

**ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING
SUCCESS RATES IN BRIDGING MATHEMATICS**

By

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SUMMARY

The aversion to the study of mathematics and the resultant poor performance by students generally cannot be overemphasized and this still poses a great threat to the needed skills in the science, technology and commerce sector in South Africa. This study therefore tends to explore the importance of Mathematics to students and the economy globally by focusing on which contributive psychological factors are responsible for low performance in mathematics among Pre degree students as a case study.

In addition also, the teaching and learning strategies used in the classroom that will help curb mathematics anxiety among students will be looked into. Furthermore a test to ascertain if poor teaching methods or pedagogical content knowledge of mathematics' teachers influence anxiety thereby leading to poor performance in mathematics will be carried out. By utilizing a mixed method approach, an integration of the qualitative and quantitative approaches, the study attempted to provide an insight into the poor performances in Mathematics by Pre-degree students in a Private Institution of higher learning by exploring the following affective domains: 1) Anxiety 2) Motivation (lack of either the Internal & External type) and also considering the teaching strategies adopted on the other hand.

The theoretical framework applied to this study was three fold in nature, namely, to investigate the nature of the relationship between mathematics anxiety and mathematics achievement on one side, secondly, to investigate the nature of the relationship between motivational orientation and mathematics achievement on the other side. Finally, it will investigate the relationship between teaching methods and mathematics achievement.

The major findings that emanated from this study were as follows: there is a strong impact of the affective factors (anxiety, beliefs, emotions and motivation) on mathematics learning and success rates among Pre-degree students in South Africa. This study shows the importance of affective factors (such as anxiety, negative attitude, lack of motivation) in determining the success and or failure of mathematics learning, with the intention of promoting and encouraging positive traits, attitudes and beliefs in the students.

The issue of teaching strategies was however not of a strong impact on success rates in bridging mathematics among the students as their lecturers were commended to be on top of their subject, but only that strategies to teaching mathematics must be dynamic, effective and varied as much as possible to meeting the students diverse learning styles .

Key Terms

- Pre-degree Foundational Programme
- Bridging mathematics
- Mathematics anxiety
- Intrinsic and Extrinsic motivations
- Teaching strategies
- Affective and Cognitive domains
- Transformative Paradigm

DECLARATION

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I declare that **ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATES IN BRIDGING MATHEMATICS** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNATURE OF STUDENT

DATE

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Samson Oluwaseun Sofowora
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LIST OF ACRONYMS

TIMSS	-	Third International Mathematics and Science Study
ANOVA	-	Analysis of Variance
REC	-	Research Ethics Committee
MGI	-	Midrand Graduate Institute
SMEC	-	Science and Mathematics Education Centre
CAS	-	Centre for Aboriginal Studies
CTEC	-	Commonwealth Tertiary Education Commission
SU	-	Stellenbosch University
NCHE	-	National Commission on Higher Education
ICCB	-	Illinois Community College Board
ZPD	-	Zone of Proximal Development
HERDSA	-	Higher Education Research and Development
HELTASA	-	Higher Education Learning and Teaching Association of Southern Africa
CHE	-	Council on Higher Education
HEQC	-	Higher Education Quality Committee
EDP	-	Extended Degree Programme
UKZN	-	The University of KwaZulu-Natal
UWC	-	University of Western Cape
PET	-	Port Elizabeth Technikon
CSA	-	Centre for Science Access
TUT	-	Tshwane University of Technology
CPUT	-	Cape Town Peninsula University of Technology
MSAFP	-	Monash South Africa Foundation Programme
MMR	-	Mixed Method Research
MAS	-	Mathematics Anxiety Scale
HEI	-	Higher Education Institution

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CHAPTER ONE

INTRODUCTION, OVERVIEW AND PLAN OF STUDY

1.1. INTRODUCTION

One often wonders why people say “they do not like mathematics”, and why there has been a great deal of aversion for the subject amongst students of nowadays which has led to the poor performance in the subject by most students. According to Beilock (2010:1860) author of *Choke*, a 2010 book on brain responses to performance pressure, said, “No one walks around bragging that they cannot read, but it is perfectly, socially acceptable to say you don’t like math.”

The researcher, in his five years of teaching mathematics at a South African high school has observed with great concern, students’ anxiety and attitude towards mathematics learning. These factors consequently lead to an avoidance of mathematically related subjects and a decline in students pursuing careers in mathematics and science to less public interest in financial markets.

These factors may have further affected their conceptual thinking and memory processes (Skemp 1986:54). I have also noticed an alarming increase in the number of students dropping mathematics for mathematics literacy later on in high school.

Before the new curriculum (NSC) was introduced in 2008, students could choose to take mathematics on Higher Grade level, Standard Grade level or not at all. The “not at all” part is the scary statistic. In Brombacher (2010) report on mathematics and mathematics literacy; during 2000 - 2005 as many as 40% of students did not have mathematics as a subject at all. Furthermore, about half the students who took mathematics were on the Standard Grade level. During the period from 2000 to 2005, the average percentage of students out of the entire cohort of matric exam candidates merely passed on Higher Grade mathematics was a dismal 5.2%. Forcing students to do Higher Grade mathematics, “in order to keep all options open for tertiary education” was a common trend that actually set students back, because failing mathematics meant there was no option for tertiary education at all, hence the introduction of Mathematical Literacy.

The result of these failures have been attributable to a complex set of interacting factors such as anxiety, lack of motivation and poor teaching methods (Meece, Wigfield, and Eccles 1990). There has been a spillover effect from the high school so called anxious mathematics students to the Pre-degree programmes of higher education or tertiary institutions today. There is an influx of students with this perception that “mathematics is not for them”. Their belief has been that mathematics is for the “strong hearted” few.

However, the main cause for mathematics anxiety can be traced back to their prior experiences with formal or traditional instruction in mathematics at elementary and secondary level (Lazarus, 1974; Jackson and Leffingwell 1999). These negative feelings regarding mathematics have been imported by these students into their tertiary studies.

For a variety of reasons, it is inevitable that some students will leave secondary school without undertaking and/or passing all 12 subjects which are pre-requisites for entry to the tertiary courses they may want to undertake at some stage. Such students need a "second chance" to qualify for admission into any tertiary courses. One approach, which forms the focus of this research, involves higher education institutions providing appropriate *bridging courses* to enable currently unqualified students to upgrade their knowledge sufficiently to qualify them to enter tertiary programmes (Fraser, Malone and Taylor, 1990).

“Bridging mathematics” is a course which connects the ideas of the mathematics taught at secondary school levels with those taught at tertiary level. There are a number of South African students and including those who live abroad whose stories and progression show that the National Senior Certificate results (or equivalent) are not necessarily sufficient predictors of success in Higher education, although a number of students have revealed that they are ill-equipped for such success. The varying standards at our secondary schools today reveal a large diversity in students’ readiness for higher education, which is aggravated by the number of second language students. Within the National Policy, there is the mandate to improve equity, widen access and redress those glaring inequalities among them the National Plan for Mathematics and Science taken as school subjects (Council on Higher Education, 2010; Jansen, 2010; Coughlan, 2006).

Some have queried why the University included mathematics at Pre-Degree level; the reasons for this are not far-fetched. These include the following:

- importance of related numeracy and logic skills required in every degree
- continuous decline in National School Certificate (NSC) mathematics numbers and performance
- Perceived inability of Mathematics Literacy to achieve Higher Education objectives and also decline in performance
- Shortage of mathematics teachers = poor teaching at secondary level for some students. (Journal of Anxiety Disorders: Hopko, McNeil, Lejuez, Ashcraft, Eifert, and Riel, 2003)

The Pre-degree programme was established to allow less fortunate matriculants the benefit of tertiary education, one of the few schools to start this programme was Midrand Graduate Institute (MGI) in 2003. Of the total enrolment up until 2011, approximately 95% of students took English as their second language. There are approximately 16 first languages some of which are the eleven official languages of South Africa; to French and Mandarin. Literacy seems to be a rather large obstacle to overcome for many students. Evidence has revealed a high correlation between the medium of secondary schooling and English as a first language results (Council on Higher Education Poster, 2011: “The Role of a Foundation Programme at a Private Higher Education Institution”).

It has been observed that students enrolling for the Pre-degree module are matriculants from high school whose mathematics scores are low and insignificant. Most importantly, these students’ minds have been somewhat “abused” so to say, during their five years of high school. The root cause of this varying amount of mathematics anxiety is caused by poor instructional methods, such as assigning the same work for everyone, working through the textbook problem by problem, insisting on only one correct way to solve a problem, using the lecturing method often, concentrating on basic skills rather than concepts, and devoting more time to seat work and whole-class instruction (Furner and Berman, 2005; Tobias, 1998). These “traditional” ways of teaching can lead to mathematics anxiety, this being said, teachers are used to the show-and-tell approach to teaching, which rarely allows students an opportunities to interact and ask questions (Van de Walle, 2005).These

traditional teaching methods often lead to students failing mathematics, which invariably develops negative attitudes in students and ultimately a lack of interest in the subject.

A negative attitude towards mathematics is a growing barrier for many students to mathematics (Ashcraft, 2002; Popham 2008; Rameau and Louime, 2007). Most students have been forced to change their career options as a result of the need for mathematics as a prerequisite for some courses at higher institutions. Even after their dismal performances in high school mathematics, some students had no choice but to face the challenges head on by taking the mathematics bridging module, Mathematics by its nature involves both cognitive and affective effect. Sutton (1997:44) further argues that the glory of mathematics lies in the fact that mathematics does not come easily to anyone. It is in the struggle to understand and the manner in which this is met, that one learns life skills.

Learning mathematics therefore, is a cognitive endeavour which plays an important role in how much mathematics students will know in future and how they will approach the mathematical content they study. Students' feelings about mathematics and how they perceive it, the nature of the classroom and their perception of themselves all form the affective domain that is very important in determining student's achievement. A student that feels very positive about mathematics is more likely to perform better than the one with negative feelings. (Reyes, 1984)

In conclusion, sufficient research is therefore required in the areas of mathematics anxiety, motivational orientations and instructional technologies as the root causes of failure in mathematics among students; to find ways of possibly reducing or at best preventing this trend at the pre-degree level of higher institutions in Gauteng.

1.2 RESEARCH PROBLEM

The decline in South Africa's high school mathematical performances today has become evident in the higher institutions as well; this is influenced by two major psychological factors, which are intrinsic in nature among the students. These include the students' mathematical anxiety or what may be regarded as a phobia, and lack of adequate motivation for these students to do well in this subject.

When it comes to writing continuous assessment tasks or examinations, as observed by the researcher in his long years of teaching mathematics, the first trait exhibited by most students in general is their anxiety and lack of interest to write the mathematical paper, as a result of their low self-esteem. These will automatically hamper the execution and invariably their performance of the task at hand, thus disabling processing of incoming information as well as their prior knowledge.

Some students when asked if they studied and practiced their mathematics topics, their answers were in the affirmative, "Yes I did. In fact I studied all night". However, this hard and late night studying most times by students had a negative impact on their performances. As a result, some students said, "When I entered the examination hall and sat down, after looking through the questions and I was about to answer the first question, everything I read just flew off", and I started fidgeting". This statement is often common among the low-performing students.

Furthermore, these intrinsic and extrinsic factors could be responsible for the decline in high school mathematics today in many schools in Gauteng, South Africa. These factors include among others, environmental factors such as in school/classroom the educators' content and pedagogical knowledge of the subject matter, motivational orientation, learning approaches, parental influences/family issues and curriculum practices.

It has been observed that many teachers of young students feel rather uncomfortable teaching mathematics, the reason being that they do not understand mathematics themselves. They feel they are not good at mathematics and therefore, feel uncomfortable to teach it to their students (Burns, 1998; Stuart, 2000; Geist 2010). This proves that sometimes mathematics anxiety may not come from the

mathematics itself, but rather from the way the teachers present it to the students. (Stuart 2000).

In addition “Many students who suffer from mathematics anxiety have little confidence in their ability to do mathematics and tend to take the minimum numbers of required mathematics courses, which has greatly limited their career choice options.” (Garry 2005; Karimi 2009) Mathematics anxiety is the outcome of low self-esteem and the fear of failure. It causes problems for processing the incoming information as well as the previously learned information for problem solving. Such students tend to avoid mathematics whenever or wherever possible (Daane and Tina 1986; Karimi 2009).

There is also the aspect of underdevelopment of human potential in education and training during the apartheid era which has left an indelible imprint on the lack of effectiveness in teaching and learning of mathematics and science related subjects in South Africa, which can have a negative impact on students’ attitude towards mathematics.

For example, the Third International Mathematics and Science Study (TIMSS) conducted in 1995, in which South Africa participated along with 41 other countries, South African Mathematics students reportedly came last with a mean score of 351. Another TIMSS research was conducted in 2003 and similarly there was no improvement by South African mathematics and science students (Reddy, 2004).

A further report by UNESCO, UNICEF and the South African Department of Education (Sunday Times, 16th July 2001), amongst twelve countries in Africa, a sample of grade 4 students from South Africa scored the lowest in their numeracy skills throughout the continent. These outcomes will obviously have a resultant effect on the number of students who in fact do have the skills required for future careers in the fields of science and technology in South Africa. To this end, we shall consider the purpose for this study as the research progresses.

1.2.1 RESEARCH QUESTIONS

Main Research Question: What Contributing factors lead to students falling short of the required rates in bridging mathematics?

In addition to the above main question, the following sub-questions will be addressed by this study. They include:

- i. Why has most South African students' interest in learning mathematics dwindled over the years?
- ii. What do teachers do to help students' low self-esteem and attitude towards learning mathematics and performing well in it?
- iii. What triggers the high level of anxiety amongst high school students when it comes to writing mathematics tests or examinations?
- iv. Can a lack of motivation be attributable to pre-degree students' poor performances in mathematics?
- v. How do students perceive their lecturers level of preparation in mathematics before executing them in classes?
- vi. Do the lecturers' methods or strategies impact students' performances and their mathematics anxiety?
- vii. What teaching strategies should teachers/lecturers adopt to teach 'mathematics anxiety students' in order to improve their success rates?

1.3 AIMS OF THIS STUDY

The importance of mathematics for students and the economy globally cannot be over emphasised hence, there is a need to study the cognitive, metacognitive and psychological behaviour of students towards mathematics learning and performance. To this end, the aims of this dissertation will be discussed in the following three dimensions;

- i. To establish which contributing factors lead to low performance in mathematics among pre-degree students.
- ii. To determine what teaching and learning strategies in the classroom may lead to curbing mathematics anxiety among students?
- iii. Lastly, to test if poor teaching methods or pedagogical content of mathematics lecturers contributes towards anxiety or demotivates students leading to poor performance in mathematics.

1.4 HYPOTHESES

In this study three null hypotheses will be tested with a significance level of 0.05, they are:

Ho₁: Mathematics anxiety is independent of academic performance of students in the mathematics bridging course.

Ho₂: Lack of motivation is independent of academic performance of students in the mathematics bridging course.

Ho₃: Teaching strategies is independent of academic performance of students in the mathematics bridging course.

If after the result is carried out using the students t-test with the ANOVA table and the results clearly reveal a significant difference in the academic achievement of mathematical anxious demotivated students, with poor teaching methods in mathematics, the null hypotheses (Ho₁, Ho₂, Ho₃), will be rejected.

1.5 RESEARCH METHODOLOGY

This study firstly, intends to investigate the nature of the relationship between mathematics anxiety and mathematics achievement; secondly, the relationship between motivational orientation and mathematics achievement, and thirdly, it will also investigate the relationship between mathematics anxiety and teaching methods. The research will make use of the mixed model method integrating both quantitative and qualitative methods of data collection.

1.5.1 LITERATURE STUDY

The literature study entails various publications that were done earlier by accredited scholars and researchers; bringing to light knowledge and ideas related to this topic (chapter 2).

This literature review provides the foundation as well as direction to the empirical research.

1.5.2 SAMPLE COLLECTION

The research designs used in this study include a cross section and literature study. The nature of this investigation is empirical involving a qualitative method of data collection and analysis using an inductive approach. The researcher participated in the data collection, exploring via a series of particular observations and using these to form a hypothesis.

To collect the data for this study a questionnaire will be designed containing both open-ended and closed-ended questions on some of the factors which are antecedents of poor academic rates in mathematics (for example high anxiety rates, little or no motivational orientation, poor teaching standards, etc.) and, which impacts on students' retention in higher education. A Five point Likert scale will be used to capture the students' responses to the closed-ended questions. A questionnaire with thirty six items will be given to students with responses given according to the Likert scale, namely: Scale 1 = ***strongly disagree***, scale 2 = ***disagree***, scale 3 = ***neutral***, scale 4 = ***agree*** and scale 5 = ***strongly agree***.

The target population for the study will comprise of all the pre-degree students attending the bridging mathematics module at the Midrand Graduate Institute (MGI) in Midrand, South Africa. The random sample is from a mixed gender population of pre-degree students at MGI. The sample size of this research will be 120 students (equal ratio of men to women). The students will be assessed via interviews, questionnaire and will be pre-identified as having high mathematics anxiety.

Mathematics achievement will be assessed by analysing the classroom progress of these students sampled over a period of time.

1.5.3 DATA ANALYSIS

Once the data is collected from the respondents regarding mathematics anxiety and motivation orientations; inferential statistics and an analysis will be carried out which includes; mean and variance statistical tests, student's t-test and possibly an analysis of variance (ANOVA).

1.5.4 RELIABILITY, VALIDITY AND OBJECTIVITY

To test for reliability, validity and objectivity of the questionnaire prepared for the sample of respondents, a pilot study will be administered on a small sample of respondents before the main study is conducted.

A structured sample of the actual questionnaire and interview schedule will be administered on a smaller sample of respondents; the data will be analysed for inconsistencies, gaps, repetitions or flow in the data collection instrument.

To this end, the questionnaire would be valid due to supporting interviews and the reliability will be further confirmed by a statistical analysis. The questionnaire will be introduced, administered, read aloud and where necessary explained by the researcher.

This process will help to ensure that;

- i. No offensive language is contained in the questionnaire
- ii. There is clarity with regards to the instructions, questions, administration time, layout, coding of questionnaires and data input
- iii. There is a conduction of preliminary data analysis.

1.6 ETHICAL CONSIDERATION

With regards to ethical considerations of my respondents, I will conduct a pre-test unstructured interview either in telephonic or in written consent forms from the respondents (i.e. the identified sample students). I will receive approved written consent from my case study school to conduct my research with the students, their parents and the lecturers.

The aim of consent forms will be to explain the research, get their permission for participation of their wards/children and possibly to get a past history of students (respondents) and their signatures on the form.

In addition, the students will be given a prototype copy of the unstructured consent form, stating why the interview is being conducted and get their consent to willingly participate in the research.

Furthermore, a clearance certificate will be received from the Research Ethics Committee (REC) of the University of South Africa (UNISA). This committee will look especially at the alignment of the study's title along with its purpose, the problem statement and research design covered in the proposal abstract that will be submitted by the researcher; consent forms from the appropriate authorities to conduct the research, letters to the participants in the study and the proposed data collection instruments will be evaluated against relevant sections discussed in the proposal abstract as well.

1.7 CLARIFICATION OF CONCEPTS

The ***Pre-degree Foundation Program*** was introduced at MGI in 2003 as a programme to prepare students who did not pass their matric Senior Certificate with exemption, for a degree programme. Students who fail to meet entry requirements for degrees or those who have the incorrect subject combinations for a desired degree, are permitted to complete the Pre-degree Foundation Programme as an alternative access path. Increasingly this has also become a path for those who struggle with English as the language of teaching and learning. The Higher education institution is one of three private institutions who currently offer a foundation programme.

The pre-degree programme is a foundation programme for students wishing to get a second chance to write an entrance exam into the University to study their desired field. The programme runs for a full year. Once passing the appropriate subjects, of which bridging mathematics is one, students are permitted to register for a degree programme the following year. The main purpose of the Pre-degree Foundation Programme is to prepare students to succeed in their degree studies. A secondary effect is to evaluate the suitability of students for degree studies.

The purpose of ***bridging mathematics*** modules as it were, is to develop relevant numeracy skills and numerical literacy and their application in problem solving so that students are adequately prepared to study first year mathematics modules. Students will also develop their ability to understand and communicate mathematical concepts and interpret results.

Tobias and Weissbrod (1980; 65) defined mathematics anxiety as, “The panic, paralysis and mental disorganisation that arises among some people when they are required to solve a mathematical problem. Mathematics anxiety has been called an illness that is both emotional as well as cognitive dread of mathematics.” (Hodges 1983: 17 – 20; Tobias 1978; 2008: 65; Denhere 2015: 7).

In addition, ***Motivations*** are reasons individuals have for behaving in a given situation. They exist as part of one’s beliefs about what is important, and they determine whether or not one will engage in a given pursuit (Middleton and Spanias

1999 and Ames, 1992). Two distinct types of academic motivation interrelate in most academic settings, namely the intrinsic and extrinsic motivation. Academic ***intrinsic motivation*** is the drive or desire of the students to engage in learning “for their own sake”. Students of this nature engage in academic tasks because they enjoy them. Their motivations tend to focus on learning goals as understanding and mastery of mathematical concepts (Ames and Archer, 1988; Duda and Nicholls, 1992; Dweck, 1986). Students who are ***extrinsically motivated*** engage in academic tasks to obtain rewards (for example, good grades, approval) or to avoid punishment (for example, bad grades, disapproval). These students' motivations tend to center on such performance goals as obtaining favorable judgments of their competence from teachers, parents, and peers or avoiding negative judgments of their competence (Ames, 1992; Ames and Archer, 1988; Duda and Nicholls, 1992; Dweck, 1986).

