) said that the video study by the Third International Mathematics and Science Study (TIMSS) reported that the Japanese Mathematics teachers were prepared with notes on a variety of likely responses to key leading questions, with guidance on what the thinking responses indicated, and constructive teaching suggested. An article on high stakes testing by Blazer (2011) suggested that the NSCEDR, because it diagnoses learners' weaknesses just like high stakes tests, provided schools with the opportunity to develop instructional programmes needed to help all learners and not only low-achievers to meet national standards on their NSC examinations.

An intervention programme was developed from analysed data for arithmetic sequences of grade 8 learners (Sowards, 2014). In the research, error analysis was done on a quiz and an end of chapter test on arithmetic sequences, and an intervention plan was implemented to curb the errors and misconceptions on that topic from the learners' work. The intervention was done with 16 underachieving learners. An end of chapter test was used with the same problem from the quiz and the errors and misconceptions analysed again. The scores from the quiz to the test were found to have increased and Sowards (2014) concluded that analysing errors in formative assessment improved the performance in the summative test. In this research however, the intervention would be implemented based on the outcomes of errors and misconceptions from the data obtained from a sample of Grade 12 final examinations, and the problems where error analysis was done were not the same, but similar concepts and aspects were tested in the standardised tests. The sample in this research comprised of all learners regardless of their achievement in Mathematics.

The NSCEDR resembles error analysis on learners' work, which aided teachers to determine the type of errors committed by a student and why (Brown, Skow, & Center, 2016). In error analysis the teachers identified and reviewed student's errors to find out if the errors were persistent or not. The teachers identified the misconceptions or skill deficit and designed and implemented instruction to address that student's specific needs (Brown et al., 2016). Unlike the error analysis, the NSCEDR attempts to address a student's misconceptions and skill deficit using other students' error analysis. This study focussed on finding out if the use of the NSCEDR would help to improve the learner performance in Mathematics. Error analysis was identified as an effective method for discovering patterns of mathematical errors for any student (Brown et al., 2016), however the implementation on improving the learners' performance needs to be clarified. Error analysis is basically done on the learner's work to assist with corrective and remedial intervention however, the error analysis from the NSCEDR is not linked directly to the learners' work. The analysis of a candidate's performance in each question was of great importance in diagnosing areas of the syllabi where instruction required to be refined and restructured to impart the expected objectives (Nyaga & Bundu, 2009),. Thus, an analysis of questions in an examination is a valuable resource to teachers for guidance and improvement of instruction. This research seeks to use these guidelines in an intervention programme with the matric learners to establish the impact of these guidelines and error analysis to improve learner performance in Mathematics.

According to Nhamburo et al. (2014), learners' errors can be used by teachers to reflect on teaching methods, textbooks used, as well as the needs of the students. The NSCEDR provided the predicted errors on different topics and thus help teachers speculate questions and answers during lesson planning (Nhamburo et al., 2014). In this study, the NSCEDR provided a basis for the learners' targeted instruction to correct errors and misconceptions in the different Mathematics topics. Nhamburo et al. (2014) argued that if learners' errors were used for instruction, the leaners could pass their Mathematics examinations, but in this study, the errors from the previous learners' work were used for instruction to improve the performance of the current learners.

2.7 Perceptions on mathematics learning ability

Mathematics learning in the whole world and in particular South Africa is believed by many to be a very difficult and abstract subject to comprehend and only a few gifted learners can perform well. There is generally a very poor performance in Mathematics across many nations as Spaull (2012) posited, and as a result an insignificant number of students enrolled for Mathematics at tertiary level due to negative views of Mathematics and Science. Learners in South Africa do not only fail Mathematics at Grade 12 level, but they develop a negative attitude at a very early stage of their schooling, in particular in primary school. Observation and interaction of the researcher, as a teacher dealing with parents and learners, showed that most parents have the very same negative perceptions of Mathematics as their children, and hence the learners started their schooling being aware that Mathematics was a very difficult subject because their parents said so. The ability to deal with Mathematics problems was also affected by anxiety (Mehdizadeh, Nojabaee, & Asgargari, 2013). Anxiety among learners and attitude towards Mathematics learning as identified by researchers Charles-Ogan and George (2015) was inherent in learners. These had serious implications on the way learners think and behave (Mensah, Okyere, & Kuranchie, 2013). According to Charles-Ogan and George (2015), attitude was viewed as a process that reshapes a learner's behaviour in the classroom and an emotional disposition towards Mathematics. This study aims to change the attitude of learners and their perceptions on Mathematics achievement through an interactive intervention programme scheduled outside the normal teaching time.

Teachers' perceptions and beliefs about Mathematics learning, according to Cooper, Baturo, Warren, and Doig (2004), affect their instructional patterns and how they deal with learners. While teachers may not be aware that their belief that a learner would fail, or even worse, saying the learner would fail, it is clearly a contributing factor in the learners' failure. According to Githua (2013), it was found that students' perceptions to formative evaluation was highly related to students' motivation to learn Mathematics, thus for a student to perform well in Mathematics, his/ her perceptions to formative evaluation, which included easy or difficult tasks, importance, usefulness and feedback, contributed significantly to the motivation to learn Mathematics. The researcher in this study tried to avoid labelling learners, and rather praised, and rewarded positively, the performance of the learners during the intervention programme, in order to raise the self-worth of each and every learner, at the same time attempting to instil a love and enjoyment of doing Mathematics.

2.8 Difficult topics in high school mathematics

The low performance of learners in Mathematics is not only caused by learners failing all topics dismally, but there are some topics which frequently appear year after year as being areas of underperformance. Figure 2.1 shows the average percentage of marks per question in the 2014 NSC examinations from a sample 100 scripts from each of the nine provinces in South Africa. From figure 2.1, the average percentage performance was 70% in Equations, Inequalities and algebraic manipulations. The topic on equations, inequalities and algebraic manipulations is the basis of most topics, and while learners are performing better, the performance from the sample revealed that there were still some gaps in the understanding of this topic. This analysis is manifested by the low average performance in Number Patterns and Sequences (58%), Number Patterns and Sequences (50%), Hyperbolic functions and graphs (49%), Exponential and logarithmic functions and graphs (44%), Parabolic and Inverse functions and graphs (37%), First Principle and Rules of Differentiation in Calculus (56%), Cubic graphs and Application of Calculus in Optimisation achieved at 53% and 32% respectively. The average performance in Annuities and Finance was 56%, while Probability and Counting Principle were at 39% and 29% respectively. From figure 2.1, the topics and aspects of a topic that were more challenging could be singled out using the average performances.

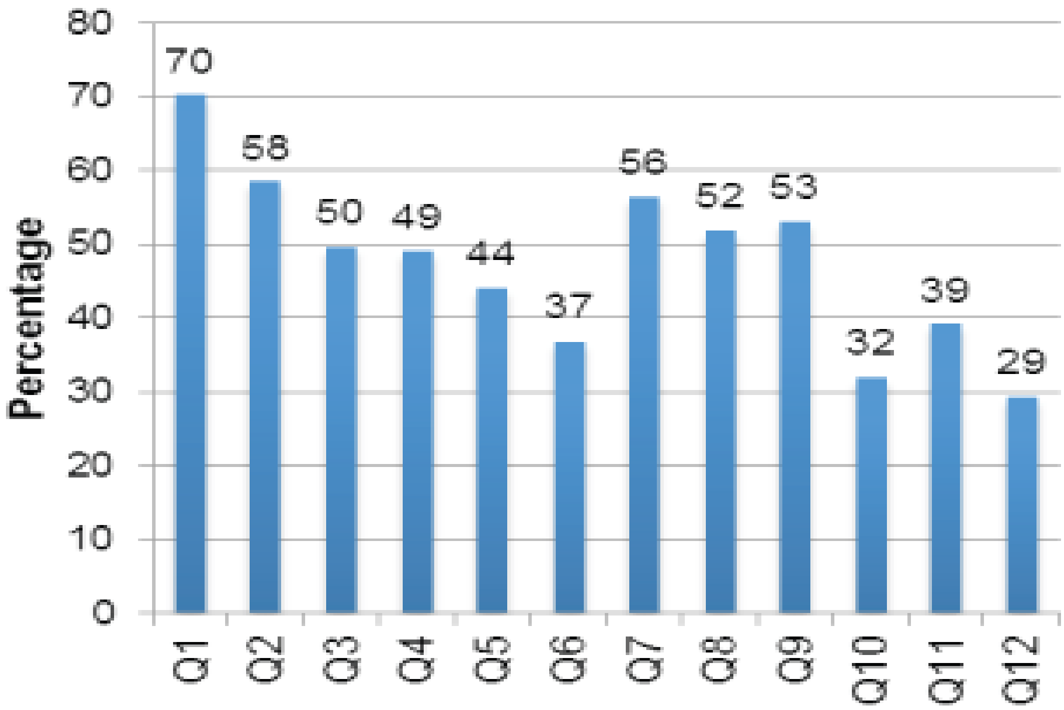


Figure 2.1: NSCEDR 2014: Average percentage performance per question in paper 1

(DBE, 2014)

In 2015, the NSCEDR showed more or less the same statistics on average performance per question as in 2014. Figure 2.2 shows a lower average performance of 60% in Equations, Inequalities and algebraic manipulations as compared to 2014. The average performance in the 2 questions on Number Patterns and Sequences increased from the 2014 performance to 60% and 56% respectively. Exponential functions and graphs average performance was at 60%, while Parabolic and Hyperbolic functions and graphs performance was 47%, as shown in figure 2.2. The average performance on Straight line and Inverse functions and graphs was 26%. The average performances, in 2014 and 2015, on questions involving Inverse functions and other functions were low. It can be concluded that the integration of Inverse functions with other functions pulled down the performance since the average performance without the inclusion is better. In First Principle and Rule of differentiation, cubic functions and Application of Calculus in Optimisation, the average performances were 52%, 29% and 22% respectively. Figure 2.2 also shows that in Finance the average performance was 43%, while in Probability and Counting Principle it was 28%.

In 2016 the average performance in Counting Principle was very low at 2% as shown in figure 2.3. This could be attributed to the learners misunderstanding the question or may be that the question was beyond the learners' ability. The average performance in Equations, Inequalities and algebraic manipulations was at 70%, while on Number Patterns and sequences the average performances per question were 54% and 31%. Exponential functions and graphs had an average performance of 42% and in a question on Parabolic and Hyperbolic functions the average performance was 27%. The question on Straight line coupled with Inverse functions had an average performance of 39%. The average performance in the three questions in Calculus were 50% on First Principle and Rules of Differentiation, 42% on Cubic functions and interpretation and 38% on Application in Optimisation, while probability and finance had average performances of 65% and 33% respectively.

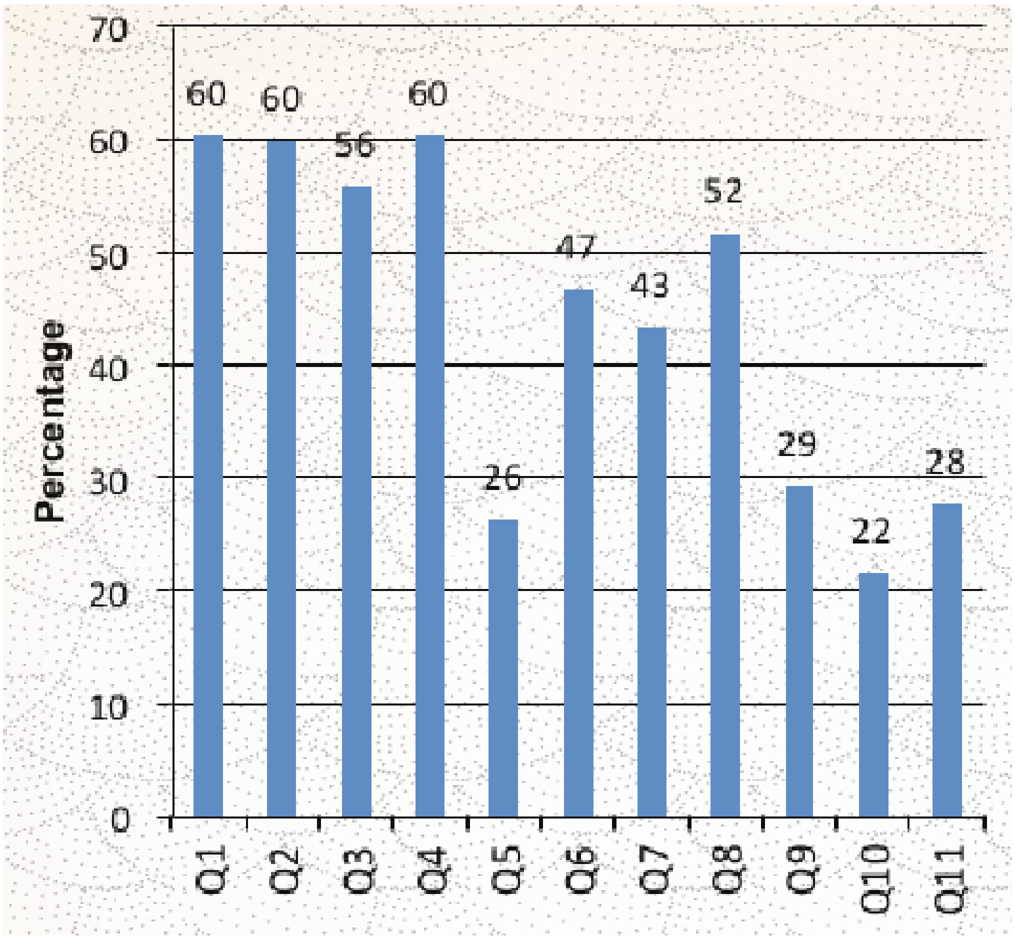


Figure 2.2: NSCEDR 2015: Average percentage performance per question in paper 1

(DBE, 2015)

In Mathematics paper two, figure 2.4 shows the average performance per question in the NSC Examinations in 2014. The figure shows that the average performance in the first two questions on Data Handling were 69% and 61%. The average performance in the next two questions on Analytical Geometry were at 57% and 42%. There were three questions on Trigonometry with average performances of 57%, 34% and 37% and in the three questions on Euclidean Geometry the average performances per question were 59%, 38% and 34% as shown in figure 2.4.

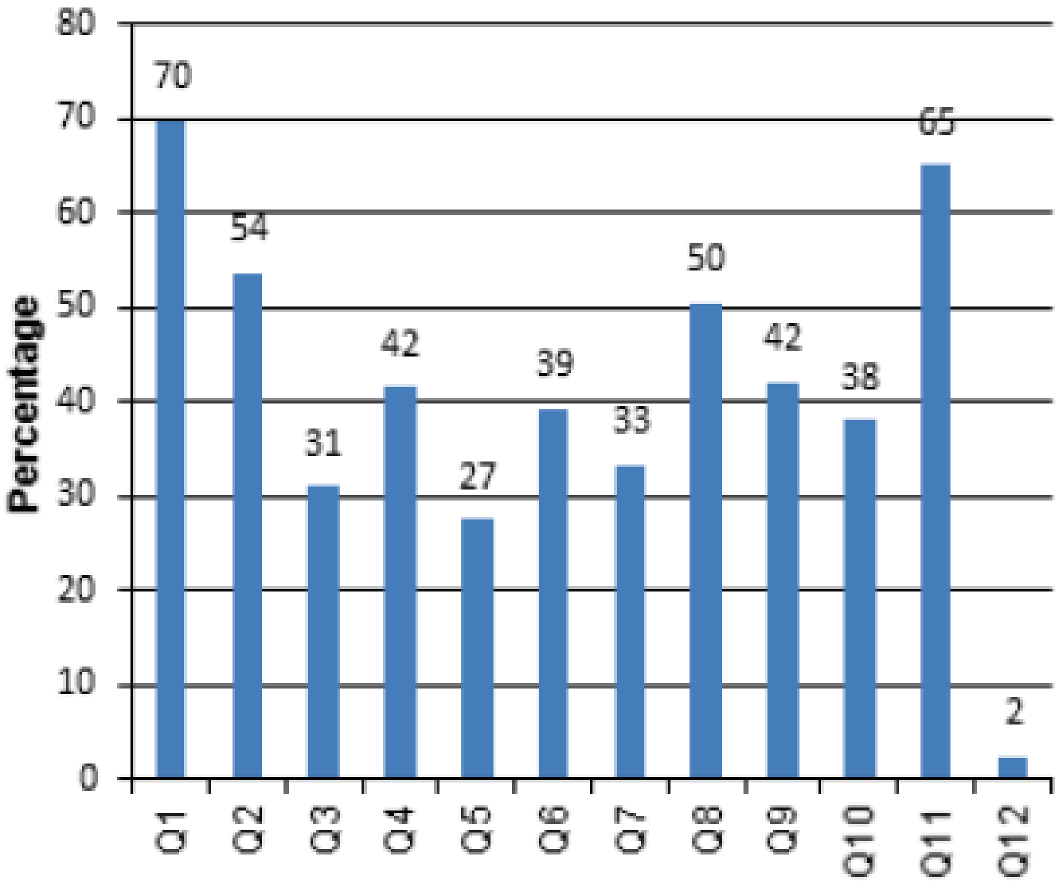


Figure 2.3: NSCEDR 2016: Average percentage performance per question in paper 1

(DBE, 2016)

In the NSC examinations of 2015 in paper two, the questions were based on Data Handling with the first two questions, followed by Analytical Geometry with two questions, Trigonometry with three questions and Euclidean Geometry with 4 questions. The average performances per question ranged from 28% in Euclidean Geometry to 72% in Data Handling. Of particular mention are the average performances in Trigonometry which ranged from 39% to 49%, while Euclidean Geometry ranged from 28% to 56%. Figure 2.5 shows clearly these average performances per question in 2015 paper two. The second question on Data Handling was performed poorly with average percentage of 33%, as shown in figure 2.5.