Teaching Strategies are combinations of instructional methods, learning activities, and materials that actively engage students and appropriately reflect both learning goals and students' developmental needs. These teaching strategies structure schedules, rules, classroom arrangements, and the safety of an enriching learning environment.

1.8 PLAN OF STUDY

CHAPTER ONE: This is an Introduction to the study, Problem Statement and aims of the study.

CHAPTER TWO: Focuses on the development of relevant literature to the study on the phenomenon of mathematics anxiety, motivation and achievement in mathematics.

CHAPTER THREE: Involves the design of the questionnaire and the research methodology.

CHAPTER FOUR: Presents the analysis and interpretation of the data.

CHAPTER FIVE: Involves the conclusions from the research investigated, and forthcoming recommendations.

CHAPTER TWO

THE CONCEPTUALISATION OF BRIDGING MATHEMATICS

2.1 INTRODUCTION

In chapter one, the researcher was able to outline the process that this study will follow, beginning with the research problem, outlining the main and sub-questions related to the study, the aim of the study, hypotheses developed, research methodology, literature study, sample collection (i.e. data collection, analysis and reliability testing) and finally ethical considerations.

Thus, in this chapter the researcher will commence from the literature or historical review of the study looking at the bridging programme in higher education institutions (HEIs) both nationally and internationally. Then the researcher will explore the need for a bridging programme, specifically a bridging mathematics course in a higher institution of learning as well as its importance to the students, university and the parents.

The necessity for a bridging programme will lead to a discussion on the theoretical approaches and views relating to the introduction of bridging or foundational programmes. From this we shall discuss the involvement of HELTASA (Higher Education Learning and Teaching Association of South Africa) in bridging and foundational courses in HEIs in South Africa, further outlining some of the foundational or bridging courses available at some public and private HEIs in South Africa.

After condensing the study, the researcher will give an overview of the Pre-degree programme in his own field of study at Midrand Graduate Institute (MGI); highlighting the history of the programme, its challenges, successes and review over the years. The researcher will then concentrate on the main focus of the dissertation, which is looking at the definition of mathematics anxiety, and its relationship with mathematics avoidance leading to a discussion on the relationship between the affective and cognitive aspects of students, defining motivation as another important

keyword in the study as well as how motivation can help improve cognitive and affective aspects of students in mathematics outcomes.

Finally, the researcher will describe in great detail past and recent studies on motivation as it affects mathematics success rates and the need for more research in this area of study. In concluding this chapter, there will be a brief summary of the main themes.

2.2 A HISTORICAL PREVIEW OF BRIDGING PROGRAMMES IN HIGHER EDUCATION INSTITUTIONS INTERNATIONALLY AND LOCALLY

Bridging mathematics has been an informal network of researchers and practitioners from Australia, New Zealand, Southern Africa and the Pacific since the late 1980s. The political and educational climate that saw theories of the network in those early years is not the climate that exists today. However, although the change has affected both the research and teaching practice of its members, fundamental issues related to adults learning mathematics in all its forms are still being discussed (Taylor and Galligan, 2005).

Firstly, in Australia, the Science and Mathematics Education Centre (SMEC) and the Centre for Aboriginal Studies (CAS) at Curtin University of Technology obtained a grant from the Commonwealth Tertiary Education Commission (CTEC), under its Equity Program, to develop bridging programmes for Aborigines who possess an inadequate secondary level education and who wish to qualify for entry into undergraduate science and technology courses in higher education. The project team worked under the guidance of an advisory committee comprising of Aboriginal educators and with both Aboriginal and non-Aboriginal community representatives (Hardy, Miller and Stewart, 1998).

The project team recognised the importance of having a manageably small "bridgeable gap" between prospective students' current standards of achievement in mathematics and science and the standards of achievement required ensuring that they would not be disadvantaged further as first-year undergraduate students. Students who had completed year 12 but had not performed well in the university entrance examinations seemed to be most suitable. Unfortunately, the numbers of

Aboriginal students in Western Australia meeting this description was found to be too small to provide a viable pool of prospective students (Malone, Fraser and Forrest, 1985a).

From the Figures provided by the Commonwealth Education Department (Perth) indicated that very few Aboriginal youth (less than five) were undertaking university entrance examinations in Mathematics II, Mathematics III, Chemistry, Physics and Physical Sciences (Malone, Taylor & Forrest, 1985a). However, it was found that sufficient numbers of Aborigines had progressed beyond Year 10 at secondary school and had studied Mathematics I or II or III, Chemistry, Physics or Physical Sciences at Year 11 to provide a viable client group for the science and mathematics bridging programmes. Aborigines who had not participated in these subjects at Year 11 were considered as providing too large a bridgeable gap for the scope and resources of this project.

This review of the literature on Aboriginality led the project team to reach a conclusion that an appropriate learning environment will be one in which tutors would nurture social relationships with students and foster cooperative learning activities and which will in turn enable students to attend to important family responsibilities without unduly affecting their abilities to meet their bridging program goals (Davis, 1980; Harris 1982; Graham, 1984; Kearns, 1985).

For bridging mathematics as one of the bridging programmes this meant the development of programmes to service and support students who previously had little chance of accessing university studies. For example, in 1994, 23 out of 35 Australian universities reported some form of bridging programme and/or 'Learning Centre' which included mathematics support (Postle, Clarke and Bull, 1995).

Based on literature on ethnic minorities (Aitken and Falk, 1983; Atwater and Simpson; Jordan, 1984), it was concluded that prospective ethnic minority students would be served best by a supportive learning environment which fosters positive attitudes and self-concepts, promotes peer-group support and a positive image of Aboriginal cultures, and orients students to the academic and social practices, expectations and values of the institution. The attitudes and activities of the tutors

and counsellors with whom the students would have daily contact were regarded as being crucial to the successful maintenance of a supportive learning environment.

Literature on students' learning of science and mathematics (Gilbert, Osborne and Fensham, 1982) made it clear that design criteria for the bridging programme materials should account for any inadequacies in the scientific and mathematical background knowledge of second-chance students. The programmes should provide for differential rates of conceptual development among students, and should enable close monitoring of the conceptual development of individual students. Further support for the conclusions of the project team was obtained from a review of 32 references on strategies for teaching low-achieving mathematics students (Suydam, 1984). Strategies of relevance to second-chance students included diagnostic testing, the articulation of instructional goals, successful achievement of short-term goals, ongoing evaluation, and expression of positive expectations and confidence in the abilities of students.

Specific bridging mathematics courses were usually of two types: pre-tertiary stand-alone courses and in-context support. However, much of the work of bridging mathematics practitioners is not documented nor is preparatory programmes for Australian residents regulated or scrutinised. Each university sets up and manages its programmes at its own discretion resulting in a wide diversity of programmes and approaches (Clarke, Bull and Clarke, 2004). Within the pre-tertiary courses, the number and type of courses are diverse (Cobbin, Barlow, Gotslelow, 1994).

The bridging mathematics Network (BMN) a national coordination agency was established and aimed to develop the Australian bridging mathematics Network; by proposing a research agenda which aim was to look at a wide range of topics specifically targeted at the community of students they know so well (Taylor and Galligan, 2005). These topics include:

- Ways of overcoming mathematics anxiety by helping students of whom English is a 2nd language
- Organising Group Work
- Using Technology
- Organising Tests and other methods of establishing students' needs

- Using writing to learn mathematics
- Helping students to develop mathematics learning set, etc.

Trends in bridging mathematics, since its inception in 1992 were viewed in terms of conference participation and in the number of papers included within the conference proceedings. Today bridging mathematics programmes are many and diverse, yet the staffs in these programmes are often marginalised within the Australian Higher Education sector. The status of mathematics within schools and universities is at low ebb, with many students opting to study easier types of mathematics, universities removing mathematical pre-requisites from award programmes and not recognising the embedded mathematics within many of their courses. These trends ensure that initiatives allowing students to bridge the mathematical gaps to university are still necessary (Taylor and Galligan, 2005).

Going back to the basis, South African academic development practitioners have been working at foundation level for nearly thirty years. As pointed out by Boughey (2007), the majority of early initiatives intended to provide support to students located the problem of 'under preparedness' in these students themselves majorly the black students, it was argued that these students lacked the skills, the conceptual background and the language proficiency necessary to succeed at tertiary level. Consonant with the location of 'under preparedness' in students, early initiatives then worked with the students by providing additional classes and tutorials intended to make up for the deficiencies that students were thought to bring with them to university.

By the mid-1980s, a number of scholars began to challenge this understanding of 'under-preparedness' by pointing out that the 'problem' lay not in the students, but rather in the institutions to which those students had been admitted (Boughey, 2007). These challenges to what were, at the time, dominant understandings of 'under preparedness' lay in what is termed a 'critical' orientation to research and, thus, to 'knowing'. In the late 1980s, practitioners took up the challenge to think about 'under preparedness' in a different way and increasingly began to produce work which was located in this critical orientation (see Boughey, 2005 for a review of this work). This

shift in thinking also heralded a shift in name and field, which had, until that time, been known as 'Academic Support' began to be named 'Academic Development'.

For the purposes of this research under preparedness is understood as the condition where the knowledge and competencies of the learner entering an educational programme compares negatively with the assumed knowledge and competencies on which that programme is based. Deficiencies in knowledge, skills and academic proficiencies may mask the student's innate ability which can contribute to students performing below their potential or even failing when they may have the ability to pass (Woollacott and Henning, 2004).

In 2009 the Foundation Studies Seminar held at Rhodes University, South Africa, intended to try to make up for some of the losses experienced due to instabilities in the field of Academic Development by introducing some critical thinking to those involved in running the foundation phase of Extended Programmes at universities across the country. Since a successful transition from school to university is crucial for academic success, many higher education institutions, such as Stellenbosch University (SU), Midrand Graduate Institute, Computer Training Institute (CTI) Pretoria, and a host of other tertiary institutions are attempting to 'bridge the gap' between school and university in a responsive manner by expanding their bridging programmes (Hay and Marais, 2004).

These programmes aim to "address the gap between secondary and tertiary institutions and to compensate for the under preparedness of students by providing them with additional support in preparation for their mainstream studies "(Essack and Quayle, 2007:73). Many different terms are used for these interventions. For the purposes of this research, *bridging* refers to "helping underprepared students gain access into tertiary institutions, to bridge the gap in knowledge and skills and also to provide adequate foundations for learning" (Woollacott and Henning, 2004:4).

Under preparedness should not be equated with a fundamental inability to cope with higher education, though the term is sometimes used as a euphemism for this. As previously mentioned, since the students who currently gain entry to higher education are in the top quintile of the population in terms of prior performance, the

larger proportion of underprepared students among them should not be discounted as lacking the potential to succeed (Woollacott and Henning, 2004).

An alternative view of the situation in South Africa is that a significant part of the problem is inadequate articulation between the secondary/further education system and higher education in its existing standard forms. Students from educationally disadvantaged backgrounds have generally not been exposed to key academic approaches and experiences that are taken for granted in traditional higher education programmes (Council of Higher Education, Monitor No. 6).

The resulting 'articulation gap', as referred to in the 1997 White Paper by the Department of Education (DoE, 1997), is manifested in students as a lack of sound foundations for tertiary studies, and has profound effects on students' ability to respond positively to higher education programmes, irrespective of how talented they are.

Foundational provision, in the form of foundation courses and other interventions were integrated into what have become known as 'extended' degrees, or pre-degree programmes, with the express aim of enabling talented students from disadvantaged educational backgrounds to build sound academic foundations for succeeding in their programme of choice. Foundational provision has its origins in the 1980s, when a growing numbers of black students, many of which came from educationally disadvantaged backgrounds, gained access to some historically white universities, later on the historically black institutions gave increasing attention to the under preparedness of the majority of their intake (DoE, 1997).

According to the Department of Education policy (DoE 2006b), "Foundational provision is commonly intended primarily to facilitate the academic development of students whose prior learning has been adversely affected by educational or social inequalities. Foundational provision is thus aimed at facilitating equity of access and of outcomes." Since the 1980s foundational provision has been introduced in a variety of forms and institutional settings. In the policy development period after 1994, an analysis of the role of foundational and other forms of 'intermediate' provision in promoting access to and success in higher education was commissioned

for the National Commission on Higher Education (Scott 1995; NCHE 1995), and the 1997 White Paper included recognition of foundational provision and extended programmes as a key means of addressing the articulation gap (DoE, 1997).

This recognition was confirmed in the NPHE in 2001 (DoE 2001), and provision for funding was made in the new higher education funding framework of 2003 (DoE, 2003). Earmarked funds totaling some R600 million have been made available in two funding cycles (2004-06 and 2007-09) to date.

We shall now look at the reasons for the need of bridging programme courses in higher institutions.

2.3 THE NEED FOR BRIDGING PROGRAMME COURSES IN HIGHER EDUCATION INSTITUTIONS

Foundational provision and extended programmes have recently been defined by the Department of Education as follows:

“Foundational provision is the offering of modules, courses or other curricular elements that are intended to equip underprepared students with academic foundations that will enable them to successfully complete a recognised higher education qualification. Foundational provision focuses particularly on basic concepts, content and learning approaches that foster advanced learning. Even where the subject matter is introductory in nature, foundational provision must make academic demands on the students that are appropriate to higher education”. “*An extended curriculum programme* is a first degree or diploma programme that incorporates substantial foundational provision that is additional to the coursework prescribed for the standard programme. The foundational provision incorporated must be (a) equivalent to one or two semesters of full-time study, (b) designed to articulate effectively with the regular elements of the programme, and (c) formally planned, scheduled and regulated as an integral part of the programme” (DoE, 2006b)

The Illinois Community College Board (ICCB) and the Illinois Department of Commerce and Economic Opportunity (DCEO) defined bridging programmes as those courses which prepare adults with limited academic or limited English skills to enter and succeed in credit-bearing postsecondary education and training leading to

career path employment in high-demand, for middle- and high-skilled occupations. The goal of bridging programmes is to sequentially bridge the gap between the initial skills of individuals and what they need to enter and succeed in postsecondary education and career path employment (Jenkins, Bush, Cohen, Kossy and Henle, 2002).

It further states that a bridging programme may be designed as, i) a single course (for students at higher reading and mathematics levels) that moves students directly into credit-bearing courses, with the aim of eliminating the need for remediation or, ii) a series of courses, in which students first complete a lower-level bridging course that prepares them to enter a non-credit or credit occupational course or programme that leads to an entry-level job. In this case, the student can opt out for needed work/income and return to a higher-level bridging course without having to repeat content. The bridging programme materials emphasise diagnostic assessment, individualised instruction, short-term learning goals and the independence of students, although a course tutor also must be available to play various instructional, personal support and management roles (Jenkins, Bush, Cohen, Kossy and Henle, 2002).

Galligan and Taylor (2008) found out in their survey that New Zealand's bridging (or developmental) programmes are provided by many of their tertiary institutions to support students who find themselves mathematically underprepared for their courses. Fitzsimons and Godden (2001) also found out that students who may well have avoided mathematics in choosing their area of study are forced to confront it because mathematics is so pervasive that most university courses require, often implicitly, at least basic algebra if not more. Responses by institutions can vary greatly in the way of assistance to students. For example, a small survey of bridging programmes in some New Zealand universities indicated that each university has at least one foundation (enabling/preparatory) programme, either full-time for one year or shorter, which a Pre-degree programme is (Fitzsimons and Godden, 2001).

A module in the bridging programme that serves as a prerequisite for most degree modules is the bridging mathematics, which is meant to service and support students

who previously had little chance of accessing university studies, to have an opportunity to pursue their choice of careers (Source: www.mgi.ac.za).

The purpose of this module is to develop the learner's numerical and literacy skills which are essential for problem solving, so that students will be adequately prepared to study first year mathematics modules. In addition to this, they will be able to develop their abilities to understand and communicate mathematical concepts and interpret calculations. The bridging mathematics course's aim is to either help students meet quantitative requirements for their majoring subjects, bridge students into the standard calculus/algebra course, or form part of a pre-service primary teaching programme (Source: www.mgi.ac.za).

Bridging programme fills the gap left by underpreparedness of students entering the higher education institutions. The researcher will now focus on the impact of constructivism on bridging programmes in HEIs.

2.4 THE CONSTRUCTIVISTS' VIEW OF BRIDGING PROGRAMMES IN HIGHER EDUCATION

A constructivist model of knowledge development (Pope and Gilbert, 1983; Steffe, 1989) provided a conceptual framework for the articulation of four main criteria for designing the chemistry and mathematics bridging programmes. A constructivist perspective provides the view that knowledge is actively constructed in the mind of the learner on the basis of his/her pre-existing cognitive structures. This can be contrasted with a perspective of the learner passively absorbing knowledge transmitted by the teacher or textbook. As students construct their knowledge, the bridging course provides academic support in the four ways described below.

- i. Diagnostic Assessment:* The first design criterion addresses the central role of a learner's prior knowledge in moderating the quality of his/her newly constructed content knowledge. It is widely recognised, especially in mathematics and science (Novak, 1986), that many students have gaps and misconceptions in their background knowledge that prevent meaningful learning from occurring. Regular diagnostic assessment of individual students can help to identify and remedy problematic background knowledge prior to constructing their new content knowledge.

In a study on factors/causes for failure in entrance examinations in Cape Town University of Technology, Faculty of Informatics and Designs, Rohlwink, (a Senior Lecturer in the Extended Curriculum Programme) in 2006, conducted a diagnostic numeracy test. This test was administered to the students entering for this programme every year, their results reveal fundamental weaknesses for the students who battle to pass these tests, reflect on their difficulties concerning numeracy and possible interventions as supported by Vygotsky's Zone of Proximal Development (ZPD) as discussed by Vockell (2001) as well as concepts of metacognitive apprenticeship as devised by Collins, Brown and Holum (1991).

Over the past few years Rohlwink (2011) asserted that to a varying degree, students entering in to the faculty of Informatics and Design are lacking the necessary competences in these basic mathematical skills. They cannot convert measuring units (for example mm^2 to cm^2); calculate surface areas and volumes of 2-D and 3-D objects. To this end, a series of tutorials were set up to fill the gaps observed. The diagnostic test conducted helped highlight some major problem areas, such as,

- The general uncertainty about formulae for area and volume
- The inability to convert one measuring unit into another, specifically where areas or volumes were concerned

After the test had been conducted, marked and returned back to the students and feedback was given, a lively class discussion ensued about the factors, which hindered them from performing well in numeracy. The following reasons were given for their poor performances from both the class tests and private interviews conducted by Rohlwink (2006).

- a. The students identified with the most serious problems struggled to remember the formulae of the shapes by heart; similar to the questions given in their matriculation exams.
- b. Mathematics and the mathematics literacy students maintained that too much text in a question distracted and confused them. They preferred to be given a task that was clearly stated in predominantly numerical characters; triggering the correct thought patterns in their minds and they would know

how to solve the problem. Words obscured their mental pictures, making it difficult to select the appropriate method to be applied.

- c. The students stated that they had been “trained” to answer matric papers in a particular manner. Matric papers seem to contain a certain range of questions, which could be answered using various methods available taught to the students. Their matric teachers would have asked the students to work through as many exam papers as possible using each of the available methods. Consequently, when faced with the fundamental problems that do not match any of these practiced methods; the majority of the students were unable to continue.
- d. Finally, many students admitted they had no confidence in their mathematical abilities, developing a fear of numeracy. Some students get ‘panicky’ when given any set of problems to solve on their own.

To this end, it was decided after 2001 at the Cape Peninsula University of Technology to develop a far more structured programme for the next intake of students. They will be asked to keep a regular learning journal to record their progress, their thoughts and reactions to work done in the numeracy component of Professional Business practice. This reflective learning would allow them to witness the unfolding of their own cognitive skills and self-regulation, whilst becoming active agents in their own intellectual development (Vockell, 2001).

- ii *Individualised_Instruction:* The second design criterion provided an instructional focus on the individual student rather than the whole class. Individualised instruction recognises that cognitive development is a personalised phenomenon and that students, have individual learning needs. A very prominent feature of this individualised instruction is found in Higher Education Research and Development of South Africa (HERDSA, by Taylor and Nightingale, 1990), where there is flexible time structuring enabling students to learn at a rate that best suit their individual abilities, rather than being subjected to a whole class, lock-step approach to encountering new curriculum content.

- iii *Short-term Learning Goals:* Pope and Gilbert (1983), stipulates that a student should formulate and achieve short-term learning goals. This achievement motivation is a necessary element that fuels an ongoing learning process. Students need to foster and sustain these goals if they are to develop confidence in their own abilities as students. These goals will be sustained by activities such as continuous, summative and formative assessments, which provide the platform for such opportunities for the validation of constructed content knowledge.
- iv *Independence of Learners by applying Vygotsky's Zones of Proximal Development (especially in a Numeracy class):*
Finally, a constructivist perspective highlights the need for the learner to accept responsibility for the process of knowledge construction occurring within his/her own mind. Traditionally, teachers were perceived as solely responsible for the quality of students' learning outcomes. In a review of research on teacher thinking, Clark and Peterson (1986) describe how many teachers accept responsibility (and acclaim) for the successful learning outcomes of their students, but attribute responsibility for failure to their students. It is likely that many second chance students, whose previous learning experiences have been characterised by low achievement, hold similar beliefs. In order to develop realistic learning belief systems by identifying themselves as being primarily responsible for the success of their own knowledge construction, they should be provided with the opportunity to exercise self-management in relation to the planning, conduct and evaluation of their learning activities. The fourth programme design criterion therefore, involves assisting students to develop the attitudes and skills of independent students.