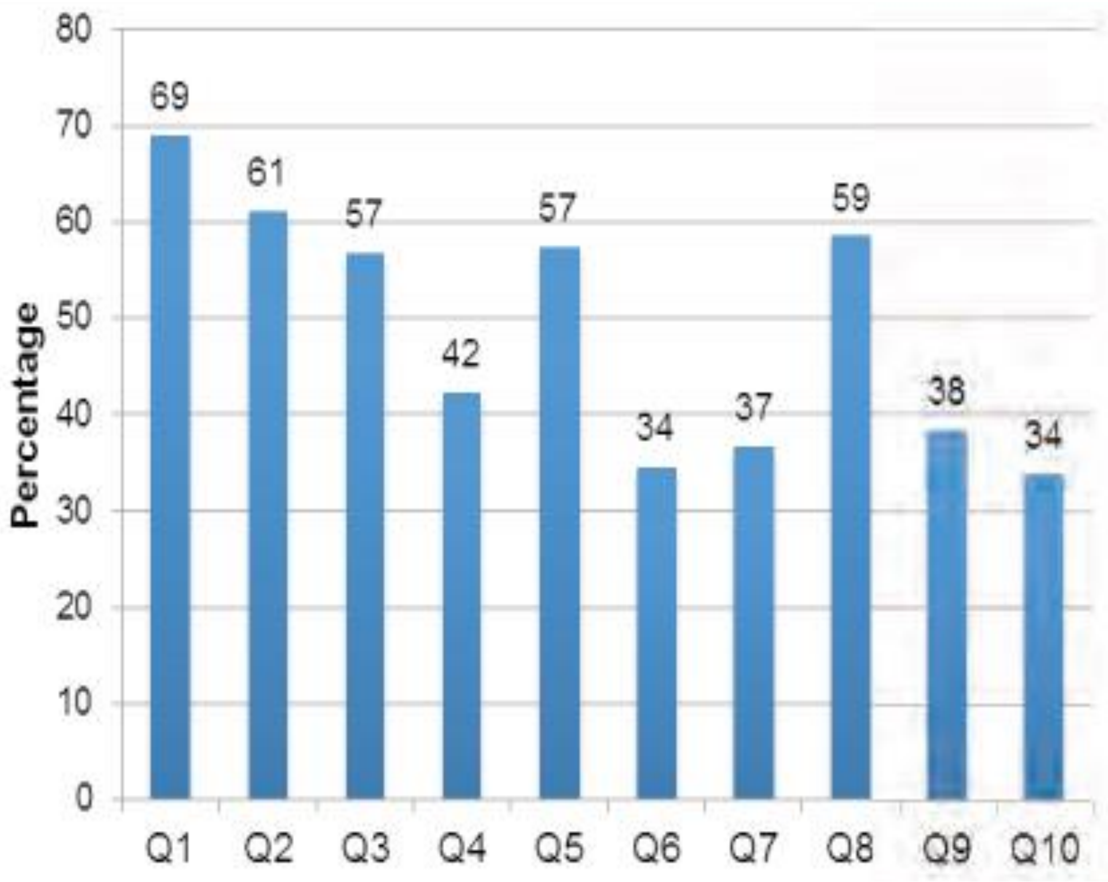


Figure 2.4: NSCEDR 2014: Average percentage performance per question in paper 2

(DBE, 2014)

The average performance per question in 2016 is shown in figure 2.6. The paper was made up of 10 questions comprising of two questions on Data Handling, followed by two questions in Analytical Geometry, three in Trigonometry and three in Euclidean Geometry. As in 2015 Trigonometry and Euclidean Geometry are to be highlighted as the average performance in general was low. The first question on Data Handling had an average performance of 74%, while the second question on the same topic had an average performance of 52%. Analytical Geometry average performance was 59% and 69%, while the average performance in Trigonometry ranged from 32% to 44% and in Euclidean Geometry the range was 36% to 57% as shown in figure 2.6.

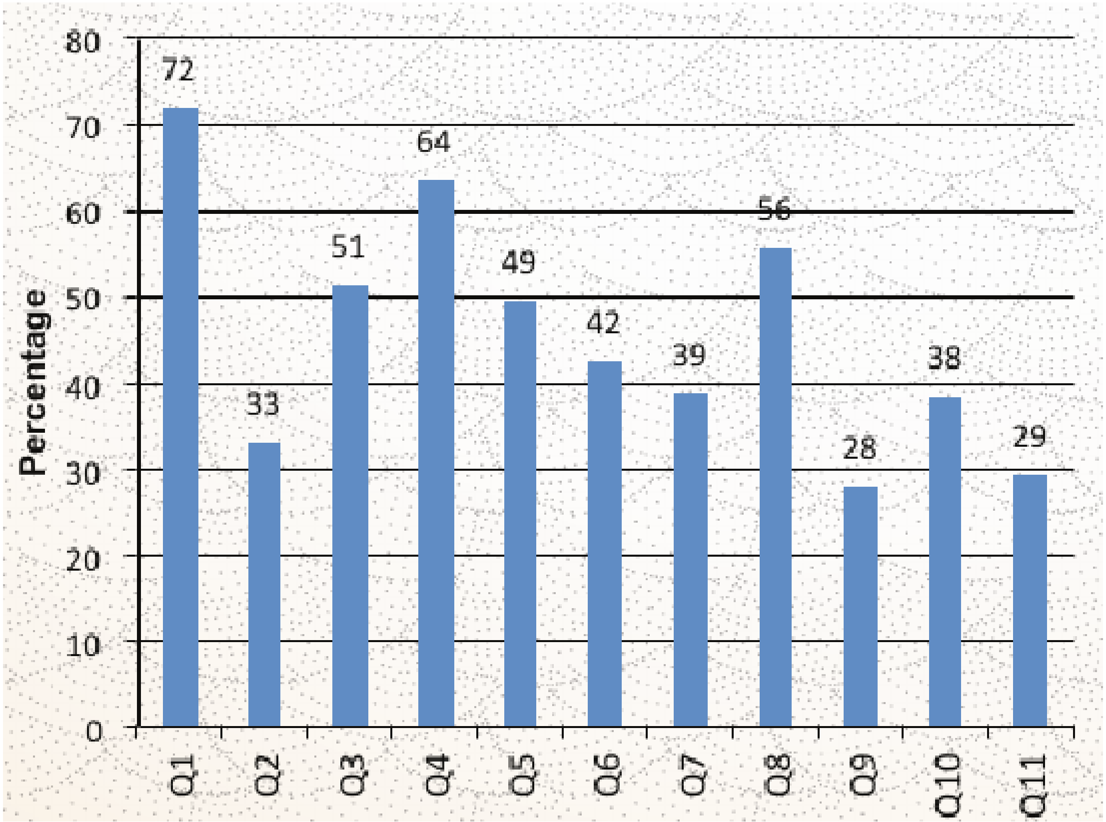


Figure 2.5: NSCEDR 2015: Average percentage performance per question in paper 2 (DBE, 2015)

According to the NSCEDR for 2016 to 2015, Calculus, Trigonometry, Euclidean Geometry, Functions and graphs, Probability and Counting Principle and Analytical Geometry were among some of the topics that were underperformed. The NSCEDR of 2014 highlighted that most learners struggle with Grade 11 and 12 Mathematics because they failed to do the basic Mathematics at Grade 8, 9 and 10 . According to the assessment policy for Grade 12, these underperformed topics constitute more than 67% of the marks in the examination.

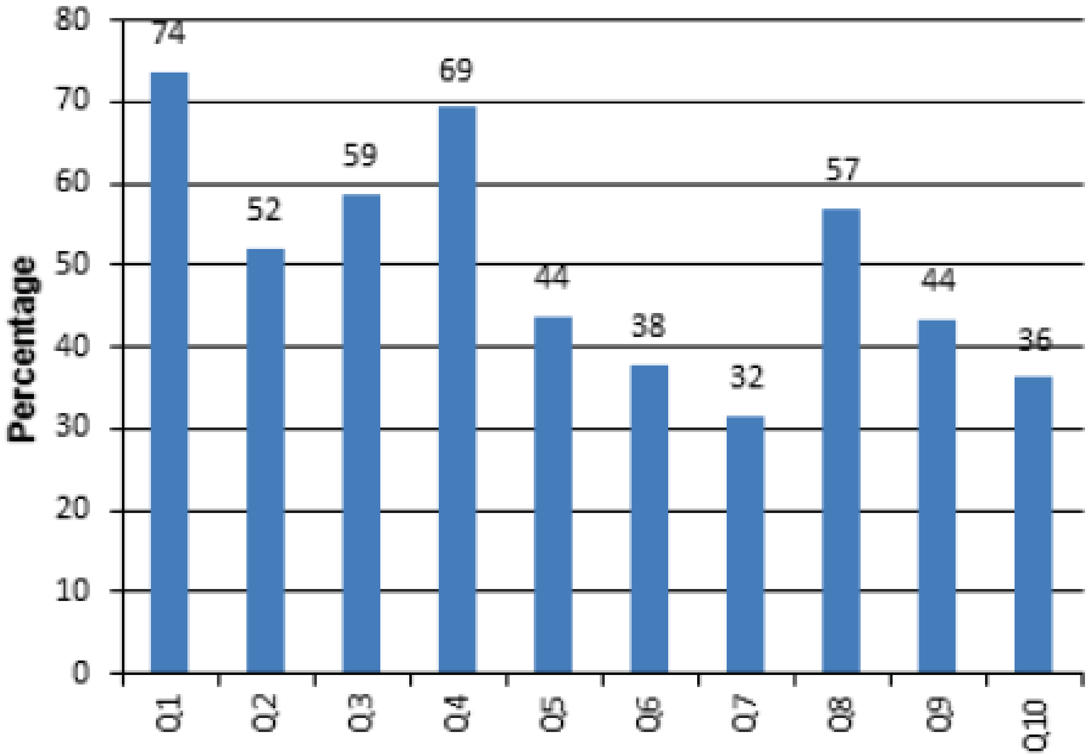


Figure 2.6: NSCEDR 2016: Average percentage performance per question in paper 2

(DBE, 2016)

In the research carried out in Nigeria, students identified the same topics as the ones observed from the NSCEDR to be difficult (Charles-Ogan & George, 2015). Due to the low performance of most learners in some of the Mathematics curriculum topics, there were some topics and aspects that were difficult to the learners and these varied from concept to concept. The NSCEDR exposed these challenging topics, however the identification of difficult topics by the learners, and what causes them to be difficult, need to be established so as to find ways of making instructions easier for learners to conceptualise and perform better on the assumed difficult topics.