According to Rohlwink (2011), we can combine the above concept with Vygotsky's Zone of Proximal Development (ZPD). In her article '*Situated Learning and Cognition Theoretical Learning and Cognition*', Hedegaard (1998), discusses Vygotsky's concept as it is presented in a collection of his writings (1987). Vygotsky formulated this concept in relation to school children and the tasks they could confidently perform under the supervision of an adult or mentor, after which they would then be

given more advanced tasks which would stimulate their cognitive development. In this way they would be taken to ever-higher levels of understanding and mastery.

Rohlwink (2011) applied this very basic version of Vygotsky's concept to the students in the Informatics and Design Faculty at Cape Peninsula University, taking them back to a point at which they could experience success because they could, independently but under her supervision apply certain basic methods of calculation. This would give them a sense of achievement and security. Eventually with her help they would approach tasks that demanded slightly more advanced data input and computational skills.

To this end, she will lead the students step by step until they have reached a sufficiently advanced level at which they can work independently.

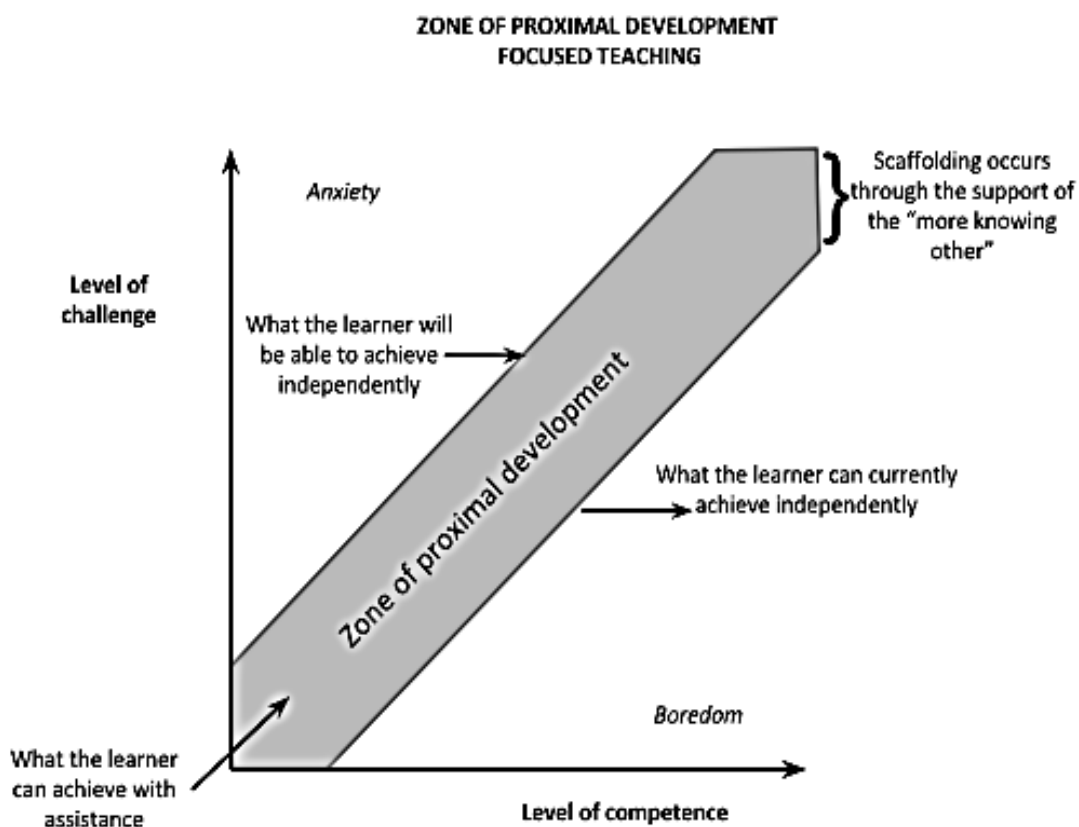


Figure 2.1 Diagram of Vygotsky's Zones of Proximal Development, (adapted from Dedoose, 2012).

2.5 SOUTH AFRICAN HIGHER EDUCATION INSTITUTIONS INVOLVED IN BRIDGING COURSES / FOUNDATIONAL PROGRAMMES

The Higher Education Learning and Teaching Association of South Africa (HELTASA) emerged out of the history of the Academic Development (AD) movement in South Africa. AD has become an international movement and field concerned primarily with staff, student, curriculum and institutional development in higher education and training (HET). Its main concern is improving teaching and learning in HET (Volbrecht, 2003).

South African AD, after vibrant activity linked to the liberation struggle from the mid-80s to the early 1990s had suffered a series of setbacks in the late 1990s, leading to the decline or dispersal of the South African AD as a collective movement and after 1995, the demise of the South African Association for Academic Development (SAAAD). After a second presentation of the draft constitution at the AD conference of 2004 at the Nelson Mandela Metropolitan University in Port Elizabeth, it was decided that an Executive should be elected to work on the constitution and resubmit it at the AD conference to be held in Durban in 2005. The Executive proposed a revised constitution together with a new name, the Higher Education Learning and Teaching Association of Southern Africa (HELTASA). Both the name and the draft constitution (with some amendments) were accepted by the AGM and the new organisation was formally launched (Volbrecht, 2003).

Perhaps the key historical shift was from AD to “Higher Education Teaching and Learning”. “Academic Development” in the South African context has historically focused mainly on the deficits (perceived or real) of “disadvantaged” students. Policy documents from the period after 1994 tends to perpetuate this focus and make it clear that legislative bodies do not see AD as an integrated concept involving development of staff, students/students, curricula and institutions/organisations (Boughey, 2010).

A focus on teaching and learning across all sites of tertiary-level learning is more likely to achieve such integration because it will be highlighted as one of the key tasks of all tertiary educators regardless of their rank or the level or location in which they operate. A focus on educators concerned with teaching and learning rather than

the confusing (in South Africa) abstraction of “Academic Development” gives a greater sense of agency to the project of tertiary-level development. The new focus also promotes networking amongst teaching and learning specialists in central AD units, specialists in mainstream departments and programmes, and tertiary educators working outside HET institutions (Boughey, 2010).

Working with the Council on Higher Education (CHE) and the Higher Education Quality Committee (HEQC), HELTASA could play a valuable role in exploring and researching issues around the quality of teaching and learning in higher education and training, as well as building professional networks similar to those currently coordinated by the higher Education Academy in the UK. The success of HELTASA will largely depend on the extent to which it can mobilise a broad spectrum of tertiary educators in a series of focused developmental projects (Boughey, 2010).

To this end, one of these developmental projects is the Academic Support Programmes. The overall objective of Academic Support is to help students who have academic shortcomings to work towards achieving academic success in a chosen field of study. One of the possible ways that this goal may be achieved is to provide students with Academic Support Programmes, which ensure that they develop the necessary basic skills that would ensure success on entrance (Tomlinson, 1989). Students’ support programmes take different forms from one institution to another: Pre-admission and Pre-entry orientation courses; orientation programmes; skills development programmes and bridging programmes.

Access programmes or Academic Support Programmes can be seen as actions taken by higher education institutions to improve the participation rate of under-represented groups and students experiencing socio-economic disadvantages (Higher Education Authority, 2006). This means that a lower-income student should be financially able to attend a four-year course and live on campus. Most of the South African population is seen as belonging to the low-income to middle-income classes. Thus, access to higher education goes hand in hand with funding matters. However, the majority of South Africans cannot afford higher education studies nor do they have the skills to attend a higher education institution. This places limits on access to the higher education institutions for these individuals (Griesel, 1999).

The need for Academic Support Programmes arises from the recognition that some students entering university are not prepared when it comes to carrying out university studies successfully (Tema, 1988). In this regard, support programmes can be described as an academic service designed with the aim to assist “at risk” students, to encourage and to retain them. Tertiary institutions in various parts of the world are experiencing similar problems with regard to access to higher education for students who are not ready to enter the system (Pretorius and Labuschagne, 1991).

An argument made by Sharwood (1998) is that Academic Support Programmes do improve the learning of students in such a way that it helps with the development of underdeveloped skills. Academic Support Programmes can focus on different areas such as student development, staff development, curriculum and organisational development (Hunter, 1990).

The funding of the Academic Support Programmes technically otherwise known as ‘Extended Programmes with an integrated Foundation Phase’ has been made available by the National Department of Education (DoE) for Public Universities and Technikons. By 2004 the Department of Education (DoE) offered formal funding for Foundation Programmes (FP) at South African institutions of Higher Education (HE) for the first time.

To this end, we shall be considering the types of Academic Support (Foundational) Programmes in some public higher institutions in South Africa of recent, which have benefitted from the funding.

2.5.1 BRIDGING/EXTENDED COURSES ACROSS VARIOUS HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA

- i. At **Rhodes University** it is known as the Extended Studies Unit in 2005. This was an extension of the Extended Programmes in the Faculties of Science and Humanities in addition to the one which existed in the faculty of Commerce.

Students who do not meet the University's usual admission requirements may be offered a place on an Extended Programme which is completed over four rather than three years. Students enrolled on Extended Programmes start earning credits towards their degrees as soon as they enroll; Extended Programmes are therefore not like foundation courses which require students to complete an additional catch up year before they start their degrees (Source: Academic Review Report, 2005).

- ii. At the **University of the Western Cape (UWC)** the introduction of the Foundation Programme as it is called, was provided by the Department of Academic Development in the Faculty of Economics and Management Sciences in 2005. This is now formally included in the B.Com four year degree spread across the first two years of the degree (Source: UWC General Calendar, 2005).
- iii. **Stellenbosch University's** Health Sciences Faculty, terms it the Extended Degree Programme (EDPs) since 1995. It is an MBChB programme for 7 years, inclusive of a mainstream programme of 6 years of academic and professional training (Young, 2007).
- iv. At the **Nelson Mandela Metropolitan University (NMMU)** it has been renamed as the University Foundation Programme in 2005 after the merger of University of Port Elizabeth, Vista University and Port Elizabeth Technikon (PET). This also was terminated in 2006 due to a financial crisis, but was later replaced by an extended 5-year diploma/degree at NMMU. However, applicants who do not comply with the minimum statutory requirements for degree or diploma entry can be admitted to an extended diploma or degree programme. They must successfully complete the first two years of the extended programme to qualify for full degree or diploma status (Snyders, 2001).
- v. The **University of Kwazulu-Natal (UKZN)** has the Centre for Science Access (CSA) situated within the Faculty of Science and Agriculture, in the College of Science, Agriculture and Engineering. This Foundation

programme, though relatively new its constituent programmes all have histories of providing access to science-related degrees to students from disadvantaged educational backgrounds. These Access Programmes identify candidates with potential and once registered they receive the required support to enable them to succeed. First year programmes are restructured and additional courses are offered to improve their communication and academic writings skills. Pre-degree courses and a mentorship programme are offered to assist with their academic development and challenges they may face (Source: Division of Management Information, UKZN).

- vi. The **University of Limpopo** runs five Extended Degree Programmes (EDPs) in the Faculties of Humanities, Management Sciences, Law, and Agriculture and Sciences. These EDPs involve the following programmes: BA Media Studies, BA Social Sciences, B Comm. Accounting, LLB and BSc. In the first four programmes, the first year is extended over a period of two years during which the mainstream workload is slightly reduced (Sepota, 2008).
- vii. The **University Of Cape town (UCT)**, provides an Education Development Unit (EDU) in the Commerce Faculty that runs academic development programmes or foundational provision courses in Economics and Financial Accounting for students from socio-economically disadvantaged backgrounds and who fall below the minimum requirements for entry in to the mainstream (Smith, 2007).
- viii. At the **Tshwane University of Technology (TUT)** a generic year Foundation Programme (FP) is offered to students coming in to the institution's main courses in the Faculties of Science, Engineering and ICT. The FP consisted of eight subjects four of which are generic to all FPs, these being Mathematics, Computer Literacy, and English and Life Skills. The National Diploma (extended curriculum programme with foundation provision) is where applicable, also presented as a three and a half year, four or five year qualification (Painter, 2007).

- ix. At the **Cape Town Peninsula University of Technology (CPUT)**, the Extended Programmes with academic support is also called the Foundation Provision Programme for the 2007-2009 cycles. Though there had been some one-year foundation programmes before this time. The current extended programmes involve mostly the extension of the first year into two years. This means that students study half the regular subjects in year 1 and the other half in year 2.
- Within each year, the study of the regular subjects is supported through more intensive teaching of the subjects and through linking them with additional courses in language and numeracy (Garraway, 2007).
- x. The **University of Zululand** offers both the Extended/Augmented curriculum, and the Foundation stream curriculum. The Extended curriculum enables students to complete the first academic year over two years and they will receive additional tuition and support. This stream will add an additional year to the minimum time required to complete such a programme. (for example, in Bachelor of Science and Bachelor of Industrial Science). However, the Foundation stream enables students to spend their first year in a dedicated programme designed to improve their academic background. (Source: General Calendar Unizulu 2007).
- xi. The **University of South Africa** offers only extended programmes in the Science Faculty for MAT0511 and MAT1510 modules known as “Access to mathematics” bridging modules. These access modules will soon be phased out by management as a new higher certificate is being developed which will give successful students access to further their studies in mathematics, physics, statistics, computer science and chemistry. The pass mark for this module is 75% minimum, and entrance requirement to this module by matric students will be at least a 40% mark for grade 12 mathematics not mathematics literacy (Source: www.unisa.ac.za).

Other higher Institutions offering bridging courses/extended programmes are the Private Universities. These include the following:

- **Monash University, South Africa:** Here the extended programme is termed the Monash South Africa Foundation Programme (MSAFP), designed as a pathway to receiving a Monash undergraduate degree. The programme enables students whose scores do not meet the requirement for direct entry into an undergraduate programme to bridge the gap between their highest education qualification and the academic qualifications accepted by Monash South Africa (Annual report, Monash University, 2007).
- **Midrand Graduate Institute (MGI):** At MGI the extended programme is known as the Pre-degree Foundation Programme introduced sometime in 2003. It was meant to prepare students who did not pass their Matric Senior Certificate with exemption, for a degree program. The programme spans a full year. On passing the appropriate subjects, students will be allowed to register for a degree programme the following year. This programme is specifically provided to prepare students to succeed in their degree programme and to evaluate the suitability of students for degree studies (Source: www.mgi.ac.za).

To this end, a further explication of the Pre-degree programme at MGI will now be presented.

2.6 PRE-DEGREE AS A FOUNDATION PROGRAMME IN MIDRAND GRADUATE INSTITUTE (MGI)

Due to the perceived high rate of unpreparedness by students for university studies and the inadequate articulation between the secondary/further education system and higher education in its standard form, there is an urgent need for an alternative educational system that will help in addressing these anomalies. Students from educationally disadvantaged backgrounds have generally not been exposed to key academic approaches and experiences that are taken for granted in traditional higher education programmes. This has resulted in an 'articulation gap' as referred to in the 1997 White Paper (DoE 1997:2.32). It is manifested in students as a lack of sound foundations for tertiary studies, and has profound effects on students' ability to respond to higher education programmes irrespective of how talented they are.

According to the Department of Education (2002), a foundation programme prepares potential students, who would otherwise not meet matriculation requirements to qualify for admission to undergraduate courses. This would mean that foundation programmes seek to teach the academic skills that students need to become successful in their higher education studies. Foundation programmes differ from extended curriculum courses in that they do not provide automatic access to the mainstream and are often used as a selection or channeling system.

The term “foundation”, as argued by Warren (1998), could have different meanings. Firstly, it may be understood as bridging in a backward-looking sense, which attempts to redress the gaps in the knowledge and limitations of cognitive, communication and learning skills. Secondly, bridging programmes can be forward-looking by means of laying a foundation for further studies, such as entry-level courses to introduce students to academic concepts and ways of learning. A foundation programme can also combine bridging courses with mainstream courses.

At Midrand Graduate Institute (MGI) therefore, we tend to combine both dimensions of a backward-looking sense, where students’ gaps in knowledge, cognitive, communication and learning limitations are being addressed. Also we infuse the forward-looking dimension of laying a solid foundation for their future studies either within our university or elsewhere. This means at MGI, at the foundation or Pre-degree level, we only offer students bridging courses which help to combine the above qualities for preparation into their mainstream courses the following year (Source: MGI webpage, Pre-degree admission, 2012).

Therefore, in order to offer a foundation programme there is a need for a healthy dose of optimism and a resilient belief in “ugly ducklings”. There are a number of students whose stories and progressions show that the National Senior Certificate Results (or equivalents) are not necessarily sufficient predictors of success in Higher Education. Equally there are a number of students who reveal that they are ill equipped for such success. The variety of standards at Secondary Schools leads to a large diversity in student readiness for higher education. The number of second language students aggravates this. Within the National Policy, there is the mandate to improve equity, widen access and redress past inequalities and to transform the

higher education system to serve a new social order (Council on Higher Education, 2010; Jansen, 2010; Coughlan, 2006).

In 2003, the Pre-degree Foundation Programme was introduced at MGI to prepare students who did not pass their matric Senior Certificate with exemption, for a degree programme. In addition, students who fail to meet entry requirements for degrees or those who have the incorrect subject combinations for a desired degree, are also allowed to enter for the Pre-degree Foundation Programme as an alternative access path to their desired degree courses. Increasingly this has also become a path for those who struggle with English as the medium of teaching and learning. MGI is one of three private institutions who currently offer a foundation programme.

The Pre-degree programme is a foundation programme that spans a full year. On passing the appropriate subjects, students are permitted to register for a degree programme the following year. As mentioned earlier, the main purpose of the Pre-degree Foundation Programme is to prepare students to succeed in their degree studies and a secondary effect is to evaluate the suitability of these students for degree studies. As a bridging year between school and university-level education, the aim of the programme is to teach students the academic skills, knowledge and attitudes required to succeed at a tertiary level, in a supportive environment such as MGI (Source: MGI webpage, 2012).

The following summarises some of the Challenges and Opportunities found within this context:

- Perceived changes in matric quality and the implementation of a new Higher Education Qualification framework, have led many institutions to raise entrance criteria and move towards extended programmes (Goode, 2011).
- High level of adjustments to the NSC results in 2010 and credibility of NSC has been widely commented on (for example, Jansen, 2010)
- In the programme, approximately 95% of students have English as their second language. There are approximately 16 first languages ranging from the South African eleven official languages including French and Mandarin. This means that for many of the students, a large obstacle is literacy.

Evidence shows that there is a higher correlation between the medium of secondary schooling and English as a first language (Source: MGI webpage, 2012).

- Students enter Higher Education from diverse socioeconomic and cultural backgrounds, with a broad range of reading, writing, language skills and an uneven academic preparation (Griesel, 2003)
- The roll out of this programme on 11 additional remote sites and the inclusion of foreign students increases this diversity (Source: MGI webpage, 2012).
- There has been an “explosion in demand” for higher education, due to the massification of education, aspirations and the perceptions that education is synonymous with increased economic participation (Coughlan, 2006). In consonance with this there has been a rise in the number of students applying for the Pre-degree (Foundation) programmes over the years, in 2012 there were about a 1000 students, this figure has further escalated to 1500 for the 2013 academic calendar (Source: MGI webpage, 2012).
- Expectations of what a Foundation Programme can achieve needs to be managed; expectations of Students, Parents, Sales Managers and Academic Staff are divergent (Source: www.academia.edu).
- Result in a need for a clear, shared understanding by all stakeholders of the role and scope of a foundation programme (Source: www.academia.edu).
- Private provider context demands high accountability in terms of value for money (Source: www.academia.edu).

The literature on the definition of anxiety, its implication, and as a factor affecting success rates in mathematics would be discussed hereafter.

2.7 MATHEMATICS ANXIETY, ITS DEFINITION AND IMPLICATIONS

Mathematics as we all know is a unique subject in every school curricula that pupils have to answer questions for which there is only one correct answer. This situation combined with many other factors such as unsuitable curricula and the culture of doing mathematics quickly, can lead students to a negative attributional style (Chinn, 2004; Chinn and Ashcroft, 2007) and finally to learned helplessness (Seligman, 1998). If unaddressed, this helplessness can persist into adulthood. Zaslavsky

(1999) looked at over 200 mathematics 'autobiographies' and observed a common pattern, namely that the respondents felt powerless, out of control and lacking self-esteem.

Mathematics anxiety has been operationally defined in different ways, for example as a "feeling of tension, apprehension or fear that interferes with mathematics performance" (Richardson and Suinn 1972:551), or as Cemen (1987) that it is a state of discomfort, which occurs in response to situations involving mathematics tasks that are perceived as threatening to their self-esteem. These definitions focus on different adverse outcomes of mathematics anxiety and illustrate the potential influence of anxiety on both the ability and the confidence to learn mathematics. Richardson and Suinn (1972) definition focuses particularly on the impact of anxiety on cognitive performance, while Cemen (1999) construction highlights the impact on self-esteem.

One definition of mathematics anxiety that is very common as described by Tobias and Weissbrod (1980:65) that it is, "The panic, helplessness, paralysis, and mental disorganisation that arises among some people when they are required to solve a mathematical problem". Tobias and Weissbrod (1980), asserted that Mathematics anxiety is a serious and pervasive problem, especially in the community college setting. Students may experience mathematics anxiety in many forms and degrees, from 'freezing up' during a mathematics exam, to avoiding anything that has to do with numbers.