According to Kingsdorf and Krawec (2014), learners with learning disabilities struggled with solving word problems. Even though there were topics or aspects of topics where most learners struggled, Kingsdorf and Krawec (2014) advocated for teachers, subject advisors, curriculum developers and all stake holders to understand the specific errors exhibited by the learners to improve instruction for the benefit of the learner. This study attempted to use the past 3 years' examination analysis from the NSCEDR to identify the topics that were consistently underperformed, and hence regarded as difficult, and did not intend to look at performance of learners according to their physical disabilities. This was used as a basis to try and come up with instructional strategies that best simplified the topic or better still, improved conceptual understanding, procedural fluency, strategic competency and adaptive reasoning within all learners. For learners to learn Mathematics successfully, they should be proficient in the following strands of Mathematical proficiency: conceptual understanding where a learner demonstrates comprehension of mathematical concepts, operations and relations; procedural fluency where a learner should be able to carry out procedures flexibly, accurately, efficiently and appropriately; strategic competency requires a learner to be able to formulate, represent and solve mathematical problems; adaptive reasoning where the learners develop the capacity to think logically, reflect, explain and justify their reasoning, and productive disposition, which is a habitual inclination to see Mathematics as a sensible, useful and a worthwhile subject (Hiebert, Morris, & Glass, 2003).

In a study focussing on analysing errors and misconceptions in Grade 12 Calculus, Luneta and Makonye (2010) found out that most of the errors and misconceptions committed were a result of knowledge gaps in basic algebra. Some of the errors were found to be a result of learners over-depending on procedural fluency and no conceptual understanding. Difficult topics in Mathematics therefore, may be as a result of some knowledge gaps in the basis of the topic in lower grades which would lead to learners facing a lot of challenges in their Grade 12 final examinations. Causes of these knowledge gaps may be attributed to many other factors that might require their own investigation. According to Hiebert et al. (2003), if teachers themselves were mathematically proficient, they could then teach to develop mathematical proficiency, and thus raise the mathematical understanding of learners and improve their performance. Knowledge of the topics, and aspects of a topic found to be difficult, would be a starting point for teachers and curriculum developers to reassess their teaching strategies, so as to teach for understanding, rather than teaching for passing examinations only.

2.9 Gender differences in mathematics achievement

Some researchers (Benbow & Stanley, 1980; Fennema & Sherman, 1978; Frenzel, Pekrun, & Goetz, 2007) on gender differences in Mathematics achievement had almost the same conclusion that boys outperform girls in Mathematics. The gender achievement gap in general was found to be skewed towards the boys, however Niederle and Vesterlund (2010), posited that the skewness had shifted in such a way that girls are performing more or less the same as the boys in Mathematics. According to Goldin, Katz, and Kuziemko (2006), the gender gap changed dramatically such that female high school students were recently outperforming their male counterparts in most subjects. A strong belief that boys perform better was also supported by the adults' beliefs. Due to the adults' beliefs that boys were more capable in Mathematics than girls, boys worked harder to achieve better results than girls, while girls were demotivated by the belief. Current researchers like Kurtz-Costes, Rowley, Harris-Britt, and Woods (2008) differed from the old researchers. The current researchers found that there was no significant difference in learner performance in Mathematics between boys and girls.

In a study by Beller and Gafni (1996) on gender differences on the performance of nine and thirteen year olds in Mathematics and Science examination, they found that the gender differences were small in Mathematics performance especially among the nine year olds. While some studies have proposed that stereotype threats affected the performance of girls' Mathematics performance, Ganley et al. (2013), found that the performance of girls was not threatened by stereotype threats and non-stereotype threats. In two of the three studies done, Ganley et al. (2013) found that there were gender differences in Mathematics performance regardless of stereotype threat or not. In this study the researcher aimed to find out if there were any gender differences in performance as a result of the intervention programme using the NSCEDR's findings to improve the performance of the learners in Grade 12 learners. Thus, this study sought to find out short term differences between the performance of boys and girls in Mathematics due to a uniform intervention programme conducted with the learners.

Gender differences in Mathematics performance were found to be different in terms of countries. It was found to be persistent in some other countries than others (Else-Quest, Hyde, & Linn, 2010). Stereotypes, however of girls and women being inferior in Mathematics persisted in communities despite similarities in mathematical performance. As scientists attempt to account for the underrepresentation of women in Science, Technology, Mathematics, Engineering and other mathematics related careers, an understanding of gender differences in Mathematics achievement and attitude is a topical issue being pursued. In the study conducted by Else-Quest et al. (2010), while there were gender similarities in achievement, boys showed more positive Mathematics aptitude than girls. The research in question sought to find out how the intervention programme integrated with the implementation of the error analysis and misconceptions outlined in the NSCEDR document would affect the different gender in South Africa.

2.10 Summary

Different views have been said and discussed on how to improve Mathematics performance using error analysis and feedback which has been likened to the NSCEDR in this research. Some of the factors that affected Mathematics performances were discussed. The next chapter will outline the research methodology followed in carrying out the research, data collection methods and analysis.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The performance of Grade 12 learners in Mathematics is a worrying issue in South Africa. Over the past years it had been a subject of discussion and fingers pointed in many directions. The purpose of this study is to examine the impact of the NSCEDR on learner performance. The introduction of the NSCEDR document by the Department of Basic Education is an attempt to intervene and highlight errors and misconceptions committed by learners in Grade 12 final examinations. The document gives suggestions on how to remedy the mistakes encountered. The NSCEDR's question by question analysis has been used to identify topics and aspects where learners had difficulties comprehending. Interventions using the NSCEDR were used in an attempt to improve the performance in Mathematics. In this chapter, the participants, instruments, sampling methods, research design and data collection and analysis methods will be addressed. The procedure would be explained as well.

3.2 Research methodology

A mixed method approach was used in this research. According to Creswell (2002), a mixed method approach allows for a better understanding of a research problem. It is good for this research as it would allow the researcher to build on to the strengths of both the quantitative and qualitative data. A mixed method approach was employed in an attempt to identify the general performance of previous learners in different topics and then use the information to intervene in order to improve the performance of the learners. A quantitative approach was used to answer the research questions on the impact of the NSCEDR on learner performance, while a qualitative approach was used to identify difficult topics and aspects in the NSC examination Mathematics syllabus. The qualitative approach was employed to identify the difficult topics through document analysis of NSCEDR and observing learners work during the intervention. The researcher needed to understand why the learners are failing in order to conduct an intervention programme utilising what has been observed and outlined in the NSCEDR document and address the challenges accordingly. Creswell (2002) stated that a quantitative study seeks to describe trends or explain the relationship between variables, while a qualitative study seeks to describe and understand complex situations (Kumar & Krob, 2005). The research is underpinned by the positivist research paradigm as the researcher had some propositions in mind that need to be proved by the study.

3.3 Research design

An action research study was employed in this research supported by a one group pre-test post-test study of the quasi-experimental design. An action research is basically conducted to find effective ways of bringing about operational changes in an institution. In this study the researcher was an active participant in the intervention programme in an attempt to improve the performance of learners in Mathematics by utilising the NSCEDR (error analysis) findings. The learners being studied were the participants in the intervention programme. The type of research, according to de Vos, Strydom, Fouche, and Delport (2011), focuses on empowerment and to increase awareness of the possible errors and misconceptions committed by the Grade 12 learners in their Mathematics examinations hence an action research design was used. The one group pre-test post-test quasi-experimental design was undertaken to compare the scores of the learners prior to receiving the intervention programme to the scores after completing the intervention programme. A single group was studied without a comparison group. The learners were all given the same treatment, the intervention programme and wrote the pre-test and post-test to find out if there were any changes in the performance of the learners after the intervention. The quasi-experiment one group pre-test post-test design was chosen due to ethical reasons as it was not possible to form two different groups and implement the programme in one group only because the school setting prohibits this (Creswell, 2002). The pre-test and post-test was used even though the tests were not the same but because the content of the tests was the same. The pre-test was based on the grade 11 standardised test for the end of the year, while the post-test was based on the September standardised trial examinations. Figure 3.1 illustrated the layout of the research design used.

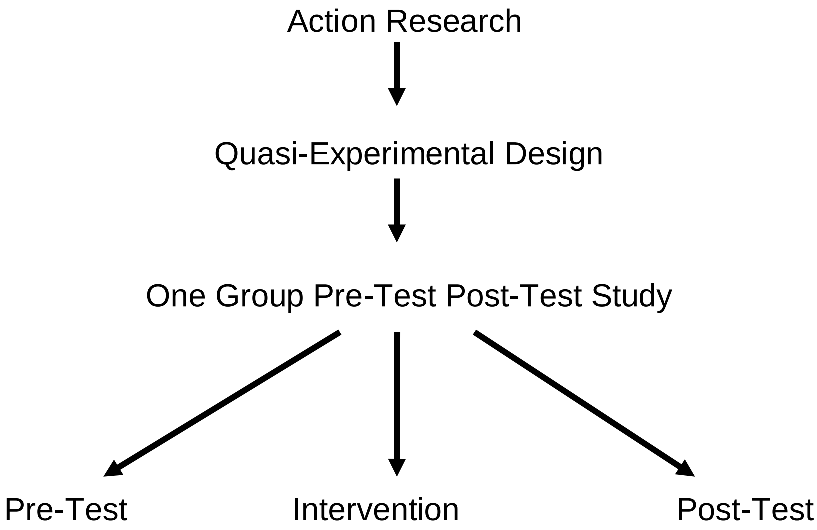


Figure 3.1: Research design

The action research fed into a quasi-experiment whereby the participants were not assigned randomly but all the participants were assigned to the one and only experimental group. The quasi-experiment then led into the one group pre-test and post-test design because there was only one group for the experiment. In the group a pre-test was conducted and marks recorded followed by an intervention where the participants were all involved in extensive learning and revision sessions during extra times in the school, thereafter a post-test was conducted and marks were recorded. The Grade 11 and Grade 12 tests were referred to as pre-test and post-test respectively due to the content of the tests. Both tests were based on the same content, that is the topics and aspects covered in Grade 11 end of year test and the Grade 12 September test resemble the parallel forms of the same test hence pre-test and post-test. The pre-test and post-test had a high content validity however, the internal validity was compromised because, besides the intervention being the independent variable other variables like maturity and the time period between the pre-test and the post-test could have helped the learners to do better in the post-test.

3.4 Participants

The population for the study consisted of Grade 12 learners doing Mathematics in 2017 in South Africa. The sample comprised of 74 Grade 12 learners from one school taught by the researcher. The sample consisted of 28 boys and 46 girls. Convenience sampling design was used to select the participants. This sampling design, is a non-probability sampling technique which does not require the selection of participants randomly. The technique was used because of accessibility and proximity of the participants to the researcher who was involved in the intervention programme and is working full time at the school.

3.5 Data collection instruments

Standardised Mathematics test scripts were used to collect data. A standardised test is a test administered and scored in a consistent manner. The tests were constructed by national examiners according to national examination guidelines outlined in the Curriculum and Assessment Policy Statement (CAPS). The instruments' validity was therefore assumed to be high since the standardised test were set and moderated by Mathematics experts. The reliability of the results was also taken to be high because the markers were trained by subject specialists on the marking procedure and the marking guidelines were provided by the expert examiners. The standardised tests results were used to answer the questions on the impact of the NSCEDR on learner performance in Mathematics. An observation schedule was used to collect data from the NSCEDR document and to understand and figure out the challenging topics, errors and misconceptions that needed to be addressed to improve the performance through the intervention programme. The NSCEDR documents for 2014 to 2016 were used in the document analysis to understand better the challenges faced by the learners in their Mathematics examinations, of which the information found was used to prepare intervention plans to improve the performance of the learners.

3.6 Data collection procedure

First and foremost, the researcher did a thorough analysis of the NSCEDR document to understand the errors and misconceptions committed by learners in their examinations. The topics and aspects of a topic where errors and misconceptions were committed were recorded in the observation sheet. The researcher carried out an error analysis of the pre-test scripts to identify the errors committed by the learners in the research so as to be compared with the error analysis after the intervention programme.

An intervention programme was carried out for 6 weeks starting 25 July 2017. The intervention was in the form of revision on all the mathematical content to be examined. The learners were put in groups of nine to ten according to their pre-test performance. The interventions were done during 30 minutes of the one-hour school break time and after school hours for one hour as well as every second Saturday for four hours. Learners were given few questions on a topic and asked to respond to them after which the solutions for each learner were written down on the chalkboard and the learners critically analyse the different solutions for errors and procedural errors. The researcher was the last person to highlight some of the errors and misconceptions and even reading out some of the errors identified from the NSCEDR document. On 3 of the Saturdays, learners were given one-hour test aiming at correcting some misconceptions and errors of which were then discussed and corrected during the weekday lessons.

The test scripts of the September trial examinations were marked using the standardised marking guidelines and the marks for each learner recorded. The errors committed by each learner were analysed so that they could be compared with the errors in the pre-test.

3.7 Data analysis

An outline of the topics and aspects of topics that were challenging were given from the most difficult to the least difficult, using an average percentage of the percentages given in the NSCEDR documents used to answer the research question on the topics, and aspects of a topic that were more challenging to learners.

The correlation coefficient of the pre- and post-test marks was given and described from an Excel output. The descriptive statistics from the SPSS and Excel output were used to compare the performance of the learners in the pre-test and post-test standardised tests. The significance of the difference in performance was tested at 5 percent significance level using the paired t-test. The errors committed in the pre-test were compared to the ones in the post-test to see if there was any change in the number of errors committed after the intervention.

The learners' marks were grouped according to the performance in the pre-test, those who got below the pass mark, below 30% formed the group of low performers, while those above 30% formed the high performers group. 30% was used as a cut-off point in accordance with the DBE's policy on examination pass percentages cut-off mark. An independent t-test at 5% level of significance was carried out compare the differential performance of the two groups after the intervention programme from the SPSS using the differences in the pre- and post-test marks.

The performance of the learners was compared in terms of gender. The descriptive statistics percentage performance for girls was compared and an independent t-test was performed at 5% level of significance to describe the difference in performance after the intervention programme from the SPSS and Excel output.

3.8 Summary

This chapter discussed the research methodology of the study. The research design, population and sample, data collection instruments and procedure, data analysis methods and ethical considerations were described. Chapter 4 will examine the data analysis and presentation of the results.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter will focus on data presentation, analysis and interpretation of the results. The chapter will present, analyse and interpret the findings from three NSCEDR documents on challenging topics followed by the results of intervention programme from 74 pairs of learners' test scripts. The participants of the intervention programme were 74. The purpose of this study was to determine whether the use of the NSCEDR findings on Mathematics NSC examinations improve the performance of the learners or not.

The objectives of the study were to determine the topics and aspects of topics challenging to learners and the impact of the use of the NSCEDR on the performance of the learners.

4.2 Preliminary analysis

The topics and aspects of a topic deemed difficult or challenging were outlined from the most challenging to the least challenging as obtained from the three NSCEDR documents used and the observations from the participants' scripts. A bar graph showing topics and aspects that are challenging together with the year, was presented. These were also presented in the form of a table with average percentage performance from the three NSCEDR documents.

The impact of the NSCEDR was analysed using raw marks of learners from the pre-test and post-test. The percentages and frequencies were used to present the demographic information of the participants and participants' qualities. The mean and standard deviation for both pre-test and post-test were calculated. The correlation between the pre- and post- marks was calculated to see whether the performance in post-test was related to the performance in the pre-test. A paired t-test at 5% level of significance was used to find if there was a significant difference in performance of the participants as a result of the intervention with the NSCEDR using Excel and SPSS.

For the impact of the NSCEDR on gender, the mean and standard deviation for differences in performance between the pre-test and post-test were calculated for each gender. An output from excel of an independent t-test at 5% level of significance was presented to show if there were any gender differences in performance as a function of the NSCEDR. An Excel output of the correlation of the pre-test and post-test for the two groups will be given.

To determine whether the NSCEDR impacted differently on different participants according to their performance in the pre-test, frequencies and percentages for each group were presented as well as the correlation of each group and an independent t-test for the mean difference in performance for each group was calculated using Excel and SPSS.

4.2.1 Difficult topics in Mathematics

Three NSCEDR documents for November NSC examinations were analysed for performance of learners per question, topic and aspects where possible. Questions whose performance level was less than 40% in the three NSCEDR documents were taken to be difficult. The topics and aspects of a topic that have been observed to be difficult in each document are presented in Figure 4.1 below. From Fig 4.1 it can be observed that some topics appeared to be challenging in all the three successive years of examinations. Application of Trigonometry to 3-dimensional shapes (3Ds), application and optimisation in Calculus, proofs in Euclidean Geometry, interpretation, inequalities and transformation in functions and counting principle in probability were found to be challenging in all the three years of examinations. Graphs and interpretation of Trigonometric functions were found to be challenging in 2014 and 2016 examinations, while Similarity and Proportionality problems in Euclidean Geometry were challenging in 2014 and 2015.

Probability involving the counting principle has been observed to be the most difficult according to the average performance of the 2014 to 2016 sample results from the NSCEDR, while Trigonometry, involving graphs and interpretation, was the least difficult of the 7 aspects of Mathematics topics found to be difficult or more challenging to learners. The topics and aspects of a topic that have been found to be difficult or challenging are given in table 4.1, together with the average performance difficult, and the paper under which each topic belonged. The average performance was obtained by taking the mean of all the percentage performances of each topic over the three years. The column labelled paper indicates the examination paper in which the topic was examined. Analysing these difficult topics and relating them to their percentage contribution the examination according to NSC examination guidelines, Trigonometry and Euclidean Geometry contributed approximately 30% of the final mark, while Calculus and Counting Principle parts contributed about 10%. The section on functions contributes about 8%. The observations from the NSCEDR documents as well as from the research participants showed that most learners did not attempt to answer questions on Euclidean Geometry and 3Ds in Trigonometry. This was evident from the learners' scripts in the pre-test and post-test. Out of the 74 learners who wrote the pre-test and post-test, about 46% and 41% respectively, of the learners did not attempt to answer most of the questions in Trigonometry and Euclidean Geometry. These two topics were perceived to be difficult by a sizable number of learners.

Table 4.1: Challenging topics in Grade 12 Mathematics

Topic	Aspect	Average % performance	Paper
Probability	Counting Principle	20	1
Functions and graphs	Interpretation and transformations	30	1
Calculus	Application to optimisation	31	1
Euclidean Geometry	Circle geometry proofs	32	2
Euclidean Geometry	Similarity and Proportionality	33	2
Trigonometry	Application to 3D	34	2
Trigonometry	Graphs and interpretation	36	2