A more recent definition of anxiety has been defined as the emotion in which feelings of tension, worried thoughts and avoidance tendencies are observed. It is known to affect a large range of mental processes (Eysenck and Derakshan, 2011). One of such mental processes is the working memory (WM), known as the cognitive mechanism responsible for active maintenance and goal-directed manipulation of information (Cowan, 2011).

It has been argued by experts that "mathematics anxiety" can bring about widespread, intergenerational discomfort with the subject, which could lead to anything from fewer students pursuing mathematics and science careers to less

public interest in financial markets. “People are very happy to say they don’t like math,” this was reported by a Professor from the University of Chicago Psychology and the author of *Choke*, a 2010 book on brain responses to performance pressure. He further asserts that “No one walks around bragging that they cannot read, but it is perfectly socially acceptable to say you don’t like mathematics” (Beilock, 2010:161)

When a student has mathematics anxiety, it is more than just disliking it, but that he feels negative emotions when told to engage in an activity that requires numerical or mathematics skills. It adversely affects students’ attitudes to learning; it can cut off the working memory needed to learn and solve problems, according to Willis (2010), a neurologist based in California and author of the book “*Learning to love Math*”.

In perceiving a problem, a student first processes the information through the amygdala, the brain's emotional center, which then prioritises the information going to the prefrontal cortex, the part responsible for the brain's working memory and critical thinking. During stress, there is more activity in the amygdala than the prefrontal cortex; even a minor stressor as seeing a frowning face before answering a question can decrease a student's ability to remember and respond accurately (Willis, 2010).

According to Ansari (2008), the principal investigator for the Numerical Cognition Laboratory at the University of Western Ontario, in London, Ontario, “When engaged in mathematics problem-solving, highly mathematics-anxious individuals suffer from intrusive thoughts and ruminations. This takes up some of their processing and working memory. It's very much as though individuals with mathematics anxiety use up the brainpower they need for the problem on worrying.”

In a series of studies, Ansari (2008) and his colleagues at the Numerical Cognition Laboratory, have found that adults with high mathematics anxiety are more likely to have lower-than-typical ability to quickly recognise differences in numerical magnitudes, or the total number of items in a set, which is considered a form of dyscalculia.

As part of normal development, children become increasingly adept at identifying which of two numbers of items is bigger, but Ansari found those with high mathematics anxiety were slower and less accurate at that task, and brain scans showed activity different from that of people with low mathematics stress doing the same tasks. Due to the fact that understanding numerical magnitude is a foundation for other calculations, Ansari suggests that small, early deficiencies in that area can lead to difficulties, frustration, and negative reactions to mathematics problems over time (Ansari, 2008).

Moreover, mathematics anxiety can become a generational problem, with adults uncomfortable with mathematics passing negative feelings on to their children or students. This will eventually cause their children or students to develop a fear for the subject (Ansari, 2008).

Teachers who have mathematics anxiety need to confront and control their negative feelings, fears, and insecurities, to avoid unintentionally passing on these negative attributes to their students (Whyte and Anthony, 2012; Wood, 1988; Gresham, 2007).

2.7.1 MATHEMATICS ANXIETY (ITS ORIGIN)

Trujillo and Hadfield (1999) wrote the following about the origin of mathematics anxiety. The causes of mathematics anxiety can be subdivided into three areas namely, environmental, intellectual, and personality factors.

The environmental factors include negative experiences in the classroom; parental pressure; insensitive teachers; mathematics presented as rigid sets of rules and non-participatory classrooms (Dossel, 1993; Tobias, 1990; Furner and Brenan, 2004). The Intellectual factors include being taught with mismatched learning styles, student attitude and lack of perceived usefulness of mathematics (Cemen, 1987; Miller and Mitchell, 1994). Finally, the Personality factors entail a reluctance to ask questions due to shyness, low self-esteem, and viewing mathematics as a male domain.

According to Ashcraft, Kirk and Hopko (2002: 181-185), "Early reports suggested that mathematics anxiety is a non-intellectual factor; in the sense that it was

observed even in otherwise successful students, which nonetheless had serious consequences for educational and career-related choices.”

From this, it can then be seen that the origins of negative beliefs and anxiety about mathematics are as diverse as the individuals experiencing them.

2.8 MATHEMATICS ANXIETY AS A KEY CONCEPT IN THE VICIOUS CYCLE OF MATHEMATICS AVOIDANCE

Mathematics anxiety has some symptoms associated with its detection in students, these symptoms and other negative mathematics experiences may lead to a “vicious cycle” in which fear of mathematics interferes with learning mathematics, which leads to more negative mathematics experiences (Preis, Christy, and Bobbie, 2001).

The symptoms mentioned earlier could be either psychological or physical.

- a) Psychological: this may elicits weight loss, paralysis of thought; loss of self-confidence, negative self-talk, mathematics avoidance and isolation (feeling that you are the only one in this manner).
- b) Physical: this is noticed in students for example nausea, shortness-of-breath, sweating, heart palpitations and increased blood pressure.

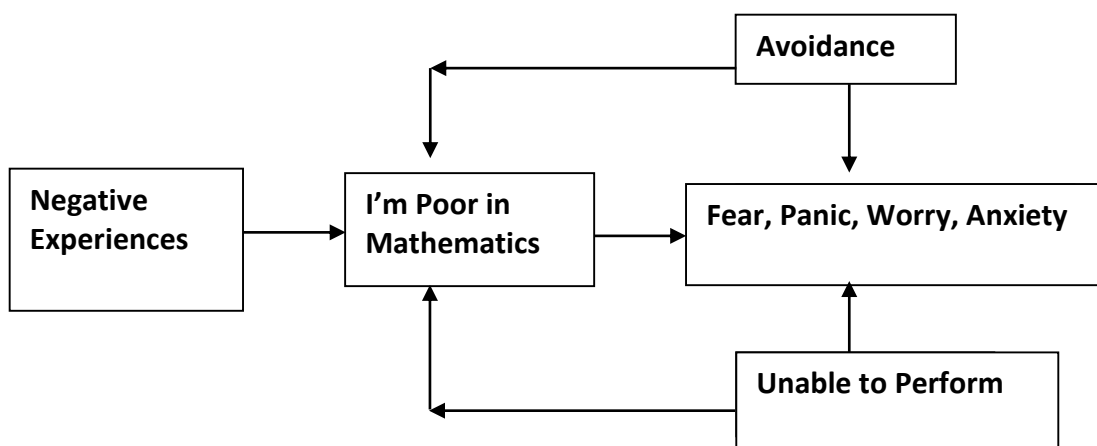


Figure 2.2: Mathematics Anxiety Flow Pattern (adapted from Tobias, 1987).

The ‘vicious cycle’ as we can see above in the diagram (Fig. 2.2) depicts students’ negative experiences with mathematics results in their delay or avoidance of mathematics related courses, which invariably limits their educational opportunities. This means students are ill equipped and underprepared to face their mathematics

tests or exams, thus eliciting fear, panic or worry, and these will obviously culminate into poor mathematics performance.

It has become evident that in today's increasingly technical society, students need to have knowledge of mathematics. According to Rosamond (2013) of National University, "Starting salaries go up \$2000 per year for every mathematics course after the ninth grade." In a Business week article sometime in 2006, it states that, "The world is moving into a new age of numbers... just look at where the mathematicians are now, they are helping to map out advertising campaigns, they are changing the nature of research in newsrooms and in biology labs and they are enabling marketers to forge new one-on-one relationships with their customers. As this occurs more, the economy falls into the realm of numbers." (Business Week, "Mathematics Will Rock Your World", 2006)

Staying away from any mathematics situation seems to be a solution for many who experience anxiety. However, this will reinforce the belief that they are incapable; each time they avoid mathematics, they confirm their lack of knowledge and confidence in that area. Hence, whenever they approach mathematics, the chances are that they will fail and their expectation of failure is again confirmed (Mitchell and Collins, 1991).

It is not too late for students with mathematics anxiety to get help, preferably from a counsellor or psychologist, if they do not want to lose out of the ever-changing labour economy demands of today. As we must know, mathematics success leads to educational success which leads to career success (Arem, 2009).

2.8.1 MATHEMATICS ANXIETY HOW DOES IT WORK?

In understanding how mathematics anxiety works, Tobias (1987) states that we need to reconfigure our brains as a three-part system with an *input area*, a *memory bank*, and some kind of *understanding and recall pathways* connecting the two. This hypothetical model of the brain is useful for thinking about mathematics anxiety. Hypothetically the brain would look like this:

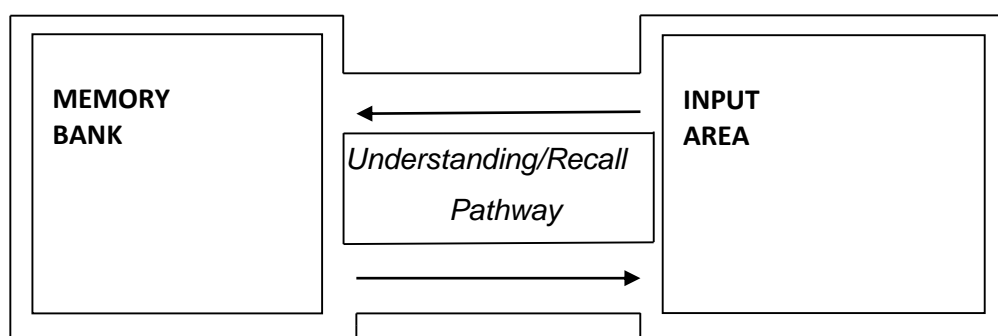


Figure 2.3: Diagram of the Three-Part Brain System (adapted from Tobias, 1987).

“When faced with a problem or a new piece of mathematics information with the system working properly as it should, one will call up from memory the right formula or approach. One would move back and forth effortlessly along the recall and understanding pathways of your brain until you succeed in solving the problem or understanding the new mathematics idea. There are times when a student may get stuck with problem solving; the student should endeavour to return to his/her memory bank, or get some necessary input from the problem, or better still consult the textbook for guide. He or she might also decide to put some hypothetical numbers into the problem to make it more concrete. In whatever manner the problem is solved, the student will be busy moving along the pathways of the brain, activating his/her memory, and using his/her analytical skills, in learning and doing” (Tobias , 1987: 6-7).

If however, the student’s memory bank is not intact and his/her understanding and recall skills are not well developed, when faced with a problem or new mathematics material they allow their emotions to come in to play by panicking. He/she tells him/herself, “This is just the kind of problem I can never solve,” having a defeatist approach from the onset. He/she will feel the tension from time pressure (being pressed for time to finish the test) or the uncertainty that comes from lack of confidence (Tobias, 1987).

In the brain what happens at this stage is that the understanding and recall pathways will become cluttered by emotions. There would be the spontaneous inability to think, not because the ‘hardware’ is inadequate, but because the pathways have been blocked, they cannot remember. Self-confidence is lost because they cannot analyse

the problem properly. They may even doubt their intelligence to do the work. In actual fact however, the reason is that, they have allowed their feelings to create too much 'static' in their brain. Eventually his pen or pencil will stop working, the brain stops functioning because he assumes he cannot think, but in actual fact, "They cannot think because they stopped working" (Tobias, 1987).

According to Ertekin, Dilmac, and Yazici (2009), anxiety is not innate but is acquired and developed. Generalised anxiety may contribute to underachievement not only in mathematics but any other subject. Mathematics is part of a person's environment from an early age. Parents who fear mathematics can also pass on the negative attitude towards their children. Many elementary teachers have mathematics anxiety and are uncomfortable teaching mathematics; this negative attitude is also passed on to students (Geist, 2010). Other variables affecting the development of a student's mathematics anxiety can include gender stereotypes, socioeconomic issues (Kesici and Erdoğan, 2010), shyness and personality (Woodard, 2004), other learning disabilities (Wadlington and Wadlington, 2008), memory and thought processes (Prevatt, Wells, and Li, 2010), learning styles, teaching styles, and the motivation of the student; anxiety is often an outcome of an attitude (Ertekin et al., 2009).

Mathematics anxiety affects an overwhelming part of the population. Thilmany (2009) stated that 60% of university students in her study have had or currently have mathematics anxiety. This negative attitude about mathematics is becoming a growing problem and barrier for the proper development of many individuals. Females are socialised to dislike mathematics, and even if they are good at it, many female students will fall under the pressure of their peers to believe that all women are not good in mathematics situations (gender stereotyping). Most girls do not develop a mathematics anxiety until around the fourth grade. The National Assessment of Educational Progress shows that fourth grade girls actually outperform boys on the mathematics portion of the test; these performance scores however disappear and fall behind by the eighth grade. Girls are thought to only be good at mathematics because of their hard work, while boys are good at mathematics because they are talented (Geist, 2010).

According to Arem (1993:1), "Mathematics anxiety is a clear-cut, negative, mental, emotional, and/or physical reaction to mathematics thought processes and problem solving". It is often caused by negative experiences with mathematics in childhood or early adolescence. Often students who believe they are mathematics anxious are merely just victims of test anxiety." Arem (1993), counselled a student, Jonathan, an 18 year old, who was very distraught because he was failing mathematics but felt he really knew the work. He was sure his poor performance was due to a mathematics block or perhaps a deep-seated fear of mathematics. Upon questioning him, it was obvious that he did know his mathematics, but when he goes into the exam room, he would totally "blank out". This was also the case with other subjects as well; he panicked every time halfway through his exams.

What is needed in situations of test anxiety is help and guidance to overcome the anxiety. Generalised anxiety may contribute to under achievement not only in mathematics but any other subject.

2.8.2 PAST EXPERIENCES AS RESULTANT EFFECTS TO STUDENTS' ANXIETIES IN MATHEMATICS

Arem (2010; 14-23) identified several different reasons for the onset of mathematics anxiety in students which will be discussed as follows.

2.8.2.1 Embarrassments

Many students have been embarrassed and humiliated in front of the whole class when called to solve a seemingly thought-provoking mathematics problem on the board. Many of these experiences date back from their first grade all the way through high school. They shiver with self-consciousness when called upon by the teacher to answer a mathematics problem or do their times tables in front of the class.

2.8.2.2 Poor Curriculum

The introduction of "new mathematics" to some students created a major stumbling block to their progress. Other curriculum choices that have also adversely affected students include incessant changes in the school curriculum on mathematics topics for different grades, unsatisfactory textbook selections which are not explicit enough

for self-study, inadequate pre-algebra preparatory courses, gaps in course sequencing and modules moving at too fast a pace.

2.8.2.3 Family Pressures and Expectations

Many parents or guardians have often discouraged their children by being overly demanding or overzealous, very inconsiderate as to their choice of words used on their children, comparing them with other peers around them. Some parents have also put pressure on their children by tutoring them mathematics in order for them to pick the same career path as them or they feel they should be doing.

2.8.2.4 Desire to be perfect

The desire of students is to always excel in obtaining the right answer to a mathematics problem and that there should always be a right and a wrong answer. If however, they get the answer wrong, they feel it is a poor reflection on them and their academic abilities. They tend to not feel good about themselves, and this negative self-image develops within them, making them avoid situations that will highlight their weaknesses, as with mathematics. Each time they are called upon and they give a wrong answer they feel less worthy, dumb or unintelligent.

2.8.2.5 Poor Teaching Methods

Some teachers have ridiculed their students by shouting at them, telling them they would not be able to learn mathematics, due to their inability to comprehend what they taught them or through their poor performances in tests or class work. Others have no alternative teaching methods to help their students learn mathematics properly. In addition, some have even discouraged their students in doing mathematics as they themselves never really liked mathematics, but are just victims of circumstance.

2.8.2.6 Negative Mathematics games people play

The most self-defeatist words we say in our minds are known as mind games, which have gone a long way in projecting our fear and hatred for mathematics. These talks are detrimental to our thinking and can easily lead to loss of self-confidence in mathematics, which is one of the most important aspects of achieving success in mathematics. Statements such as, "I was never good in mathematics, so I can't be

good now.” “Why do I need mathematics anyway?” or “Everyone knows how to do it except me” etc. are very common among students.

2.8.2.7 Cultural Myths and Stereotypes

In our society today, the community retains (including parents, teachers, friends, relatives, books, magazines, and media, etcetera) certain false beliefs regarding mathematics. When students read or listen to such fallacies, which have no basis in reality, it will obviously affect or even stop them from progressing in mathematics. Statements such as, “Do you believe that you must have a ‘mathematics mind’ or be a mental giant to succeed in mathematics?” or “Do you believe that only men are good in mathematics?” or “That careers requiring mathematics are mainly for men.”

Most parents have also discouraged their children in mathematics by telling them, that they were never good at mathematics when they were in school, but yet they are successful in life.

From the above it has become evident that unpleasant encounters with mathematics in students’ formative years can be disastrous to subsequent learning. Students who were made to feel bad about mathematics become wary and biased against it, mistrusting their own ability. Bad feelings persist, crippling prospects for learning new material and generating anxiety and self-doubt. Mathematics anxious students often say to themselves, “I’m stupid,” “I’ll never be able to do mathematics,” “I Know I’m going to fail”, etcetera. All these lead to a continuous flood of negative talk about mathematics which before long will culminate in to anxiety, overwhelming fears of failing or looking stupid, and panic sets in.

Other side effects are physical in nature, such as nausea, profuse perspiration, headaches, tight muscles, or a number of other obvious physical symptoms. Mentally they become confused or disorganised, making a lot of careless errors, forgetting formulae they knew, and not being able to think straight or blank out completely. Physical symptoms of mathematics anxiety also include increased heart rate, clammy hands, upset stomach and light headedness. The psychological symptoms would include an inability to concentrate and feelings of helplessness, worry and disgrace (Mission College 2009, Plaisance 2009, Jackson 2009, Woodard

2009). To this end, the after mathematics will be poor progress, avoidance of mathematics related courses and feelings of failure. This can be represented diagrammatically below in Fig. As the “*Mathematics Anxiety Process*”

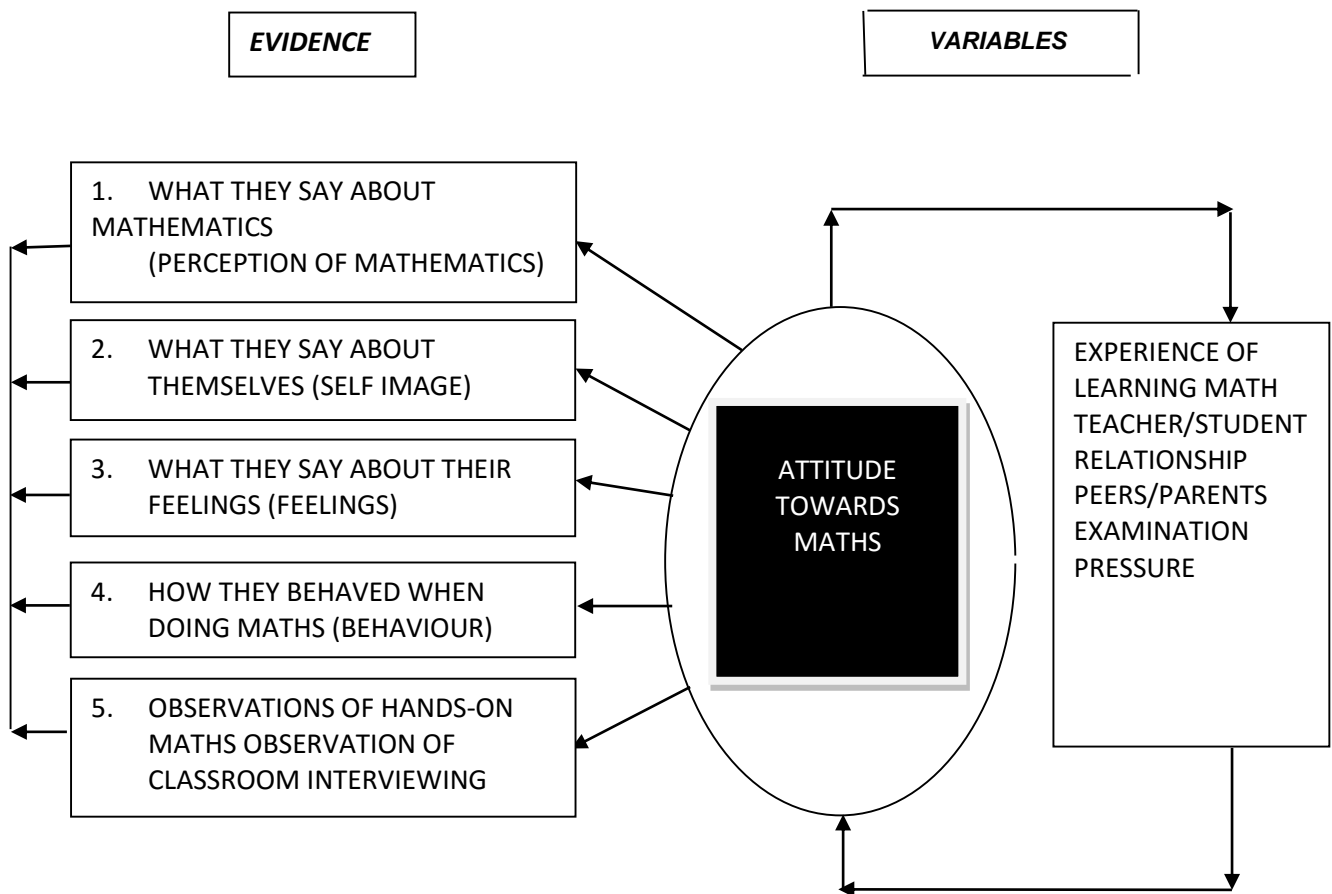


Figure 2.4: The Attitude and Mathematics Anxiety Cycle (adapted from Mitchell and Collins, 1991).

We shall now consider various studies related to mathematics anxiety and the strategies that can help in curbing it.

2.8.3 STUDIES RELATED TO MATHEMATICS ANXIETY AND STRATEGIES TO CURBING IT

Psychology Literature has provided a number of research works on conceptualisation of mathematics anxiety, such as European Journal of Psychology, Journal of Experimental Psychology, to mention but a few. Richardson and Suinn (1972); have defined mathematics anxiety in terms of its debilitating effects on mathematics performances among students. Feelings of tension and anxiety among students interfere with their manipulation and solving of mathematics problems in a wide variety of ordinary life and academic situations.

Due to its prevalence, researchers have conducted many studies to investigate the components of mathematics anxiety. They were able to show that mathematics anxiety usually consists of two domains (Ho, Senturk, Lam, and Zimmer, 2000; Wigfield and Meece, 1988): the *cognitive* domain and the *affective* domain. The factors in the cognitive domain are related to students worrying about doing well in mathematics, while the factors in the affective domain are primarily associated with the feelings of nervousness, tension and unpleasantness.

These factors in both domains play a dominant role in students' mathematics anxiety. For instance, in a study that involved three nations, Ho and his colleagues (Ho et al., 2000) concluded that the affective component of mathematics anxiety consistently related to the poor performance in mathematics. To this end, many strategies have been proposed by many researchers to address anxiety, one of which was the work of Williams (1988) who summarised two interventions, namely, the mathematics dominated intervention and the anxiety focused intervention.

Williams (1988) asserted that for the mathematics dominated intervention, the assumption is based on the fact that the more students know about mathematics the less anxiety they will have towards it. To address this issue, we need to teach more mathematics to reduce the mathematics anxiety. On the other hand, the anxiety focused intervention places emphasis on teaching people how to reduce mathematics anxiety itself.

Tsanwani (2009) views mathematics anxiety as an irrational and impedimental dread of mathematics. This term is used to describe the panic, helplessness, mental

paralysis and disorganisation that arise among some individuals when they are required to solve a problem of a mathematics nature. The literature further indicates that mathematics anxiety refers to a person's feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in a wide variety of ordinary and academic settings (Khatoon and Mahmood, 2010; Leppavirta, 2011; Newstead, 1995; 2006; Perry, 2004).

It can also be viewed that the sense of discomfort observed while working on mathematics problems, is associated with fear and apprehension to specific mathematics related settings (Khatoon and Mahmood, 2010; Ma, 2003) and seems ubiquitous. The literature shows that students across all levels (grades) of schooling experience it, in some way or another (Hembree, 1990).

McAnallen (2010) conceptualised mathematics anxiety as an effective response that includes avoidance of mathematics, subsequent failure to learn mathematics skills, and thus negative career and school-related decisions. Ferguson (1986) identified three common types of mathematics anxiety that include: *mathematics test anxiety* (associated with anticipating, taking, and receiving mathematics tests); *numerical anxiety* (associated with number manipulation); and *abstraction anxiety* (associated with abstract mathematics content).

Vinson (2001) states that mathematics anxiety should be regarded as something more than a mere dislike for mathematics. Moreover, Mohamed and Tarmizi (2010) are of the opinion that it should be seen from a broader perspective as a complex construct of affective, behavioural, and cognitive accentuations to a perceived threat to self-esteem, which occur as responses to settings involving mathematics.

Mathematics anxiety may also be associated with the social learning theory (Erdoğan, Kesici and Şahin, 2011). The social learning theory focuses on learning that occurs within a social context. It considers that people learn from one another. Negative or positive perceptions of mathematics from parents and/or teachers are likely to send some messages to the students (Şahin, 2008), such as how difficult mathematics is and at the same time tell them how mathematical skills can be essential for future careers (Thomas and Furner, 1997).

Chikodzi and Nyota (2010) and Şahin (2008) argue that mathematics anxiety may not necessarily be experienced by students enrolled for the subject (mathematics) only, since every learner irrespective of the subject enrolled for, makes use of mathematics knowledge in one way or another. Chikodzi and Nyota (2010) further contend that the misconception of the non-utility of mathematics in actual life arises from the practice of teaching mathematics divorced from real life, whilst mathematics is deemed to be inseparable from organised life.

City Press in 2012 reports that one in six Grade 12 mathematics students scored less than 10% in the subject mathematics in 2011. There has also been a massive decline in the number of students enrolling for mathematics in recent years. For example, 300,000 students wrote the Mathematics paper in 2008, compared to only 225,000 in 2011. Many South Africans involved in education and business view the decline in passes and enrolments in scarce or gateway subjects such as mathematics as a worrying trend (Hlalele, 2012). Recently there was a decline in the pass rate of Matric Mathematics, from 59.1% in 2013 to 53.5% in 2014 as announced by the Minister of Basic Education on the 6th of Jan 2015

There are however effective strategies that can be applied to assist in reducing mathematics anxiety in students such as anxiety management training, desensitisation and support groups. In a meta-analysis, Hembree (1990) examined 151 studies related to mathematics anxiety. There were three types of treatment that were presented in those studies to address mathematics anxiety, they include the following:

Treatment Style	Treatment Example
Classroom Intervention	Curriculum Style
Attempt to relieve mathematics anxiety within whole classes	<ul style="list-style-type: none"> • Heuristic versus algorithmic instruction • Special classwork using computers • Provision of special equipment (for example calculators) • Special techniques for presenting material (tutorial, small group, and self-paced)

	<ul style="list-style-type: none"> • Psychological Intervention: Psychological treatments were behavioural or cognitive in nature
<p>Behavioural: Relieve emotionality (feelings of dread and nervous reactions)</p>	<ul style="list-style-type: none"> • Systematic desensitisation: students were taught the coping strategies and progressively exposed to the anxiety causing situations • Relaxation training
<p>Cognitive: Relieve from expressed concerns or worry about the subject</p>	<ul style="list-style-type: none"> • Reconstruction: Cognitive modification to restructure faulty belief and build self-confidence in mathematics. • Group Counselling

From the above analysis of Hembree's study on the treatment study and treatment of mathematics anxiety, the meta-analysis revealed that neither classroom interventions nor cognitive group counselling could effectively reduce mathematics anxiety. Cognitive restructuring of the faulty belief had a moderate effect on alleviating mathematics anxiety. Systematic desensitisation along with anxiety management training seemed to be most successful in reducing mathematics anxiety levels.

Other factors related to mathematics achievement such as motivation will be discussed next.

2.9 IMPROVEMENT OF AFFECTIVE AND COGNITIVE BEHAVIOURS IN MATHEMATICS THROUGH MOTIVATION

Learning is often regarded as either a temporary or a permanent change in behaviour and knowledge that arises as a consequence of some internal or external stimulus. It involves the internal development and reorganisation of relevant physio-cognitive structures and processes (Card, Moran and Newell, 1983). The external

stimuli involved usually taking the form of organised pedagogic and experiential activities that are often designed so that learning is optimised (Barker, 1995a).

Invariably, the success of a learning process is often critically dependent upon the frequency, level, quality and type of feedback that is given to students during the 'critical phases' of a learning task, such as mathematics. This feedback might be made available in an explicit way or it might form an implicit part of the learning process itself. Feedback is important because it can significantly influence motivation that is, an individual's desire to succeed in some task or activity with respect to the various activities in which he or she becomes involved (Brown, Armstrong and Thompson, 2013).

It can be argued therefore, that the effectiveness and efficiency of learning depend, among other things, upon both intrinsic (from within) and extrinsic (from without) motivation. For example, good teachers motivate students while the bad ones can have a de-motivating effect (extrinsic factor). Similarly, enthusiastic and enquiring students often achieve much more (pedagogically) than those who lack basic intrinsic qualities (Brown, Armstrong and Thompson, 2014).

In an effort to improve students' cognition and affective outcomes in mathematics and/or school learning, educational psychologists and mathematics educators, have continued to search for variables (personal and environmental) that could be manipulated in favour of academic gains. The only popular factor was that of motivation leading other variables (Tella, 2003).

To aid good performance in mathematics, there is an urgent need for instructional materials, which are designed and developed to support mathematics teaching and learning (Skemp 1989). In fact, psychologists believe that motivation is a necessary ingredient for learning (Biehler and Snowman 1986). Motivation therefore may help break the cycle of low performance among the students in High Schools.

The issues of motivation of students in education and the impact on academic performance are considered as an important aspect of effective learning. The impact of motivation on education of mathematics cannot be undermined. That is why Hall

(1989) believes that there is a need to motivate learners so as to arouse and sustain their interest in learning mathematics.

It is worth noting that due to the importance attached to mathematics at each level of education, there is a need to study the cognitive and affective implications of mathematics teaching. If the teachers are used to traditional methods of teaching the students may be discouraged and this may lead to their failure in the subject (Tella, 2003). In addition, due to the diverse population in our universities and the need to assist this sect of students, the university authorities have searched for alternative methods, that is, the importance of the relationship between the affective and the cognitive aspects of students' learning. This relationship is one of the lynchpins of the constructivist learning theory. Instructional programmes in mathematics, especially those designed for adult students returning to study mathematics, must develop both aspects simultaneously to be effective (Benn and Burton, 1993).

In support of this the Poststructuralists believe that the learning of mathematics is deeply bound in socially organised activities and systems of meaning (Agre, 1997) and that students need to communicate, argue and reflect in a social environment. Bandura's (1997) social cognitive theory maintains, "It is students' beliefs about the value of a learning activity, their expectation of success and their enjoyment of it that will motivate them to undertake it." Such components of the affective domain have been discussed widely in literature for many years (Tobias 1993, Higbee and Thomas 1999). The relationship between cognition, as measured by performance, and mathematics anxiety and other measures of the affective domain (mathematics self-concept, mathematics self-efficacy, joys and beliefs about mathematics) has also been widely reported (Benn and Burton, 1993).

However, it has been observed that these relationships are not very strong, many still express concerns, for example, Evans (1999) believes that affect has a strong influence on the ability of students to transfer mathematics skills from one context to another, and argues that this has been ignored in accounts of mathematics thinking.

2.10 MOTIVATION FOR ACHIEVEMENT IN MATHEMATICS: PAST AND RECENT STUDIES

Motivation as mentioned earlier can be categorised into two main types; intrinsic and extrinsic. Students who are intrinsically motivated engage in academic tasks because they enjoy them. They feel that learning is important with respect to their self-images, and they seek out learning activities for the sheer joy of learning (Middleton, 1992/1993a). Their motivations tend to focus on learning goals such as understanding and mastery of mathematics concepts (Ames and Archer, 1988: Duda and Nicholls, 1992: Dweck, 1986).

For students who are extrinsically motivated they engage in academic tasks to obtain rewards (for example, good grades, approval) or to avoid punishment (for example bad grades, disapproval). These students' motivations tend to center on such performance goals as obtaining favourable judgments of their competence from teachers, parents, and peers or avoiding negative judgments of their competence (Ames, 1992; Ames and Archer, 1988: Duda and Nicholls, 1992: Dweck, 1986).

When individuals engage in tasks which motivate them intrinsically, they tend to show a number of pedagogically desirable behaviours including increased time on tasks, persistence in the face of failure, more elaborative processing and monitoring of comprehension, selection of more difficult tasks, greater creativity and risk taking, selection of deeper and more efficient performance and learning strategies, and a choice of an activity in the absence of an extrinsic reward (Lepper, 1988).

Through various researches in the field of motivation, it has been observed that although ability and perceived competence each contribute to students' desire to learn mathematics, intrinsic motivation is more complex than the additive effects of these domains. When students see themselves as capable of doing well in mathematics, they tend to value mathematics more than students who do not see themselves as capable of doing well (Eccles, Wigfield and Reuman, 1987; Midgley, Feldlaufer 1989), but these expectations of success may also influence short-term strategy use (Meece, Wigfield and Eccles, 1990; Pokay and Blumenfeld, 1990), thereby inhibiting or augmenting achievement.

It is expected that students who feel comfortable with mathematics, must be challenged to achieve, and must succeed before the development of intrinsic motivation can begin. The findings of past studies on motivation suggest that the decline in positive attitudes toward mathematics can be explained in part as functions of lack of teachers' supportiveness and in the classroom environment.

These findings along with results from national assessments (Dossey, Mullis, Lindquist and Chambers, 1988), suggest that motivational patterns are learned and what is particularly distressing, is that students generally learn to dislike mathematics and that this dislike becomes an integral part of their mathematics self-concept.

We shall now look at certain main theories, review research and discuss results in terms of classroom practices that facilitate or inhibit students' developing productive motivational patterns.

2.10.1 BEHAVIOURAL THEORIES OF MOTIVATION

For most of the 20th century, the behaviourist theories of motivation dominated the literature. In this spectrum, motivations are seen as incentives for performing a given behaviour (Spence, 1960). After this, came newer reformulations of these theories (McClelland, 1965, cited in Covington, 1984), which have focused on the potential conflict between an individual's perceived necessity for success and perceived necessity for avoiding failure.

Although there has been a decline in popularity of behavioural research, which invariably led to a decline in studies of this field, this theoretical orientation has provided powerful knowledge about student motivation in mathematics. Firstly, research indicates that success in mathematics is a powerful influence on the motivation to achieve. Students perceive that success is reinforcing, and they will engage in mathematics if they expect to be successful. In addition, students will not only engage more, they will also enjoy tasks more for which they have a moderately high probability of success than tasks for which the probability of success is near chance (Dickinson and Butt, 1989).

Secondly, and more importantly, an orientation towards achieving success in mathematics can be built into the classroom. According to Alschuler (1969), when

students are given incentives to achieve, the motivation and achievement of the entire class can be raised. When students are rewarded for choosing a high level of personal success in mathematics, they tend to enjoy mathematics more and achieve more than when they are not given incentives. Slavin (1984), recommended the provision of *group incentives* to motivate students to achieve (i.e. providing a group reward for individual learning). This is because when the group score is rewarded, children are motivated to help others and are pressured to learn well themselves; through this practice, individual accountability is emphasised.

There are however several limitations evident in this paradigm, which depends on the achievement measures that use either multiple choice tests or well-defined problems.

In addition to this, the operational definition of 'success' inherent in behaviourist research, with a focus on discrete observable behaviours may be too molecular in scope or too far removed from children's attitudes to be a valid index of their achievement motivation. Time-on-task is often used as an index of motivation (Dickinson and Butt, 1989).

Reliance on time-on-task, however, introduces a confounding variable into the research design: The difficulty level of a problem is related to the time required to solve the problem, independent of motivation. In addition, because behaviourist theories have not traditionally been concerned with individual differences, they fail to provide information on how students define success and failure in mathematics (Middleton, 1999).

When engaging in an intrinsically motivating activity under obvious conditions that the activity is merely a means to an end will diminish subsequent intrinsic motivation because the presence of the reward is the primary reason for the student to engage. Consequently, in the absence of the reward students become less likely to engage in similar tasks in the future (Middleton, 1999).

There has been a plethora of research that suggests that when rewards are used to get someone to engage in some activity, the probability of subsequent disillusionment with the activity increases significantly (Kohn, 1996; Cordova and

Lepper, 1996; Ryan and Deci, 2000). Motivations help guide children's activity; to provide a structure for evaluating the outcomes of activity; and help determine whether or not children will engage in future mathematics activities.

2.10.1.1 Attribution and learned helplessness theories

Attribution theories deal with how the outcomes of an activity are evaluated in relation to the individual's perception of his or her own contribution (i.e., ability and effort) and the contribution of the task demands (i.e., difficulty, consistency, precedent) (Weiner, 1972). In mathematics education, attribution theory is the most widely held of the theoretical orientations discussed, perhaps because:

- (a) Attribution theories are cognitive, describing the *processes* by which motivations are acquired and changed and
- (b) They are applicable to a remarkable range of domains.

Moreover, attribution theories provide a middle ground between competing models of motivation such findings can be discussed in terms of reinforces and contingencies or in terms of students' thoughts, plans, and goals.

2.10.1.2 Attribution and achievement in mathematics

It has been observed that students in lower elementary grades are generally highly motivated to learn mathematics. They believe that they are competent and that working hard will enable them to succeed.

Many first and second graders do not distinguish between effort and ability as causes of success in mathematics (Kloosterman, 1993). However, there is considerable evidence that some students begin to differentiate ability for different content domains as early as kindergarten or the first grade (Wigfield et al., 1992). By the middle grades, many students begin to perceive mathematics to be a special domain in which smart students succeed and other students merely "get by" or fail. They begin to believe that success and failure are attributable to ability and that effort rarely results in a significant change in their success patterns (Kloosterman and Gorman, 1990).

Kloosterman (1993) believes that when students attribute their successes to ability, they tend to succeed; when they attribute their failures to lack of ability, they tend to fail. Gender studies have shown that girls tend *not* to attribute their successes to ability, but *do* tend to attribute their failures to lack of ability, exactly the attribution style that leads to failure.

Kloosterman (1988) studied how seventh graders perceived the role of successes and failures in influencing their motivational attributions, their mathematics self-confidence, and their beliefs about effort as a mediator of mathematics ability and failure as an acceptable phase in learning mathematics. He found that an attributional style (a combined score, scaled in the direction of internal, stable attributions) was the best predictor of mathematics self-confidence. The belief that effort is a mediator of ability and that failure is an acceptable phase in learning mathematics also contributed to students' self-confidence in mathematics. Although girls, more often than boys, felt that failure was an acceptable phase in learning mathematics, the fact that girls also thought about their failures more than boys may have contributed to differential effects like those reported by Meyer and Fennema (1985).

These findings are significant in that when students think of ability as amenable to change or augmentation through effort, they tend to expend more effort in mathematics and, thus, are better achievers than students who believe that ability is fixed. This is because the belief that occasional failure is acceptable in learning mathematics, predicts mathematics self-confidence, the practice of allowing children to struggle with challenging problems, even in the elementary grades, is then supported. When children who have not experienced difficult problems in mathematics encounter a problem that cannot be solved in a routine fashion, they may have their confidence shattered unless they believe that occasional mistakes are a part of the learning process in mathematics (Amit, 1988; Bassarear, 1986).

The mindsets of students once reaching college or university would have formed stable attributions regarding their successes in mathematics or any mathematics related course. This is because the attributional patterns of students in mathematics related majors, tend to focus on ability and effort as the causes for success and lack

of effort for failure, females who then attribute their failures to ability may then be systematically excluded from mathematics majors as a result of their prior mathematics education (Amit, 1988; Bassarear, 1986). In addition, what operates is that “students with unstable attributions for the causes of failure tend to dislike mathematics greatly” (Lehmann, 1986). These students may also be filtered out of mathematics-related majors.

2.10.1.3 Learned helplessness and dealing with failure

An extension to the attribution theory has been the specific attention of researchers to learned helplessness, a condition in which, because of a lack of success and the attribution of failure, individuals begin to view success as unattainable (for example Dweck, 1986).

Unfortunately, these beliefs persist as a result of educational environments that; (i) place a higher value on ability and lower value on effort; (ii) offer little opportunity for individuals with diverse learning styles to supplement their abilities with sustained effort (Covington, 1984). This is because helpless individuals believe that success is out of their grasp and attribute failure to internal factors, learned helplessness often becomes perceived as a trait (i.e., stable and unchanging).

Helpless individuals tend to show little motivation for challenging tasks, and in fact, when faced with a challenging task, they display lower achievement than can be attributed to ability. Although the findings of most studies regarding learned helplessness are disheartening, there is however some evidence that attributions can be positively influenced through classroom instruction. For example, Relich (1984) hypothesised that when students are provided attribution retraining in conjunction with skills training, their feelings of learned helplessness should be reduced and their mathematics achievement should be positively affected. Those providing attribution training attempted to make students aware that they were achieving success on increasingly difficult problems as a result of at least an average ability and high effort. Students who received the attribution training displayed superior self-efficacy gains and fewer learned helplessness characteristics compared to students receiving no attribution training.

Relich (1984) then proposed a causal model that contrasted the direct effects of attribution training with the mediated effects on achievement and learned helplessness. Results of a path analysis indicated that although the attribution training had a moderate, direct influence on achievement, stronger paths resulted from mediation through self-efficacy. The attribution training also had a direct influence on reducing learned helplessness, which in turn, had a direct effect on students' development of self-efficacy. Thus, it seemed reasonable to predict that the attribution training's effects on achievement were mediated through self-efficacy via the reduction of learned helplessness.

2.10.1.4 Intervention and the role of the teacher

A major difficulty in designing appropriate intervention strategies in the mathematics classroom is the tendency for teachers' attributions to parallel and reinforce those of their students. Teachers tend to initiate more concern with boys, prompt boys more, and have more social interaction with boys than with girls (Fennema, 1984 and Peterson, 1985). Thus, teachers may unwittingly undermine their students' achievement and motivation by reinforcing failure-oriented attributions, especially for their female students.

For the most successful students, teachers tend to attribute success more for boys than for girls, and teachers see boys as the most successful and most intelligent in the class. When less successful girls fail, teachers tend to attribute their failure to lack of ability, lack of effort, and task difficulty, whereas boys' failure is more often attributed solely to lack of effort (Fennema, Peterson, Carpenter, and Lubinski, 1990). This shows teachers' attributions of their students' successes and failures could be reflected in the ways in which they interact with boys and girls in their mathematics classes. These differences in interaction patterns contribute to differential gender-related motivation and achievement patterns.