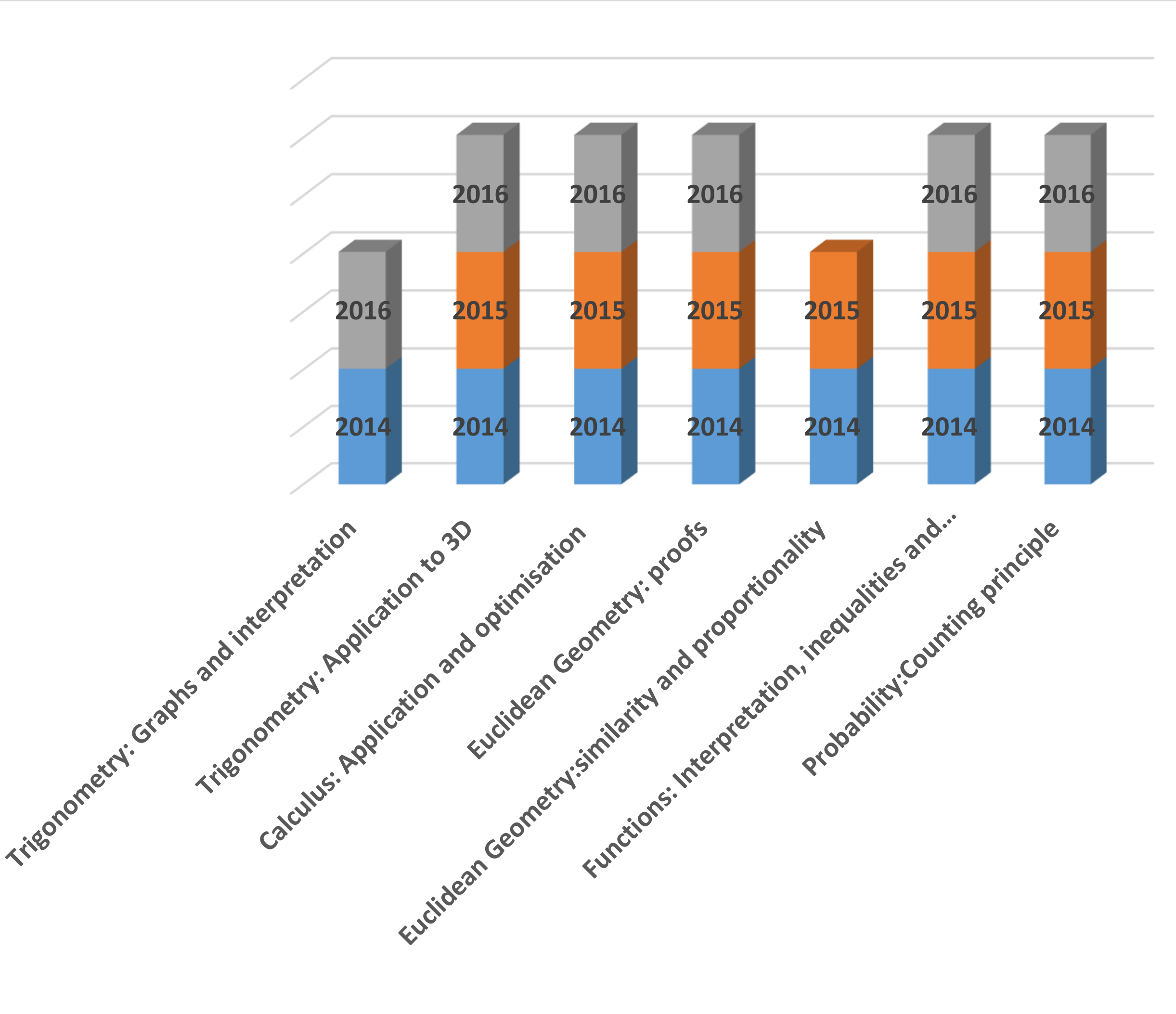


Figure 4.1: Difficult Mathematics topics as observed from NSCEDRs

4.2.2 Analysis of marks before and after intervention with the NSCEDR

The analysis of the learners' marks before and after the intervention programme using the findings of the NSCEDR are displayed in tables 4.2 and 4.3 from an Excel output. Table 4.2 shows the number of learners who wrote both the pre-test and post-test examinations and how they performed in the post-test in relation to the pre-test. From table 4.2, it can be said that the performance of the learners after the intervention improved from the performance before the intervention. The table shows that 81% of the learners improved their performance, 5% maintained their performance, while 14% of the learners' marks went down after the intervention. All learners who passed the pre-test passed the post-test and about 12% of the learners who failed the pre-test passed the post-test examination.

A cut off point of 30% was used as a pass mark according to the DBE Curriculum and Assessment Policy Statement to analyse the performance of the learners. Figure 4.2 shows the percentage of learners who passed and failed in each of the two tests. In both tests the performance of the learners was very low with 20% and 30% passing the pre-test and post-test respectively, while 80% failed the pre-test and 70% failed the post-test. With the pass percentage increasing and the number of learners who improved from the pre-test being 81% it can be tentatively said the use of the NSCEDR improved the learners' performance in Mathematics. The actual marks of the learners are displayed in appendix A.

Table 4.2: Performance of learners after the intervention

	Males		Females		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Improved	22	30	38	51	60	81
No change	3	4	1	1	4	5
Decreased	3	4	7	10	10	14
Total	28	38	46	62	74	100

Figure 4.2: Percentage performance in pre- and post-test

In table 4.3, the mean percentage mark in the pre-test was 20.2, while it was 24.9 in the post-test. The information indicates that the mean mark of the learners in the post-test examination was greater than the mean mark in pre-test examination before the intervention programme hence an improvement in performance after the intervention. To find the correlation between the pre-test and post-test mark, a Kolmogorov Smirnov test for normality was calculated. The test statistic for the pre-test marks was 0.135 and post-test was 0.108 and were compared to a Kolmogorov Smirnov critical value of 0.158 at 5% level of significance. The test showed that both the pre-test and post-test marks were significantly normally distributed. Thus, due to the marks being normally distributed, a Pearson's correlation coefficient was found to be 0.94. The correlation coefficient indicated that there was a very strong association between the performance of the learners in both before and after intervention tests. The correlation between the performance of the learners in pre- and post-test marks was high and positive which indicated that leaners who scored low marks in the pre-test scored low marks in post-test, while those who scored high marks in the pre-test scored high marks in the post-test. Both marks for the pre-test and post-test were widely spread out with standard deviations of 17.5 and 16.7 respectively.

Table 4.3: Summary of performance of learners

	No. wrote	No. passed	No. failed	Mean mark	Standard deviation	Pearson correlation coefficient
Pre-test	74	15	59	20.2	17.5	
Post-test	74	22	52	24.9	16.7	0.94

To test whether the improvement observed after the intervention was significant, a paired t-test was used to test whether the use of the NSCEDR findings improved the performance of the learners or not. The null and alternative hypotheses stated that:

H_0: There is no difference in performance of the learners before and after the intervention programme.

H_1: There is a difference between the performance of the learners before and after the intervention programme.

H_1: The performance after the intervention programme was better than before the intervention.

Table 4.4: Paired t-test for the performance of the learners

Aspect	**Value**
Mean difference	4.622
Standard deviation of the differences	5.766
Hypothesised mean difference	0
Test statistic (t-test)	6.894
Degrees of freedom	73
One tail p-value	0.000
Two tail p-value	0.000
Confidence level (95%)	1.336
Lower confidence limit	3.286
Upper confidence limit	5.958

The test was carried out at 5% level of significance and a 95% confidence level of the differences in pre- and post- test marks was calculated. The 95% confidence interval shows that the mean difference mark between pre-test and post-test was between 3.286 and 5.958, that is 95% of the differences in marks between pre-test and post-test lied between 3.286 and 5 958.

The mean of the differences in performance before and after the intervention programme was 4.622 and the standard deviation was 5.766. Two tests were done.

The null hypotheses for both tests stated that there is no difference in mean mark between the pre- and post-test marks. The first alternative hypothesis was to find out if there is any difference in the performance before and after the intervention. This alternative was referred to as a two tailed test, as it sought to determine if there was any change in the performance regardless of the direction of the change. The second alternative sought to find the direction of the change in performance, i.e. whether the performance improved after the intervention or not. A p-value of 0.000 was found for both tests and compared to the significance level of 0.05. For the first test the null hypothesis was rejected in favour of the alternative hypothesis which indicated that there was a statistically significant difference between the performance of the learner before and after the intervention. The second test also rejected the null hypothesis and concluded that the performance of the learners after the intervention was better than before the intervention. The t-test indicated that the use of the NSCEDR in the intervention programme improved the performance of the learners in Mathematics.

4.2.3 Gender as a function of the NSCEDR

Figures 4.3 and 4.4 show the performance of boys and girls after the intervention. This was done by comparing the marks in the post-test to the pre-test marks. The figures indicate whether there was an improvement, no change or there was a decrease of the post-test mark from the pre-test mark. Figure 4.4 show that of the 46 girl participants, 83% improved their performance, while for the 28 boys who participated, 78% improved their performance, as shown in figure 4.3. This could mean that girls improved more than boys after the intervention, however to ascertain this an independent t-test was carried out. Of the 28 boys, 11% had lower marks in the post-test compared to the girls at 15%. There were learners whose performance did not change. The percentage of boys whose marks remained the same was 11% compared to girls at 2%. These results may not give a clear indication of how the boys and girls performed against each other as a result of the use of the NSCEDR's findings. As a result, to compare the impact of NSCEDR on boys and girls an independent t-test was done. To be able to use the independent t-test, a Levene's test for equality of variance between the performance of boys and girl was done using SPSS. The calculated test statistic value was 0.511, which was greater than the significance level 0.05 used, hence the test showed that there was no significant difference between the variances of the differences in the marks of boys and girls, thus enabling the use of the independent t-test for equal variances to test the differential performance of boys and girls as a function of the NSCEDR intervention. The mean difference of the pre-test and post-test marks was used to test the hypothesis. The null and alternative hypotheses stated that:

H_0: There is no difference between the performance of boys and girls after the intervention versus

H_1: The performance of boys and girls after the intervention is different.