2.10.2 GOAL THEORIES: RELATING MATHEMATICS TO WHAT IS VALUED

Goal theorists are concerned more deeply with the cognitive bases of the reasons people do what they do. They are concerned with understanding how people think about engaging in meaningful (or meaningless) activity, and they also conduct

research on peoples' perceptions, interpretations of academic and social information, and patterns of self-regulation (Ames and Ames, 1984).

Moreover, researchers who ground their work in goal theory often incorporate the generalised findings from the attribution literature and attempt to posit how reasons for success and failure are related to what is valued (Ames and Archer, 1988; Dweck and Leggett, 1988). Duda and Nicholls (1992) suggested that the basic dimensions of goal orientations correspond directly to distinct implicit theories (or beliefs) of how success is achieved in academic work (see also Ames, 1992; Ames and Archer, 1988; Dweck, 1986). An individual with a *mastery* (or *learning goal*) orientation values the improvement of skills or knowledge in a given domain and believes that success depends on working hard, attempting to understand the domain, and collaborating with others. An individual with an *ego* (or *performance goal*) orientation values establishing "superiority over others" (Duda and Nicholls, 1992:290) and believes that success depends on social comparison and assertion of superior ability.

A third orientation, *work avoidance*, is an especially disturbing goal pattern in which working hard is not valued. An individual with this goal orientation believes success results from, for example, "behaving nicely in class" or other behaviours are superfluous to study and academic thoughtfulness. Work avoidance is often developed as a coping method for preserving feelings of adequacy by eliminating any threatening or difficult activities so that a legitimate negative evaluation of one's ability cannot be made by others (Covington and Beery, 1976).

2.10.2.1 The interplay between goal structures and intrinsic motivation

An individual's intrinsic motivation is mediated through the types of goal structures he or she has created (Meece, Blumenfeld, and Hoyle, 1988). In particular, possession of a mastery goal orientation will positively mediate intrinsic motivation such that one will become more actively involved in a cognitive task. An ego goal orientation (i.e., primarily seeking social recognition) has much less effect on one's developing active cognitive engagement patterns.

Motivational patterns have both generality and specificity. The pattern of goal orientations and beliefs about success listed above seem to be general orientations that students, at least by the time they are in high school, apply across different domains in their lives. However, feelings of personal satisfaction, relevance, and boredom seem to be created by students with respect to specific tasks (Duda and Nicholls, 1992; Seegers and Boekaerts, 1993).

Due to the different beliefs about the nature of different academic subjects, mastery goals do have differential effects on learning. Students who view mathematics as a fixed body of knowledge tend to develop goals of memorisation of facts and procedures. These students also tend to emphasise determining correct answers as the primary goal of mathematics learning. Students who view mathematics as a process, guided by their own search for knowledge, tend to value constructing a relational understanding of concepts, and are consequently motivated intrinsically because the knowledge they develop is their own (Underhill, 1988).

In addition, the ways in which teachers structure their classroom inquiries can greatly influence students' views of mathematics and can also lead students to develop more powerful conceptual structures in the process (Cobb et al., 1991; Cobb, Wood, Yackel, and Perlwitz, 1992). Students in inquiry-based classrooms are less likely to develop ego goals than students in more traditional classrooms. Moreover, students in inquiry-oriented classrooms are less inclined to believe that conformity to the solutions of the teacher or others leads to success in mathematics, and they tend to believe strongly that the classroom is a place where success is defined as attempts to understand mathematics and explain their thinking to others. These attitudes contribute to increased student performance on conceptual and non-routine tasks that persist even in the face of poor instruction later on (Cobb, Simon and Schifter, 1991; Cobb et al., 1992).

Goal orientation has been found to be a strong predictor of achievement (Henderson and Landesman, 1993). Students with mastery goals tend to perform better than those with ego goals regardless of the learning situation.

2.10.2.2 Theories of the Self: Personal-Construct Theories

Personal construct theories are idiographic approaches to examining individual differences in human thought (Snow, Corno, and Jackson, 1996). They are based on the premise that individuals construct knowledge about their worlds and use this knowledge to predict outcomes of activities (Kelly, 1955). The purpose of employing personal construct approaches in the study of motivation is to describe construct systems of individuals in order to uncover the ways they evaluate activities. Usually this description involves some sort of “mapping” of the relationships between constructs to ascertain the cognitive structure underlying the motivation.

According to Kelly (1955), in contrast to other approaches to the study of motivation mentioned earlier, which are typically concerned with the outcomes of motivational processes (for example, ability attributions, achievement, etc.), personal construct psychologists are interested in the processes themselves. They assume that motivation results from rational cognitive processes, and they provide a method for understanding these processes.

Owens (1987), for example, used the personal-construct theory to describe two teachers' attitudes toward mathematics and mathematics teaching. Although the teachers' conceptions of their mathematics backgrounds were remarkably similar and they rated themselves as most similar to the person they considered their “best” mathematics teacher, their concepts of what makes a good mathematics teacher differed markedly. The teacher who felt that more difficult mathematics was enjoyable also felt that inquisitiveness was a desirable trait for a mathematics teacher. The other teacher, who enjoyed mathematics that was easier, rated inquisitiveness least desirable as a trait for a mathematics teacher.

To this end, Owens (1987) concluded that their constructs about mathematics and mathematics education play a powerful role in determining how teachers anticipate their teaching roles. In addition, it seems reasonable to assume that the teachers' prior mathematics education experiences, especially identification with their mathematics teachers, play a pivotal role in determining what aspects of mathematics are motivating and thus, how they approach teaching mathematics.

Lucock (1987) found that children in high-ability mathematics tracks tended to find mathematics easier, enjoy doing mathematics more, and considered mathematics to be more useful than children in lower ability tracks. These findings are hardly surprising. However, when children who enjoyed mathematics were asked to perform routine work (i.e., learning without understanding), they became disillusioned with mathematics and tended to give up. In addition, gender differences were found between the ways in which high-ability boys and low-ability girls internalized success in mathematics tasks. Lucock (1987) found that high-ability boys tended to fail with confidence; that is, their confidence in their abilities was fairly robust despite their failure. Low-ability girls tended to succeed with diffidence; that is, their insecurity tended to be robust even when they were successful.

The above presented a discussion of different theories related mathematics achievement.

2.11 SUMMARY

It has become crucial and timely to delve into the potential of self-beliefs and attitudes towards educational planning and practice. It is known that self-concepts and related attitudes are important influences in the learning choices students make, and play a role in learning behaviour and performance. Among these attitudes and self-concepts identified in literatures over the last three decades is, mathematics anxiety, test anxiety, perceptions of the usefulness of mathematics, motivation, self-esteem and locus of control

Researchers have also been examining relationships between cognitive factors such as preferred learning styles, visual and spatial ability, the use of specific cognitive strategies and critical thinking skills, and performance in mathematics

Educators have begun to research techniques to reduce or eliminate the impact of cognitive and non-cognitive barriers to learning mathematics. Collaborative learning and verbalisation during the problem solving process are two classroom strategies that appear to have proven successful in assisting college students in overcoming negative attitudes toward learning mathematics.

Some educators might be surprised by the absence of significant relationships between self-esteem and measures of confidence or anxiety. Recent research (Higbee and Thomas, 1996; Wentzel and Wigfield, 2009), however, indicates that low academic self-concept, including subject-specific self-concept (for example, self-concept as a learner of college algebra), should be considered a separate construct from self-esteem when exploring characteristics of high-risk students. Further research and the development of instrumentation are needed in this area.

This study is just a starting point; there is need for additional research, especially experimental design research, to determine the separate impact of each affective factor (anxiety, motivation and teaching strategies) on student achievement. However, it can also be anticipated that different activities will be more or less successful depending on the needs and preferred learning styles of each student. It is not always possible within the confines of the mathematics classroom to completely individualise instruction. Thus, the introduction of a wide variety of activities, self-management techniques, as well as teaching and learning strategies may be an appropriate means of enhancing achievement among all the students in the developmental mathematics classroom.

CHAPTER THREE

AN EXPOSITORY REVIEW OF RESEARCH METHODOLOGY PROCESSES OF THIS STUDY

3.1 INTRODUCTION

It has become a common belief in the United States that learning is more a question of ability than effort. The adults in schools have come to accept their ignorance and poor performances in mathematics without embarrassment but would not accept such embarrassment with other subjects. They have often proclaimed their ignorance and lack of accomplishment in mathematics as a permanent state that cannot be reversed and over which they have little to no control. However, this can only be helped if the affective responses of both the children and adults change (McLeod and Adams, 1989).

To this end, the United States reform movement had since seen the importance of taking the affective factors very seriously and to act where substantial change is needed. According to Hart (1998) and Simon (1982), describing the affective domain is no easy task, due to the fact that some terms can have different meanings. For instance, anxiety is sometimes described as fear, while in some other researches it is termed as worry or dislike. Thus, clarification and distinctive terminologies to be used by researchers in psychology and mathematics education have become a daunting task to achieve. However, for this study we shall be considering the use of anxiety and lack of motivation as affective domains affecting mathematics performances.

This study entails the use of educational research, which is about describing opinions and other characteristics of persons or to determine the value of an intervention. It includes such things as describing students' characteristics, for example information about students' backgrounds: social background, repeating a class, participation in special education programmes, achievement scores and behavioural observations. The researcher then puts this information in a table or figure and points out possible changes in outcomes during a certain period

(www.ppsw.rug.nl). This is what a descriptive research outlines and helps present data in a clear and understandable way.

On the other hand, Evaluative research identifies the value of a new educational programme, a new learning method, an educational course for parents, or a literacy course for adults. To determine if the new educational programmes or interventions are being implemented according to the ideas of the innovators and whether they have showed the expected effects (www.ppsw.rug.nl).

In mathematics education, researchers have treated affect as an important complication theory that can be avoided. If the researcher sees the learner as only a container ready to siphon knowledge from the teacher and not someone who can create or construct knowledge on his/her own, this would have a great impact on both the affective and cognitive domain of the student. (Mcleod, 1988).

The affective domain comprises of the beliefs, attitudes and emotions which help describe students' responses to mathematics. We can observe certain changes in the stability of the affective responses, the beliefs and attitudes are quite stable while emotions may change erratically (Mcleod, 1994).

Most mathematics lecturers that are masters in their fields often point out that students' successes or failures of problem solving in mathematics can be attributed mostly to lack of self-confidence, motivation, perseverance, the prevalence of anxiety or fear of the subject and other non-cognitive traits such as the mathematics knowledge they possess (Garofalo, 1989).

In essence, we observed that researchers are more comfortable in restricting their research to cognitive aspects of mathematics performance than non-cognitive aspects, although this study focuses on both qualitative and quantitative research techniques. However, there has been considerable progress in investigating mathematics anxiety, but the concepts and terminologies underlying the research remain unclear. For instance, as Hart (1989: 94) puts it, "Anxiety has sometimes been characterised as fear, a 'hot' emotion, and sometimes a dislike, or attitude. The relationship of mathematics anxiety to performance in mathematics is sometimes difficult to demonstrate" (Gilner, 1987; Llabre and Suarez, 1985; Mevarech and Ben Artzi, 1987).

In addition to this, researches have attempted to give a clearer picture of the relationship between the various measures of mathematics anxiety, test anxiety and related concepts (Ferguson, 1986; Hendel, 1980; Richardson and Woolfolk, 1980; Rounds and Hendel, 1980), all these were only able to report modest success. It has become difficult over the years to distinguish the conception of mathematics anxiety to that of test anxiety. However, this research will be based mostly on students' anxiety to problem solving in mathematics and its resultant effect on performances.

Having looked at the conceptualisation of the bridging mathematics programme in South Africa and the emergence of the affective domain on success rates in Mathematics, this chapter will delve in to the reasons why research focus has changed over time to the aspect of affective domains as it relates to success rates in mathematics.

In this chapter the researcher will discuss in more detail the research process or methodology that will be followed in this study. The researcher will begin by describing the transformative paradigmatic perspective of the study and thereafter examine the research methodology and research strategies to be used, followed by a description of the quality assurance criteria expected of the research, as well as an elaborative role of the researcher in conjunction with the important ethical considerations guiding the study.

3.2 TRANSFORMATIVE PARADIGMATIC PERSPECTIVE

A paradigm is a set of assumptions or beliefs about fundamental aspects of reality which gives rise to a particular worldview (Nieuwenhuis, 2010). Social research and studying social life cannot proceed without a guided theoretical scaffolding or paradigm. Paradigms are also known as general frameworks through which to see life; they provide a set of assumptions about the nature of reality. A paradigm is what we think about the world but cannot prove (Lincoln and Guba, 1985).

According to Mertens (2007:2) "The transformative paradigm with its associated philosophical assumptions provide a framework for addressing inequality and injustice in society using culturally competent, mixed-methods strategies.". The recognition that realities are constructed and shaped by social, political, cultural,

economic and racial/ethnic values indicated that power and privilege are important determinants of which reality will be privileged in a research context.

The methodological inferences based on the underlying assumptions of the transformative paradigm reveal the potential strength of combining the qualitative and quantitative methods. A qualitative dimension is needed to gather community perspectives at each stage of the research process, while a quantitative dimension provides the community members and scholars the opportunity to demonstrate outcomes that have credibility of scientific testing (Mertens, 2007).

Guba and Lincoln (in Tashakkori and Teddlie, 2010) categorise the basic assumptions or beliefs that define a transformative paradigm into the following four concepts:

- **Ontology** (the nature of reality and what there is to be known about it)
- **Epistemology** (the nature of knowledge and the relationship between the researcher and the participants i.e. the relationship between the knower and the would-be-known). Epistemological questions include: If I am to really know if something is real, how do I need to relate to the people from whom I am collecting data? Should I be close to the participants so that I can really understand their experiences or should I maintain a distance between the participants and myself so that I can remain “neutral”?
- **Methodology** (the process implemented by the researcher to obtain knowledge and understanding i.e. the appropriate approach to a systematic enquiry). Methodologically, I have a choice to make that transcends quantitative, qualitative, or mixed methods, to how I collect data about the reality of human experiences in such a way that I can feel confident that I have captured that reality.
- **Axiology** (this relates to the nature of ethics). Axiologically, on what basis do we define ethical theory and practice in research? What is considered ethical or moral behaviour? How to address issues of ethics when conducting research in culturally complex communities, so as not to jeopardise the outcome of my research?

This study is conducted from a transformative paradigmatic perspective to explore the nature of anxiety among Pre-degree mathematics students using mixed methods of inquiry in an ethical manner.

3.2.1 POSITIVIST/INTERPRETIVE OR CONSTRUCTIVIST PARADIGMS

Terre Blanche and Durrheim (1999) describe three paradigms namely, the positivist, interpretive and the constructionist paradigms. In this chapter these paradigms will be described so that the current research can be placed in to its theoretical contexts and its guiding framework described. The subsequently arising methodology or how this current research will be carried out will be explained.

We shall now briefly describe the three paradigms above as put forward by Terre Blanche and Durrheim (1999):

3.2.1.1 Positivist paradigm

The positivist paradigm sees reality as stable, external and governed by laws (Terre Blanche and Durrheim, 1999). There is one reality; a truth to be discovered that is independent of human perception (Erlandson, Harris, Skipper and Allen, 1993; Lincoln and Guba, 1988). The epistemology defines the researcher as detached from the subject being studied (Terre Blanche and Durrheim, 1999).

Objectivity in enquiry is mandatory and inquiry should be value free (Erlandson, *Harry, Skipper and Allen*, 1993). The methodology relies on control and manipulation of reality; it is usually quantitative in nature using experimental designs that involve hypothesis testing. It aims at providing an accurate description of the laws that govern reality (Terre Blanche and Durrheim, 1999). The aim of science is to arrive at generalisations preferably causal in nature. The truths of these generalisations are dependent on the ability to predict and control (Erlandson, et al., 1993).

The Positivist paradigm will be used to shape the ontology, epistemology and methodology of this proposed study as developed by the quantitative pluralists that believed that social observations should be treated as entities in much the same way that physical scientists treat physical phenomena

3.2.1.2 Interpretive Paradigm

The interpretive paradigm according to Nieuwenhuis (2007), is based on the assumption that access to reality is only gained through social constructions such as language (spoken or symbolic), consciousness and shared meanings. Human life, according to the interpretive paradigm, can only be understood from within and cannot be observed from external reality. Reality can thus be understood and interpreted, but cannot be predicted and controlled.

This paradigm treats people as though they are the origin of their thoughts and feelings. In short reality is constructed in the minds of individuals (Terre Blanche and Durrheim, 1999; Guba and Lincoln, 1988). The researcher's stance towards reality is inter-subjective and empathic. The methodologies used are qualitative in nature and acknowledge the subjective relationship between the researcher and subject (Terre Blanche and Durrheim, 1999).

This shows that the researcher's view of reality is therefore, considered to affect the study as is the perspective of those interpreting and reading it. The researcher's point of view, biases, and personal experience that impact on the study must be explored and addressed as well (Creswell, 1997).

According to Adams and his colleagues (2004), "Researchers working in this paradigm acknowledge that people's subjective experiences are valid, multiple and socially constructed (ontology). Researchers believe that they can understand the experiences of others in interaction with themselves (the researchers) and by listening to them (epistemology); and that qualitative research techniques are best suited for conducting such investigations (methodology)."

To this end therefore, the qualitative purists affirmed in the use of the interpretive or constructivist paradigms rejecting the positivist assumption of the quantitative school of thought that reality is objective, multiple and socially constructed by its participants (Krauss, 2005; Bryman, 1984; Lincoln and Guba, 2000; Amare, 2004)

This study makes use of a qualitative component in order to triangulate quantitative data findings.

3.2.1.3 The Constructionist Paradigm

For the constructionist paradigm, they see reality as socially constructed. This means that systems of meaning originate on a social rather than an individual level (Terre Blanche and Durrheim, 1999) and facts are created through an interactive process (Guba and Lincoln, 1989).

Donald and his colleagues (2006) define constructionism as an approach that sees knowledge as actively constructed by individuals, groups and/or communities. Individuals are seen as active agents who create meaning in their life worlds through social interaction in a specific context (Maree, 2004). Constructed knowledge or meaning therefore is closely related to the social, historical and cultural context in which the meaning is constructed (Donald, Lazarus and Lolwana, 2006).

The meaning that is created through social interaction is multiple and diverse. Creswell (2007) notes that the researcher is compelled by the diversity of subjective meanings to focus on the complexity of views, instead of presenting meanings in categories.

The researcher adopts a suspicious and politicised epistemological stance towards reality. Methods employed are qualitative and interpretive in nature and concerned with meaning. However, the focus is concerned with how these meanings are formed on a wider, social level. Nieuwenhuis (2007) argues that this approach aims to offer a perspective of a situation in order to provide insight into the way in which a particular individual or group of people make sense of their situations or the phenomenon under study. The emphasis of the research process is on the interaction between individuals as well as on the different contexts in which interaction takes place. In this way a more comprehensive understanding of the historical and cultural impact on the interaction can be accomplished.

It is worth noting that the paradigm the researcher uses shapes and gives direction to the methods and strategies with which the research process will be approached. The research methodology and the strategies to be used in this proposed study would be discussed in the section that follows. It has been argued by research scholars within social science that the relative preference of each research

methodology depends on philosophical issues related to the question of ontology (the nature of reality) and epistemology (the nature of knowledge) (Terreblanche and Durrheim, 1999).

Research methodology in social science or the humanities are related in the sense that they are all means of soliciting information from human participants; this study will however employ both the interpretive (by observation, interviewing and analysis of existing texts) and the positivist (by surveys i.e. questionnaires and case studies) paradigms to shape the ontology, epistemology and methodology perspectives (Chow, 2002).

3.3 PARADIGM GUIDING THE CURRENT STUDY

The onerous task of this current study is to discover how anxiety and lack of motivation can affect Pre-degree students' success rates in bridging mathematics. The aim is to be able to understand how anxiety, lack of motivation and possibly poor teaching techniques have played a role in affecting the participants' success rates in bridging mathematics at the Midrand Graduate Institute. To this end, interpretive and positivism paradigms are been selected as methodologies to execute this research.

The epistemology chosen is a combination of ethnography and case study research, which falls under an interpretive paradigm and uses a qualitative methodology. It will also employ the use of empirical observations of individual behaviour, which falls under the positivist's paradigm and uses a quantitative methodology in order to discover and confirm a set of probabilistic causal laws which can be used to predict general patterns of human activity. From this perspective, the researcher will explain in quantitative terms how variables interact, shape events and cause outcomes. Multivariate analysis and techniques for statistical prediction are among the classic contributions of this research.

Ethnography results in a description of shared beliefs and behaviours of a particular group of people. The approach is interested in how the participants theorise about their own behaviour (Uzzell, 1998). Creswell (1997) states that in using qualitative methodologies for inquiry into a social or human problem, the researcher builds a

complex holistic picture of the students' experiences in bridging mathematics. The research methodology and the strategies to be used in the proposed study will be discussed in the section that follows.

3.4 RESEARCH DESIGN

According to Nieuwenhuis (2010), research design is a plan or strategy, which moves from the underlying philosophical assumptions to specifying the selection of respondents, the data gathering techniques to be used and the data analysis to be done. Research design focuses on the end-product meaning what kind of study is being planned and what kind of results are aimed at, for example, Comparative-historical study, Interactive or exploratory study, Inductive and Deductive study, etc. For a research design the point of departure is always driven by the research problem or question and what evidence is required to address the question adequately. Fouché (2002) refers to the research design as encompassing all the decisions the researcher makes when planning a study. The choice of research design is therefore based on the researcher's assumptions, research skills and research practices, which influences the way in which the data is collected.

This proposed study is quantitative, qualitative, descriptive and exploratory in nature (that is, a mixed method) and the research design for the study is a case study. To this end, the characteristics of the research design will be discussed in more detail in the subsequent section

3.4.1 CHARACTERISTICS OF THE RESEARCH DESIGN

3.4.1.1 Quantitative research

Quantitative research emerged around 1250 A.D. and was driven by investigators with the need to quantify data. Since then the quantitative research has dominated as the research method to create meaning and new knowledge. What constitute a quantitative research method involves a numeric or statistical approach to research design. Leedy and Omrod (2001) alleged that quantitative research method is specific in its surveying and experimentation, as it builds upon existing theories. The

methodology of a quantitative research maintains the assumptions of an empiricist paradigm (Creswell, 2003).

The research itself is independent of the researcher; as a result, data is used to objectively measure reality. “Quantitative research seeks explanations and predictions that will generate to other persons and places; the intent is to establish, confirm, or validate relationships and to develop generalisations that contribute to theory.” (Leedy and Omrod 2001:102) It begins with a problem statement and involves the formation of a hypothesis, a literature review, and a quantitative data analysis. Creswell (2003:18) states, “Quantitative research employs strategies of inquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data.” The findings from quantitative research can be predictive, explanatory and confirming.

3.4.1.1. Methods to conduct Quantitative Research

There are several methods existing to use in conducting quantitative research. For the descriptive research method, correlational developmental design, observational studies, and survey research are used. These research methods may also be used in various degrees with experimental and causal comparative research. In the correlational research method, the research examines the differences between two characteristics of the study group. Leedy and Omrod (2001) felt that it is crucial to observe the extent to which a researcher discovers a statistical correlation between two characteristics depending on some degree of how well those characteristics have been calculated. Hence, validity and reliability are important components that affect correlation coefficients.

Bold (2001) noted that the purpose of a correlational study is to establish whether two or more variables are related. Creswell (2002) defined correlation as a statistical test to establish patterns for two variables. The statistical analysis of the research question can be conducted through a progression of analyses using a standard test for correlation that produces a result called ‘*r*’. The *r* coefficient is reported with a decimal number known as the Pearson Correlation Coefficient (Cooper and Schindler, 2001). During the developmental design, the researcher explores how characteristics may change over time within a study group. Two types of

development designs include cross sectional and longitudinal. In the cross-sectional study, the researcher compares two different groups within the same parameters, whereas, for the longitudinal study this is commonly used in child development research to better a phenomena of particular age groups or to study a group over a specific period of time (Leedy and Omrod, 2001).

In the observational study method, the researcher observes a particular aspect of human behaviour with as much objectivity as possible and records the data. However, in the survey research method, the researcher tends to capture phenomena at the moment. The methods used for sampling data from respondents that are representatives of a population and uses a closed-ended instrument or open-ended questions. It happens to be one of the ways to gather data in the social sciences.

Examples of data collection methodologies include the following:

- Performance Tests
- Personality Measures
- Questionnaires (with closed-ended questions or open-ended but transferred to quantitative data)
- Content Analysis

As a point of note, this study has utilised questionnaires with closed ended questions as data methodology adopted.

3.4.1.2 Qualitative research

The transformative paradigmatic perspective taken in this study includes the positivist, interpretive and the constructivist paradigms. To this end, the mixed method research will be appropriate, involving quantitative and qualitative methods. Qualitative research is a holistic approach that involves discovery. It is also described as an unfolding model that occurs in a natural setting that enables the researcher to develop a level of detail from high involvement in the actual experiences (Creswell, 1994). One focal point of a qualitative research is the social phenomenon being investigated from the participant's viewpoint.

Merriam (2002) observes that the key to understanding qualitative research lies in the idea that meaning is socially constructed by individuals through the interpretation

of their interaction with their world and that qualitative researchers are interested in understanding what those interpretations are at a particular point in time and in a particular context.

Qualitative research focuses on describing and understanding participants in their natural context (Nieuwenhuis, 2007) instead of explaining phenomena by means of statistical analysis. Data is thus collected and presented by means of words and pictures rather than numbers (Fraenkel and Wallen, 2006). The aim is therefore, to gain a better understanding of people and the construction of their world and their experiences by investigating participants in their natural setting.

Furthermore, qualitative research is conducted within a poststructuralist paradigm. There are five areas of qualitative research namely, case study, ethnography study, phenomenological study, grounded theory, and content analysis. These five areas are representative of research that is built upon inductive reasoning and associated methodologies (Leedy and Omrod, 2001).

When qualitative researchers make use of an inductive process, it means, that they build towards theory during the process of research instead of trying to prove a theory or hypothesis (Merriam, 2002; Fraenkel and Wallen, 2006). A qualitative approach will therefore give an insight into how anxiety and lack of motivation can affect students' (Pre-degree) performance rates in bridging mathematics. This means it will also showcase a rather holistic view of the interaction among the other affective and cognitive factors that are at play in determining poor success rates in mathematics at the Pre-degree level of learning.

In summarising the above breakdown of some of the qualitative research methodologies and their meanings, it shows that generally qualitative research methodologies involve listening to the participants' and subjecting the data to analytic induction (for example finding common themes) that is, it is more exploratory in nature. Its data collection methods include:

- Interviews
- Open-Ended questionnaires
- Observations

- Content analysis
- Focus Groups

This study utilises interviews with students as main respondents and lecturers as focus group. The main respondents will be asked 10 open ended questions and the focus group 7 open-ended questions. In addition to the questions asked from the main respondents a bio-data form will be completed first, containing useful information on the interviewees.

Leedy and Omrod (2001) recommend the following five qualitative research methodologies amongst various others: Case studies, grounded theory, ethnography, content analysis, and phenomenological. Creswell (2003) describes how these different qualitative research methodologies meet different needs. For instance, case studies and grounded theory research explore processes, activities, and events while ethnographic research analyses broad cultural-sharing behaviours of individuals or groups. Case studies as well as phenomenology can be used to study individuals.

Case Study

A typical characteristic of a case study research can be described from an interpretive perspective as striving for a comprehensive understanding of how participants relate to and interact with each other in a specific context and how they make meaning of the phenomenon under study (Nieuwenhuis, 2007).

Creswell (2003:15) defines case study as, “A researcher exploring in depth a programme, an event, an activity, a process, or one or more individuals”. Leedy and Omrod (2001) further require a case study to have a defined time frame. The case study can either be a single case or a case bounded by time and place. According to Leedy and Omrod (2001:149), a case study is an attempt to learn “more about a little known or poorly understood situation”. Creswell (1998:51) asserts that, “The structure of a case study should be the problem, the context, the issues and the lessons learned.”

When collecting data for a case study it is quite extensive and draws from multiple sources such as direct or participants' observations, interviews, archival records or documents, physical artefacts and audiovisual materials. The researcher must spend time on-site interacting with the people being studied. The report would include lessons learned or patterns found that connect with theories.

Furthermore, case studies are not easily verified due to its unique nature and can be viewed as selective, biased, personal and subjective. This means therefore, that case studies are often prone to problems of observer bias, despite attempts made to address reflexivity (Cohen, Manion and Morrison, 2000).

These characteristics of case study research design are similar to the approach adopted for this current study, as discussed in both the "Transformative Paradigmatic Perspective" and "Characteristics of the research design". The case study design will therefore assist the researcher in contributing to the implementation of appropriate data collection techniques and data analysis in this investigation.

The case study investigator's aim is to retell the story from the participants' point of view. Evidence in terms of specific interviews and observations are used to draw conclusions. As the research seeks description of the phenomenon, a high account of detail is given. This is compatible with the ethnographic requirement for a "thick description" (Denzel, 1989:83; Erlandson *et al.*, 1993:94)

Three main types of case studies can be distinguished (Creswell, 2008; Stake, 2005):

- **Intrinsic case study:** The researcher is interested in understanding a specific individual or situation by describing in detail, the particulars of an individual case in order to shed more light on what is going on. The purpose is not to understand a broad social issue, but to describe the case being studied.
- **Instrumental case study:** The focus is on a social issue and selects a case in order to illustrate the issue for better understanding and possibly to make generalisations with regard to a specific phenomenon in order to elaborate on a theory.

- **Collective case study:** Multiple cases are selected in order to illustrate a specific social issue, to compare cases and concepts as well and to generalise the findings for extending and validating theories.

To this end, this proposed study would use an intrinsic case study. A case as we know is selected to gain insight or knowledge into how anxiety and lack of motivation can affect Pre-degree students' success rates in bridging mathematics. Although generalisations of the results are not excluded, the researcher is cautioned by Stake (2005) not to focus on generalisations as this can lead attention away from the important aspect that can promote a comprehensive understanding of the case. Following the above discussion therefore, the researcher will focus on the collection of information that relates to the phenomenon in the case study in order to contribute knowledge to this field of study and to the existing literature.

Finally, case studies do not claim to be representative, but the emphasis is on what can be learned from a single case (Tellis, 1997). Case studies have value in advancing fundamental knowledge in the relevant knowledge domain. The underlying philosophy of a single case study is "not to prove but to improve". (Stufflebeam, Madaus, and Kellaghan, 2000:283)

3.4.1.3 Mixed Methods Approach

A mixed method research design is a procedure for analysing and "mixing" both quantitative and qualitative research and methods in a single study to understand a research problem. To utilise this design effectively, one must understand both quantitative and qualitative research.

According to Johnson and Onwuegbuzie (2004:14), they hoped that the mixed methods approach to research provides researchers with an alternative to believing that the quantitative and qualitative research approaches are incompatible and in turn, their associated methods "cannot and should not be mixed". With the mixed methods approach to research, researchers incorporate methods of collecting or analysing data from the quantitative and qualitative research approaches in a single research study (Creswell, 2003; Johnson and Onwuegbuzie; Tashakkori and Teddlie, 2004).

That is, researchers collect or analyse not only numerical data, which is customary for quantitative research, but also narrative data, which is the norm for qualitative research in order to address the research question(s) defined for a particular research study. As an example, in order to collect a mixture of data, researchers might distribute a survey that contains closed-ended questions to collect the numerical, or quantitative, data and conduct an interview using open-ended questions to collect the narrative, or qualitative, data (Johnson and Onwuegbuzie, 2004).

Most researchers use the mixed methods approach to research in order to draw from the strengths and minimise the weaknesses of the quantitative and qualitative research approaches (Johnson and Onwuegbuzie, 2004). However, we need to know that the strengths and weaknesses associated with the various research approaches are not absolute but rather relative to the context and the manner in which researchers aspire to address the phenomenon under study. For example, if the researcher purports to provide in-depth insight into a phenomenon, the researcher may prefer selecting a small but informative sample, which is typical of qualitative research. The researcher might use inferential statistics to quantify the results, which is typical of quantitative research, as strengths worthy of combining into a single research study.

The ability to design research studies that combine data collection or data analysis methods from the quantitative and qualitative research approaches helps researchers to test and build theories. This means they are able to employ the use of the deductive and inductive analysis.

Proponents of the mixed methods approach to research advocate doing “what works” within the precepts of research to investigate, predict, explore, describe, and understand the phenomenon (Carr, 1994; Creswell, 2003; Johnson and Onwuegbuzie, 2004; Sale, Lohfeld, and Brazil, 2002; Tashakkori and Teddlie, 2003). This means, in relation to the mixed methods approach to research, pragmatic assumptions govern claims about what is knowledge (Creswell; Johnson and Onwuegbuzie; Tashakkori and Teddlie, 1998). All these proponents urged

researchers now to focus on the relative strengths of quantitative and qualitative research identifying how they can be incorporated in a single research design so as to maximise the strengths and minimise the weaknesses of each (Johnson and Onwuegbuzie, 2004) and in doing so, advance a more complementary understanding of the object of the study.

In support of this, King (2010) goes so far as to argue in a divisive debate that the polarisation between quantitative and qualitative research is now much less prominent than in the 1990s, referring to Melzi and Caspe's (2010:6) assertion that, "There is growing recognition for the need to draw on, and in some cases, integrate both approaches in order to gain a more complete understanding.

More specifically, Tashakkori and Teddlie (2003:4) are among those who promote Mixed Method Research (MMR) by referring to it as the 'third methodological movement' (p. 4) in the social and behavioural sciences. In making this claim, they recognise three categories into which research practices can be roughly assigned: (a) quantitatively-oriented research practices rooted in positivist and post-positivist traditions and mainly interested in numbers; (b) qualitatively-oriented research practices, working within constructivist and naturalist traditions and primarily interested in words; and (c) mixed methods research practices, working within multiple research paradigms and interested in both quantitative and qualitative data.

We may note here, as a caveat, Giddings' opposition to calling MMR a 'methodological movement' suggests rather that, 'mixed methods as it is currently promoted is not a methodological movement, but a pragmatic research approach' (Giddings 2006:195).

To this end, the fact that the quantitative and the qualitative research approaches are not only compatible but also complimentary underpins calls for additional research studies that use the mixed methods research approach (Carr 1994; Johnson and Onwuegbuzie 2004; Mingers 2001; Sale, Lohfeld and Brazil, 2002; Tashakkori and Teddlie, 2003).

As mentioned earlier on, this study will be executed using the mixed method approach, involving an inductive and the deductive analysis. We shall now be

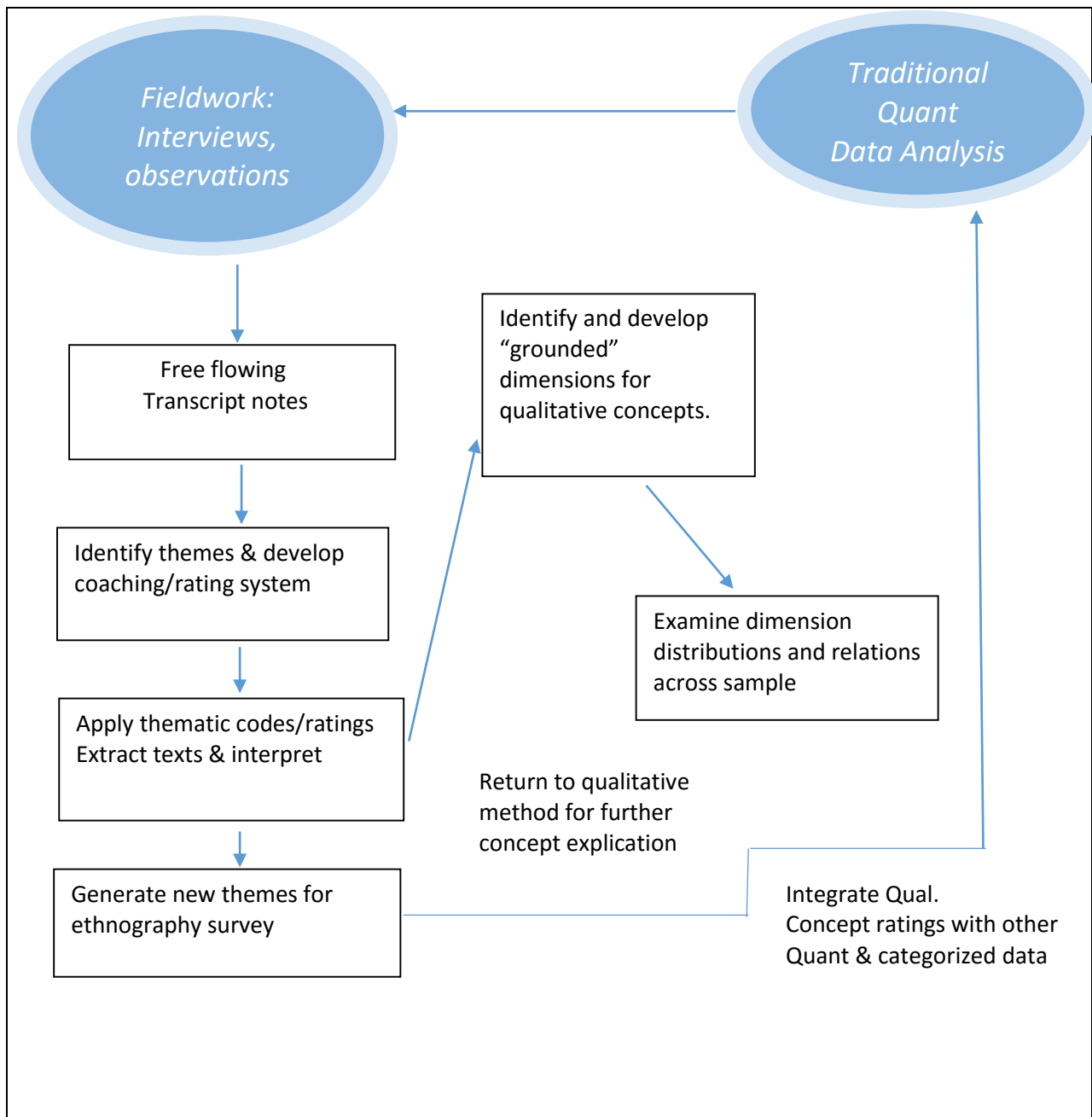


Figure 3.1: Combining and Analysing a mixed data method.

(adapted from Dedoose, 2012).

We shall now be focusing on the research site, roles of the researcher, the data collection techniques, data analysis, quality assurance criteria, and ethical considerations.

The diagram above depicts how qualitative and quantitative data can be linked together. Starting in the left column; flowing from 'Fieldwork' to 'Generate New Themes,' summarises what occurs in basic qualitative research. On the other hand, the more logical positivist (or empiricist) rules for quantitative research are, the more tightly constrained by guidelines for how data are to be collected, hypotheses defined, planned analyses, and results reported. We need to find alternative ways of combining both approaches so that more complex questions can be considered. In this exemplar model, ratings or dimensions of qualitative themes are generated, explored, and integrated with other quantitative data (Lieber and Weisner, 2010).

This mechanism above therefore serves as moving back and forth between the two types of data and allows easy access to the best evidence for particular questions; sometimes qualitative, sometimes quantitative, and sometimes both. In Dedoose, these ratings are the code weights/ratings that Dedoose uses to build visualisations that expose patterns in these complex relationships (Lieber and Weisner, 2010).

In this study however, using the dedoose approach to combining and analyzing the mixed method approach, the field work was the first step involving questionnaires and interviews execution. The researcher then went on to transcribe the interviews and questionnaires and from these, themes were identified and rated according to the responses of the participants. This helped in interpreting the extracted texts from the respondents according to their respective codes. All these processes will be applied via the qualitative and quantitative approaches.

The next step to the analysis involves examining the dimensions of the distribution of the interpreted texts across the sample. The results of the qualitative analysis will then be integrated to that of the quantitative data which will be calculated using the traditional quantitative techniques.

When focused on the same issue, quantitative and qualitative methods can triangulate. In other words they can show stability (reliability) of the findings. If similar results are obtained it is reasonable to assume that the method of research did not influence the findings. When findings diverge a possible conclusion is that the topic is in need of additional investigation (www.cwu.edu).

3.5 RESEARCH SITE

This research is conducted at the Midrand Graduate Institute (a Private University) in Midrand, Johannesburg. This university is one of the fewest that offers Pre-degree programmes of which bridging mathematics is a pre-requisite course module. The researcher used this site as the context for this research, as all necessary facilities needed to enhance the data collection process is readily available here. This is the first time such a project will be carried out within this educational institution.

This research outcome will invariably form a basis of instruction and knowledge for the University on how to tackle poor performances in mathematics at the pre-degree level.

3.6 ROLE OF THE RESEARCHER

The role the researcher adopts during the research should be that which will empower him/her to enter into a collaborative partnership with the participants in order to be able to collect and analyse data, with the sole aim of creating understanding (Maree and Van der Westhuizen, 2007).

In a quantitative study, the researcher's role will be more or less non-existent. This is because for a perfect quantitative study the participants must act independently of the researcher as if he/she were not there. In correlational studies, the data are collected without regard to the participants or the person collecting the data.

With regards to a qualitative study, the role of the researcher is different; he/she is considered an instrument of data collection (Denzin and Lincoln, 2003). This means that data are mediated through this human instrument, rather than through inventories, questionnaires or machines. To fulfill this role, the researcher will have to describe relevant aspects of the self, including any biases and assumptions, any expectations, and experiences to qualify his/her ability to conduct the research (Greenbank, 2003). In addition to this the researcher shall keep a research journal explaining personal reactions and reflections, insights into self and past, in a separate journal and how bracketing takes place.

Furthermore, the researcher needs to be a sensitive observer and to record phenomena as faithfully as possible while at the same time raising additional questions, following up on hunches and moving deeper into the analysis of the phenomena (McMillan and Schumacher, 2001; Maree and Van der Westhuizen, 2007).

As a qualitative researcher he/she must explain if their role is emic, an insider who is a full participant in the activity, programme or phenomenon, or if their role is more etic, an outsider, more of an objective viewer. Although, sometimes there could be a great deal of variations in between, with a researcher starting as an outsider and then becomes a member of the group under study. Sometimes the reverse might be the case, with the researcher starting as a member of the group and then becomes a more objective observant (Punch, 1998).

A good qualitative researcher has probing questions, listens, thinks and asks more probing questions in order to get to the deeper levels of the conversation. He will always seek to build a picture using ideas and theories from a wide variety of sources observant (Punch, 1998).

Finally, he/she is therefore expected to be continuously involved in all aspects of the study and must have the responsibility to act in an ethically correct manner and to uphold the credibility of the study at all times.