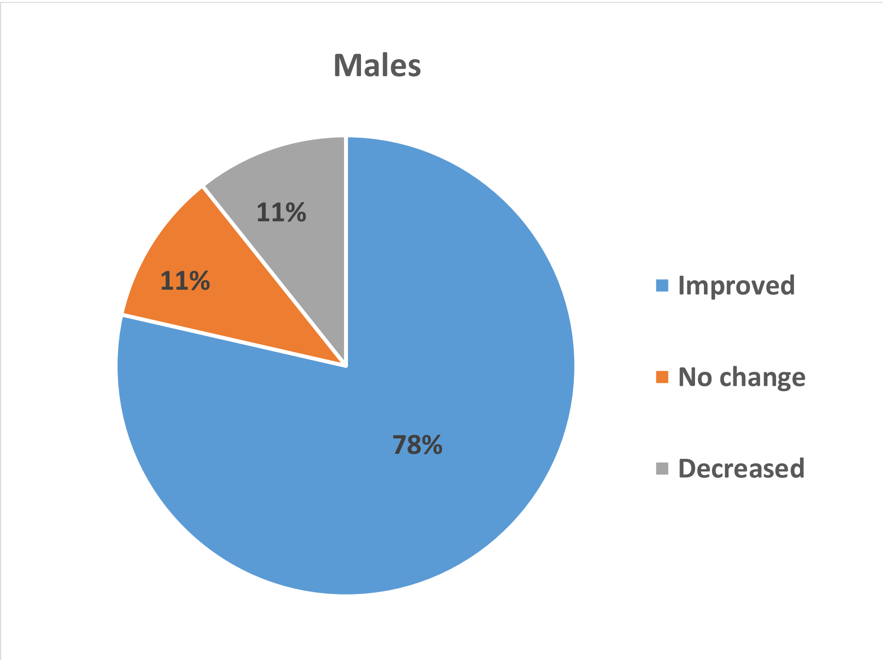


Figure 4.3: Performance of boys after the intervention

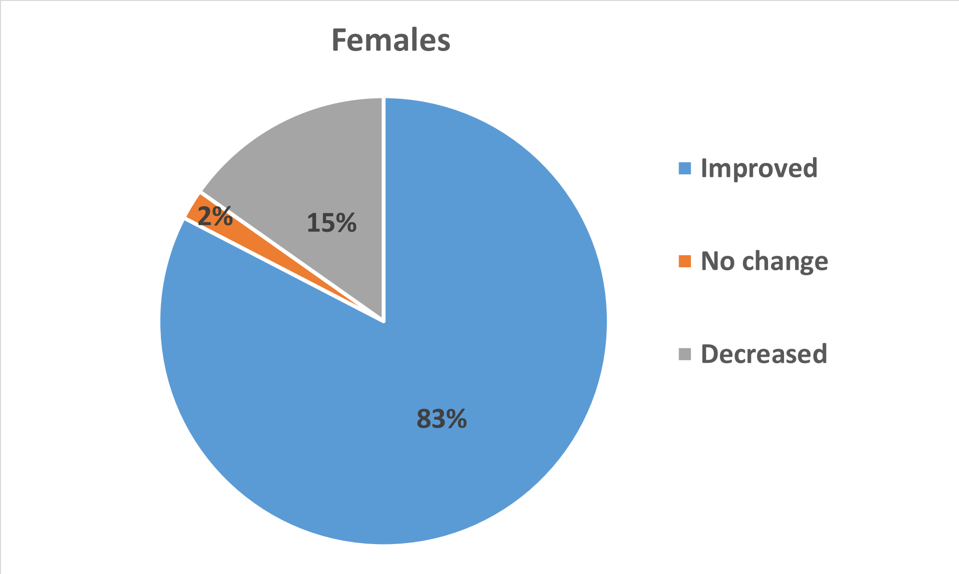


Figure 4.4: Performance of girls after the intervention

The mean difference of the pre- and post-test marks for girls was 4.304 and it was 5.142 for the boys. On average the boys' performance improved more than the girls however, the girls' difference in performance was less spread out than that of the boys with standard deviations of 5. 362 and 6.445 respectively. The independent t- test showed a p-value of 0.548 which was more than the 0.05 level of significance with 72 degrees of freedom. The t-test showed that the performance of learners after the intervention was independent of gender. Table 4.5 below shows the results of the t – test from an Excel output.

Table 4.5: Results of the t- test for independence between gender

Gender	Number	Mean	SD	t	d f	Significance
Boys	28	5.142	6.445	0.604	72	0.548
Girls	46	4.304	5. 362			

4.2.4 Effect of the NSCEDR on low performers and high performers

This section analysed the performance of the two groups of learners as a function of the NSCEDR. The groups were created according to the performance of the learner in the pre-test. A learner who obtained a mark below 30% belonged to the low performers otherwise the learner belonged to the high performers. There were 59 low performers and 15 high performers. The mean of the differences between the pre-test and post-test for high performers was 2.53, while it was 5.15 for those who had failed the pre-test. The mean difference in performance might indicate that the low performers were impacted more by the NSCEDR than the high performers. The differences in marks for pre-test and post-test were more varied for high performers than the low performers hence from the Levene's test for equality of variances, it could not be assumed that the variances were homogeneous. Table 4.6 shows the summary statistics for the performance of the two groups and an independent t-test for unequal variances was used to determine if there was any statistical significant difference between the performances of the two groups after the intervention programme. A 5% level of significance was used. The null hypothesis stated that the mean difference performance for low performers is not different from the mean difference in performance of the high performers versus the alternative which stated that there was a difference in mean difference in performance.

Table 4.6: Independent t-test on the difference in performance between low performers and high performers

Ability group	Number	Mean	SD	t	d f	Significance
Low performers	59	5.153	4.766	1.140	72	0.271
High performers	15	2.533	8.568			

The p-value (0.271) was greater than 0.05, the level of significance, hence there was no significant statistical evidence to reject the null hypothesis, thus the performance of low performers and high performers as a result of the NSCEDR was not different. The impact of the NSCEDR on low and high performers was indifferent.

4.3 Summary

This chapter presented the findings and results of the intervention programme. The intervention programme was found to have improved the performance of the learners, while the performance of the learners according to gender and performance in pre-test was found to be indifferent that is there was no evidence at 5% level that one group performed better than the other. The next chapter will give an overview of the study, review of the findings, conclusions based on the findings, limitations and suggestions for future research.

CHAPTER 5

DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents an overview of the research from the previous four chapters before the recommendations. A mixed method approach, whereby both qualitative and quantitative methods were used to find out the topics and aspects of Mathematics that were more challenging. These challenging topics boosted the unpleasant Mathematics results from the Grade 12 learners. The errors, misconceptions and suggestions from the NSCEDR findings were integrated in an intervention programme to help improve instruction and help improve the performance of the learners as well as preparing the learners for their final Grade 12 examinations. The quantitative research was used to correlate the marks from the pre-test and the post-test to determine the effectiveness of the intervention programme.

Seventy-four learners from Grade 12 were selected using convenient sampling and wrote two standardised tests (pre-test and post-test). The post-test was done to determine whether the intervention programme improved the performance of the learners or not. The participants were made up of 28 boys and 46 girls who all sat for the pre-test and post-test. Excel and SPSS were used to analyse the marks of the learners from the two standardised tests.

5.2 Research questions

The DBE and the NSCEDR have both posited that the integration of the findings from the diagnostic reports can help teachers improve instruction and in turn improve learner performance. The research questions of the study were:

5.2.1 Which topics and aspects of a topic are challenging to learners in Mathematics?
5.2.2 To what extent does the use of the NSCEDR improve performance in Mathematics?

5.2.3 To what extent does the use of the NSCEDR impact on gender?

5.2.4 To what extent does the NSCEDR impact on low performers and high performers?

5.3 Discussion of the findings

5.3.1 Research question 1

During the intervention programme it was observed that some learners were not comfortable when working with problems involving proofs of any topic, application of Trigonometry, Euclidean Geometry in general and Probability especially counting principle. These topics observed to be difficult or challenging during the intervention programme have been complemented by the findings from the 2014 to 2016 NSCEDR documents. Trigonometry and Euclidean Geometry being the outstanding ones contribute about 30% of the final Examination mark, while counting principle contributes about 3% in the NSC examinations. Thus, there are some topics and aspects of topics in Mathematics that contribute to the low performance of the learners because they are difficult to learners, and at the same time contribute a significant percentage to the final examination mark of learners, and therefore their poor performance in Mathematics.

5.3.2 Research question 2

The integration of the NSCEDR in the intervention programme was found to have some positive effects in the performance of the learners. The performance of the learners in the pre-test was significantly different from the performance in the post-test indicated by a higher mean mark in the post-test than in the pre-test. The study found out that there was a high correlation of 0.94 between the performance of the learners before and after the intervention programme. Thus, learners who did well in the pre-test performed well in the post-test whereas those who performed poorly in pre-test continued to perform poorly although there was an increase in the post-test performance. The study rejected the null hypothesis that supported that there was no difference in the performance of the learners before and after the intervention programme. A one –sided p-value of 0.0000 was found and compared to the significance level of 0.05. The test showed that the performance of the learners after the intervention programme was significantly better than before the programme thus, statistically the programme improved the performance of the learners however, only a small percentage (30%) of the learners passed the post-test. Therefore there is still a great need to integrate the NSCEDR with other teaching and learning interventions to help learners to not only improve performance but to pass Mathematics at the end of the day.

5.3.3 Research question 3

A higher percentage (83%) of girls improved their performance after the intervention as compared to the percentage of boys that was 78%. The independent t-test at 5% level of significance carried out to determine whether there was a difference in the performance of girls and boys as a result of the intervention found no significant difference between the performance of boys and girls as a function of the NSCEDR with a p-value of 0.542. The use of the NSCEDR, consequently did not impact differently on gender.

5.3.4 Research question 4

Learners who performed below 30% in the pre-test were taken as the low performers, while those who performed above 30% were the high performers. The difference in the marks between the pre-test and post-test were used to find out the group of learners that was more affected by the intervention programme as a function of the NSCEDR. The difference in performance between pre-test and post-test of the two groups of performers showed a mean of 2.53 for the low performers and 5.15 for the high performers, thus according to the mean differences, high performers improved better than the low performers. However, an independent t-test gave a p-value of 0.271, which was greater than the significance level of 0.05 used, therefore the performance of the two groups of learners was indifferent with respect to the use of the NSCEDR. In other words, from the results of the study, the intervention programme affected both groups of learners almost equally, as the test on the difference in performance was insignificant.

Having outlined the outcomes of the study, the findings agree and disagree with some researchers about the gender differences in performances of males and females in Mathematics. Researchers like (Benbow & Stanley, 1980; Fennema & Sherman, 1978; Frenzel, Pekrun, & Goetz, 2007) concluded that males outperformed females in Mathematics. Other researchers like (Niederle & Vesterlund, 2010; Goldin, Katz, &

Kuziemko, 2006) concluded that the gender performance difference had shifted in favour of females. This study however differs with the findings by the named researchers. The study found out that the gender difference in Mathematics performance due to an intervention programme did not favour any gender as there was no statistical evidence to support any gender difference in performance. Thus supporting Kurtz-Costes, Rowley, Harris-Britt, and Woods (2008)'s findings that there was no significant difference between the performance of boys and girls in Mathematics.

This study found out that low Mathematics performers and high Mathematics performers when subjected to an intervention programme showed no significant difference in their performance. The researcher did not find any researcher who compared the performance of learners in terms of their Mathematics ability except for the researches that compared the performance of learners with disabilities and those without.

Knowledge of learners' errors and misconceptions in Mathematics helped the researcher to intervene and attempt to minimise the errors thereby improving the learners' performance. The research's findings proved that with enough intervention and knowledge of possible errors and misconceptions in Mathematics, a teacher may refine her teaching strategies and help learners to perform better in Mathematics. Most researchers like Nhamburo et al. (2014) analysed and identified the errors committed by learners and did not intervene to eradicate or minimise the errors. This research therefore went a little bit further and used the identified errors and misconceptions from other learners' work in an intervention programme to minimise the errors and hence improve the learners' performance. The research therefore encourages the use of error analysis in teaching and learning to eradicate errors and misconceptions and in the long run yield better understanding and performance in Mathematics by the learners.

Lastly the research managed to highlight some topics and aspects in High School Mathematics that contribute to the lower performance of learners. While in Nigeria one researcher identified some difficult topics in the Nigerian Mathematics syllabus the researcher has identified the topics as per the South African syllabus. The findings would help all stakeholders and most especially the curriculum designers, textbook writers as well as teachers to devote more time and work on the topics for the learners' understanding. These findings if executed well would shift the focus of the supervisors on teachers failing to deliver but to focus on how best the difficult topics may be taught for the benefit of the learner.

5.4 Limitations of the study

5.4.1 Due to the sampling method and the use of the one-group pre-test and post-test research design the findings of this research could not be generalised to the whole population.

5.4.2 The time through which the intervention was carried out was very short such that the impact of the NSCEDR may not have been fully realised since all topics could not be completed.

5.4.3 The time between the administration of the pre-test and post-test was very long in such a way that maturity of the learners may have played a role in improved results.

5.4.4 Some topics had to be revisited during the intervention programme owing to the backlog of the previous years' work insufficiently completed due to fast tracking of work to be covered before the quarterly tests that are administered across all grades.

5.5 Recommendations

In this research study, the participants were the Grade 12 learners from one selected school. The improvement in the performance of Mathematics Grade 12 begins with the teacher and help provided to the learners. Knowledge of Mathematical content, errors and misconceptions is very crucial for the teacher to disseminate the information successfully to the learners to achieve good results. The recommendations from the study are suggestions on how the performance of the learners in Mathematics can be improved.

- First and foremost, it would be very important that there is enough teaching and learning time before testing the learners for school based assessment (SBA). The syllabus for Mathematics seems to be very long owing to the quarterly tests administered thereby eating into teaching and learning time for the learners. It would be better if the learners could be tested twice in a year to allow more time for learning and proper completion of the syllabus. A study on teaching time, testing, content coverage and performance is recommended.

- The NSCEDR documents need to be accessible for all educators to use. Most of the documents are kept in the academic principal's offices and hence teachers may or may not know about their availability, thus not being able to utilise them to the learners' benefit.
- Mathematics textbook writers need to revise the way the most challenging topics are presented and try to come up with more ways and methods of presenting them so that learners can apply and comprehend them. There is need to simplify the topics that are more challenging as well as giving the topics more time during teaching and learning.
- The attention given to Grade 12 learners by all stakeholders and the government, need to be uniform across all grades from primary school to high school. Intervention programmes mostly are meant for Grade 12 and while other grades are ignored, yet it would be better to intervene when the learners are still in the lower grades to improve their long-term memory and instil good attitude, motivation and Mathematical practice.
- There is need to find ways for effective use of the findings of the NSCEDR in relation to error analysis and feedback to improve Mathematics performance in Schools.
- Lastly there is need to relook at the sequencing and gradient of the topics from grade 8 to 12. The researcher feels that some of the topics covered in grade 8 and 9 have a steep gradient such that learners are demotivated and hence develop a negative attitude towards Mathematics as they go up their education ladder. Positive attitude and motivation need to be cultivated in earlier grades especially at primary school.
- For future study the researcher recommends that researchers determine the most effective way of teaching the outlined difficult topics. Furthermore an investigation on how to best utilise error analysis findings could be conducted.
- The behaviour and discipline of the learners could also be investigated to establish the impact of a learners' behaviour in his/her Mathematics

performance to shift the focus on teachers being the culprits of poor learner performance in Mathematics.

5.6 Conclusion

The reason for undertaking this research was to determine the impact of the use of the findings from the NSCEDR on the performance of learners using an intervention programme with learners selected from one school in Umhlathuze circuit. Based on the analysis and interpretation of the research questions, objectives and hypotheses of the study, the Grade 12 learners from the school were not performing well in Mathematics, hence they were involved in the intervention programme in an attempt to improve their performance. The research concludes that the effective use of the NSCEDR findings on errors and misconceptions in intervention programmes as well as in every day teaching and learning of Mathematics could help improve the performance of the learners.

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APPENDIX

Appendix A: Test marks of the participants

Names	Gender	Pre-test Mark	Post-test Mark	Names	Gender	Pre-test Mark	Post-test Mark
		100	**100**			**100**	**100**
A1	F	3	7	**A38**	M	25	25
A2	M	6	10	**A39**	M	11	17
A3	F	23	29	**A40**	F	35	40
A4	M	11	16	**A41**	M	8	27
A5	M	40	35	**A42**	F	3	7
A6	F	32	40	**A43**	M	48	65
A7	F	4	12	**A44**	F	10	18
A8	F	20	26	**A45**	M	8	12
A9	F	12	15	**A46**	M	14	22
A10	F	24	29	**A47**	M	4	14
A11	F	59	50	**A48**	F	40	45
A12	F	28	36	**A49**	M	16	26
A13	M	2	3	**A50**	F	48	57
A14	F	10	14	**A51**	M	20	22
A15	F	7	12	**A52**	F	20	27
A16	M	78	66	**A53**	M	9	23
A17	F	39	35	**A54**	M	4	9
A18	F	20	21	**A55**	F	14	13

A19	F	12	6	**A56**	M	7	13
A20	F	32	42	**A57**	F	4	6
A21	F	27	20	**A58**	F	9	20
A22	M	34	48	**A59**	M	87	92
A23	F	17	36	**A60**	F	4	5
A24	F	29	38	**A61**	F	12	16
A25	F	28	31	**A62**	M	14	14
A26	F	7	10	**A63**	M	29	33
A27	F	32	34	**A64**	M	10	14
A28	M	2	8	**A65**	M	2	7
A29	F	10	13	**A66**	M	6	16
A30	F	13	17	**A67**	F	26	31
A31	F	29	29	**A68**	F	1	9
A32	M	19	18	**A69**	F	16	15
A33	F	18	24	**A70**	F	22	34
A34	F	5	13	**A71**	F	8	15
A35	F	48	41	**A72**	M	65	65
A36	M	15	18	**A73**	F	14	20
A37	F	14	26	**A74**	F	22	24

Appendix B: Ethical clearance certificate

UNIVERSITY OF ZULULAND
RESEARCH ETHICS COMMITTEE
(Reg No: UZREC 171110-030)

RESEARCH & INNOVATION
Website: [illegible]
Private Bag X1001
KwaDlangezwa 3886
Tel: 035 902 6887
Fax: 035 902 6222
Email: [illegible]

ETHICAL CLEARANCE CERTIFICATE

Certificate Number	UZREC 171110-030 PGM 2017/367
Project Title	Impact of National Senior Certificate Examination Diagnostic Report on Learner Performance in Mathematics
Principal Researcher/ Investigator	T Chihambakwe
Supervisor and Co-supervisor	Prof DR Nzima
Department	Educational Psychology and Special Education
Faculty	Education
Type of Risk	Medium – Data collection from people
Nature of Project	Honours/4th Year [ ] Master's [x] Doctoral [ ] Departmental [ ]

The University of Zululand's Research Ethics Committee (UZREC) hereby gives ethical approval in respect of the undertakings contained in the above-mentioned project. The Researcher may therefore commence with data collection as from the date of this Certificate, using the certificate number indicated above.

Special conditions:

(1) This certificate is valid for 2 years from the date of issue.
(2) Principal researcher must provide an annual report to the UZREC in the prescribed format [due date-30 April 2018]
(3) Principal researcher must submit a report at the end of project in respect of ethical compliance.
(4) The UZREC must be informed immediately of any material change in the conditions or undertakings mentioned in the documents that were presented to the meeting.

The UZREC wishes the researcher well in conducting research.

Professor Gideon De Wet
Chairperson: University Research Ethics Committee
Deputy Vice Chancellor: Research & Innovation
15 May 2017

CHAIRPERSON
UNIVERSITY OF ZULULAND RESEARCH ETHICS COMMITTEE (UZREC)
REG NO: UZREC 171110-30
15 -05- 2017
RESEARCH & INNOVATION OFFICE