At this juncture the roles of a researcher will be summarised in a format below as put forward by Flick (2009), Brinkmann and Kvale, (2009):

- To respect and abide by the ethical code for research throughout the study.
- To inform the participants, and if necessary parents/guardians about what will be expected of their wards during the research.
- To obtain informed consent from the participants after the nature of the study has been explained to them.
- Researcher's roles during the investigation will be explained to the participants and other relevant stakeholders.
- To ensure that the physical location/room where the study will be conducted is in a satisfactory and conducive condition.

- The researcher will facilitate all informal and direct conversations.
- To endeavour to create a warm, empathic and accommodating atmosphere during the interaction session.
- To discuss the course or the direction of the research with the participants.
- Any relevant data will be stored in a safe and secured place and the researcher will analyse and interpret it responsibly.
- The researcher will discuss the interpretation of data with the participants on an ongoing basis so as to ensure that misunderstandings are cleared up and the credibility of the study is enhanced.
- To give feedback to the participants by encouraging debriefing after interviews.
- Finally, the researcher will report the data or findings in an ethical and correct manner as expected

The researcher complied with the rules set out above in the research process of this study. We shall now in this study consider the various data collection techniques and the particular one adopted for this research.

3.7 DATA COLLECTION TECHNIQUES

Data collections in case studies as well as phenomenological studies tend to concur with data analysis. This means data analysis does not commence only after the process of data collection has been finalised.

Data collection and data analysis tend to be viewed as an ongoing, cyclical process during qualitative research, making it almost impossible to distinguish them as separate entities or processes; data collection and data analysis are not easily distinguishable from each other as indicated by Thorne (2000:2). This further implies that during the research process, data collection, processing, analysis and reporting are intertwined activities (Nieuwenhuis, 2007).

It is known that researchers use computer programmes to organise and manage large quantities of data. According to Thorne (2000:2) there are many computer programmes that are used to analyse qualitative data. However, these programmes are essentially meant as aids to help sort and organise sets of qualitative data

(Thorne, 1999: 2). Thorne also asserted that qualitative data analysis requires the intellectual and conceptualising processes that are essential to transform raw data into meaningful findings. This study will use some strategies to analyse data, the purpose of which is to enhance the credibility and trustworthiness of the study (Nieuwenhuis, 2006).

In a mixed methods research, the researcher collects data to address the research questions or hypotheses. The data collection procedure needs to fit the type of mixed methods design in the study. This requires using procedures drawn from concurrent forms of data collection, in which both the quantitative and qualitative data are collected concurrently, or sequential forms of data collection in which one type of data is collected and analysed prior to a second data collection. Any issues developed during both of these approaches that the researcher noticed must be addressed (Creswell, 2005).

It has become imperative to know the general procedures of collecting data in qualitative and quantitative research because mixed methods research involves collecting both forms of data. To this end, we shall consider some general guidelines for collecting both forms of mixed methods design. A helpful way to conceptualise data collection among the designs is to consider data collection as occurring concurrently or sequentially as earlier mentioned.

In concurrent data collection, the quantitative and qualitative data are collected roughly at the same time (Triangulation and Embedded Designs), whereas in the sequential approach the quantitative (or qualitative) data is collected first, and the results inform the second (quantitative or qualitative) form of data collection (Explanatory, Exploratory and Embedded Designs) (Creswell, 2006).

This means that when data are collected concurrently, the two forms of data (quantitative and qualitative) are independent of each other, but when collected sequentially, the two forms of data are related or connected.

To gather the data for this study a questionnaire will be designed containing both open-ended and closed-ended questions on some of the factors which are

antecedents of poor academic rates in mathematics (for example high anxiety rates, little to no motivational orientation, poor teaching standards etc.) and will impact on students' retention in higher education.

It is necessary to note also that permissions are required for all research data collection. For the concurrent approaches, both forms of data collection can be described at the outset; in the sequential forms, only the initial phase of data collection can be identified with any certainty. This is because the Research Ethics Board requires a full disclosure of data collection procedures if possible. It is expected that in the sequential forms of data collection, there is a need to state the follow-up phase as tentative; recognising that an addendum may need to be filed with the Research Ethics Board when the follow-up data collection procedures are firmly established.

Finally, when researchers think about data collection, they often turn to the specific types of data collection and the procedures for collecting that data. It is believed that there are some phases to the process of data collection that, in combination, comprise the data collection steps in research. These phases shall be looked into briefly below.

We shall now look at the phases in the data collection process for both the qualitative and quantitative researches.

Table 3.1: Phases in the Data Collection Process for Qualitative and Quantitative Research (Adapted from Creswell, 2005)

Qualitative Data Collection	Phases in the process of research	Quantitative Data Collection
<ul style="list-style-type: none"> • Purposeful sampling strategies • Small number of participants and sites 	Sampling	<ul style="list-style-type: none"> • Random sampling • Adequate size to reduce sampling error and to provide sufficient power
<ul style="list-style-type: none"> • From individual providing access to sites • Institutional review boards • Individuals 	Permission	<ul style="list-style-type: none"> • From individuals providing access to sites • Institutional review boards • Individuals
<ul style="list-style-type: none"> • Open-ended interviews • Open-ended observations • Documents • Audiovisual materials 	Data sources	<ul style="list-style-type: none"> • Instruments • Checklist • Public documents
<ul style="list-style-type: none"> • Interview protocols • Observational protocols 	Recording the data	<ul style="list-style-type: none"> • Instruments with scores that are reliable and valid
<ul style="list-style-type: none"> • Attending to field issues • Attending to ethical issues 	Administering data Collection.	<ul style="list-style-type: none"> • Standardisation of procedures • Attending to ethical issues

The table above shows an integrated schedule of the various processes involved in data collection regarding both the qualitative and the quantitative approaches to research and applicable to this study.

This table is applicable to this study because the qualitative data collection techniques used was that of open-ended questions and interviews and interview protocols were followed. The quantitative data collection techniques used, include the researcher completed instrument that is, the interview schedule and the respondent completed instrument the self-checklist. Other instruments used include those with scores that are reliable and valid such as the internal consistent reliability

analysis via the Cronbach's alpha and the 'test-retest' reliability using the t-test one-tailed approach.

According to Creswell (1998), there are five phases of collecting the data, revealed in the middle column, which will be looked at from both the qualitative and quantitative aspects. We shall now consider these in more detail below.

In the above table is the comparison between the qualitative and quantitative research regarding the phases in the process of research. Firstly, with respect to sampling, qualitative research involves purposeful sampling strategies with small number of participants, while that of the quantitative aspect deals with random sampling with adequate size so as to avoid sampling error.

Secondly, the permission to conduct research is the same with both qualitative and quantitative research, as individuals or participants have the right to grant access to sites being used as well as their personal time to participate in the interviewing and answering of questionnaires. In addition to this, the institution review board will also give ethical clearance to conduct such research.

Thirdly, the data sources for qualitative research make use of the open-ended interviews or observations, questionnaire documents or by audiovisual materials (i.e. use of video recording cameras), while for the quantitative research, standardised processes must be established by using instruments (questionnaires, surveys etc.), checklists and public documents

Fourthly, with respect to recording data in the qualitative research, there is a need for interview and an observational protocol that is a narrative description of the purpose of the interview and the sub-questions will guide the interview with the protocols stated in the appendices (Lodico, Spaulding and Voegtler, 2010). For the quantitative research, recording data are instruments with scores that are reliable and valid such as the use of the t-ratio, reliability ratio, the correlation and level of significance of the data.

Finally, when it comes to administering and collecting of data in a qualitative research, there is a need to attend to important field issues that occurred during interviews as well as with the ethical issues, which must be adhered to strictly. This also applies to quantitative research, making sure that the procedures used are standardised with ethical issues being followed.

3.7.1 DESIGNING AND CONSTRUCTING MIXED METHOD RESEARCH

In addressing a research question or hypothesis, the researcher decides which people, that is, selection of participants, and research sites that provide the best information, puts a sampling procedure in place, and then determines the number of individuals that will be needed to provide data (that is sampling size) (Creswell, 1998).

In qualitative research, the inquirer purposefully selects individuals and sites that can provide rich information. Purposeful sampling means that researchers intentionally select participants who have experience with the central phenomenon or the key concept being explored (Creswell, 1998). This is the intention of this study, as certain groups of Pre-degree students will be chosen that are known to exhibit anxiety when there is a mathematics test. The central idea of choosing these particular students purposefully is to have various races, genders, diverse cultural settings, or any other factor that could differentiate participants in their exhibition of anxiety and possibly lack of motivation affecting their success rates in mathematics.

This type of purposeful sampling is known as the homogenous sampling method of individuals, that is individuals or membership in a subgroup with distinctive characteristics, for example those who exhibit fear when it comes to attempting any mathematics test.

Creswell (1998) believes that the number of a researcher's sampling size will be dependent on the type of qualitative approach used, such as phenomenology, grounded theory, ethnography, or case study. In qualitative and quantitative researches, the intent of sampling individuals is to choose individuals that are representative of a population so that the results can be generalised to a population.

3.7.2 SELECTION OF THE PARTICIPANTS/SAMPLING

Sampling which is the process of selecting a “portion, piece or segment that is representative of a whole” (The American Heritage College dictionary, 1993:1206) is an important step in the research process because it helps inform the quality of inferences made by the researcher that stem from the underlying findings. In both quantitative and qualitative studies, researchers must decide on the number of participants to select (that is the sample size) and how to select these members (sampling scheme). Sampling decisions for a mixed method of research are more complicated because sampling schemes must be designed for both the quantitative and qualitative research components of the study.

Ploeg (1999:2) says that sampling “is a process of selecting what to study and focusing on a portion of the population”. According to Ploeg (1999), researchers make sampling decisions for the explicit purpose of obtaining the richest possible source of information to answer the research question.

As we already know, in quantitative research the purpose of the researcher is to select individuals that are representative of a population so that the results can be generalised to a population. Investigators do this by first selecting and defining their population carefully. They then choose a sample from this population, which sometimes may not be workable; a random choice of individuals for the sample is attempted so that each person in the population has an equal chance of being selected.

Specifically the random sampling scheme has been presented as belonging to the quantitative paradigm whereas non-random sampling schemes have been presented to belong to the qualitative paradigm. Onwuegbuzie and Leech (2005a) notes this as a false dichotomy, rather both random and non-random sampling schemes can be used both in qualitative and quantitative studies.

Sample size considerations are also dichotomized, where small samples are associated with qualitative study and large samples with a quantitative research. Although this represents the most common way of linking sample size to a research

paradigm, the representation is too simplistic and thereby misleading (Onwuegbuzie and Leech, 2005).

In this study the participants will be selected based on the characteristics they display with regard to solving mathematics problems. It is important for the proposed study that the participants have a degree of anxiety, or possibly show a lack of motivation in solving mathematics problems. Students in the Pre-degree programme of Midrand Graduate Institute for the academic year 2013 will be used after carefully observing their responses to mathematics tests and assignments. Additional prerequisites for participants' selection would be those who find it difficult to relate to the methods being used by their lecturers to teach them mathematics in the classroom.

According to De Vos, Strydom, Fouche and Delport (2002), sampling or the selection of participants occurs subsequent to establishing the circumstances of the study. The researcher thus has a good idea of what the specific characteristics of the participants must be. It is mostly common that a mixed method researcher will select the same individuals for both quantitative and qualitative data collection so that the data can be more easily converged or compared. The selection of different individuals will introduce personal characteristics that might confound the comparison.

3.7.3 SAMPLE SIZE COLLECTION

It is often argued, whether the same number of individuals is sampled for both the qualitative and quantitative arms of data collection or should there be a difference. The appropriate standard answer to this debate is that the size of the quantitative sample (preferably randomly selected) should not be the same size as the smaller (preferably purposefully selected) qualitative sample (Creswell, 2007.).

The disparity of course will be how do we compare or converge the two databases in any meaningful way? In the Embedded Designs, it is assumed that the embedded data will play a secondary role and be supplemental to the primary dataset. Also, the embedded data typically answers a different question (for example Why has the interest of most South African students dwindled on the learning of mathematics over

the years?) than the primary data (for example What contributive factors lead to students falling short of the required rates in bridging mathematics?). For a Triangulation Design, the question of sample size will be more relevant. This means a typical approach to this type of dilemma will be most appropriate to increase the qualitative list of participants and in doing so sacrifice some of the detail elicited from individuals.

When considering the sample size, in terms of the numbers of participants to use in the study, it is advisable to select a small number of participants, as a qualitative researcher will provide in-depth information about each person on the research site. It has been observed that the larger the number of people, the less the amount of detail typically emerging from any one individual whereas a key idea of qualitative research is to provide detailed views of individuals and the specific contexts to which they hold these views. It is true that most qualitative researchers do not like to constrain research by giving definitive sizes of samples, but the numbers do range from one or two people, as in a narrative study, to 50 or 60 in a grounded theory project (Creswell, 2007).

Typically, when case studies are reported as in this particular study, 4 to 10 people are used. However, this may not suffice for this present study, as the number of Pre-degree students in relation to the other faculty students is very high. Hence, there is a need to expand the sample size further to about 120 participants, as this will help to give a fairer view of the study at hand.

For this proposed study a ***Triangulation design*** will be more appropriate, where the qualitative list of participants will be more than the quantitative list. In Social Science, triangulation is defined as the mixing of data or methods so that diverse viewpoints or standpoints can enlighten a topic; often used to validate the claims that might arise from an initial pilot study. The mixing of methodologies such as the use of survey data with interviews is a more profound form of triangulation (Olsen and Morgan, 2004).

Another approach would be to weigh the qualitative cases so that the information can be compared with the same number of quantitative cases. A final approach is to

state that the comparison of the two databases is limited because of the discrepancy in size.

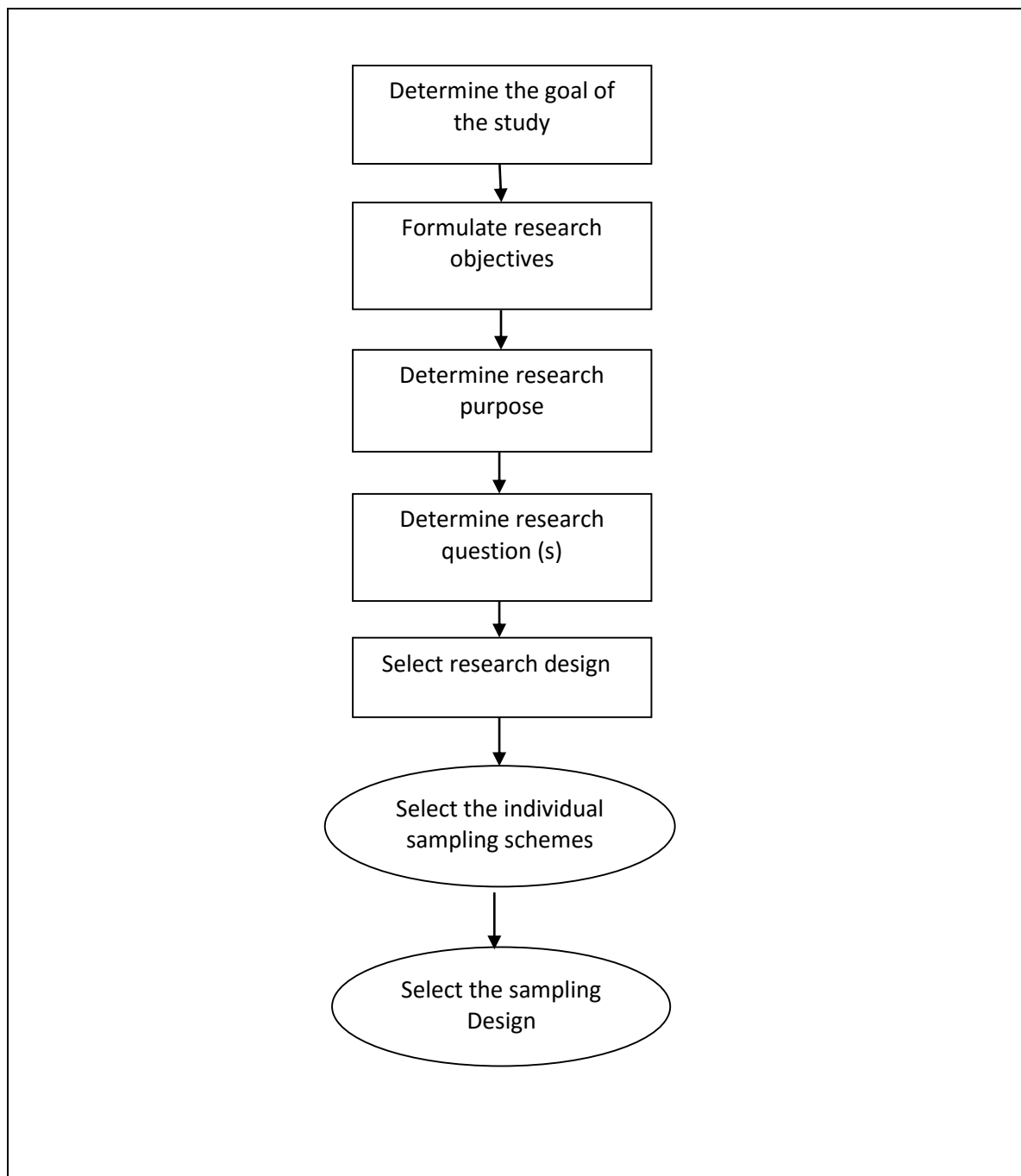


Figure.3.2: Steps in the Mixed Methods Sampling Process
(adapted from Onwuegbuzie and Collins, 2007).

3.7.4 RECORDING THE DATA

It is necessary to note that data collection involves systematically gathering information and recording such information in such a way that it can be preserved and analysed by a single researcher or a team of researchers (Creswell, 2006).

For a qualitative data collection, regarding interview data, the forms of recording involves having an interview protocol that not only lists the questions and provides space in which to record answers but also has a place for essential data about the time, day, and place of the interview. Most times what is adopted by researchers is the use of audiotapes for the interview so as not to lose out on some vital points mentioned by the respondents in the process, and afterwards he/she transcribes the interview on his/her own (Creswell, 1998).

The need to have an interview protocol is to help keep the researcher organised and coordinated when the interview is in session and to provide a record of information in the event that the recording devices fail to work. Furthermore, it provides a useful way of organising an observation. On this research protocol form, the researcher records a description of the turnout of events and processes observed; as well as his/her reflective notes about emerging codes; themes, and concerns that may arise during the observation. The use of recording forms can also serve other purposes such as for reviewing documents and for recording image data, such as photographs (Creswell, 1998).

The researcher of this study used the interview protocol form, where it recorded the events that occurred during the interview process, for instance how some respondents declined some questions asked due to reasons best known to them.

In a quantitative research, the investigator selects an instrument to use or develops an instrument. This instrument may be an attitudinal scale, with scores from the past use showing high reliability and validity. For instance, in this proposed study the researcher will be using a 5-point Likert scale to capture any of the students' responses to the closed-ended questionnaire. A set of questionnaires with twenty-one items with responses gathered on a 5-point Likert scale. Scale 1 is for ***strongly***

disagree, scale 2 is for *disagree*, scale 3 is for *neutral*, scale 4 is for *agree* and scale 5 is for *strongly agree*.

For documents with numeric data, the researcher will compose a form that summarises the data collected. Of utmost importance to the researcher is the validity and reliability of past scores using this questionnaire and whether it fits the research questions and hypotheses of the proposed study as mentioned in Chapter one, and as well as whether adequate scales are used to report the information.

3.7.5 ADMINISTERING THE DATA COLLECTION

In administering the data collection, we would be looking at the procedures for gathering or collating the data in the proposed research. For instance, in the qualitative research, much emphasis is placed on reviewing and anticipating the types of issues that may likely arise “in the field” that will yield less-than-adequate data. These issues include such things as the time to recruit participants, the researcher’s role in observing, the effectiveness of the performance of the recording equipment, the time to locate documents and the details of proper placements of videotaping equipment. All these concerns need to be addressed before the interview takes place (Creswell, 1998).

In addition to these issues mentioned above, the researcher also needs to be careful of how to enter the site of the study so as not to disrupt the flow of activities going on at the time. This will entail the ethical issues, such as providing reciprocity to participants for their willingness to provide data, handling of respondents’ sensitive information and disclosing the purpose of the research. All these are applicable to both the qualitative and quantitative researches (Creswell, 1998).

Considering the above ethical issues, one cannot be expected to be so rigid and tailored along these expectations to the fullest; there is a need for as little variation as possible to avoid biasness being introduced into the process. Standard procedures should be paramount for collecting data on instruments, checklists, and from public documents, and if more than one investigator is involved in data collection, training should be provided so the procedure is administered in a standard way each time data is needed (Creswell, 1998).

The researcher of this study conducted the interviews and administered the questionnaires personally.

3.8 DATA ANALYSIS

Due to the fact that this proposed study would be employing the mixed method approach to research, we shall be considering the ways both qualitative and quantitative data are been analysed.

Although, there is no consensus regarding the analysis of qualitative data (Creswell, 1997), however, there are a few guidelines for the researcher. Analysing qualitative data can sometimes be a complicated business, and is always a time-consuming one. Qualitative data analysis is “custom built” as qualitative researchers “learn by doing”. It is a non-linear process that involves organising, analysing, interpreting and describing the mass of collected data, and already occurs during the data collection process (De Vos, 2002; Creswell, 2003). The aim of analysis is to treat the evidence fairly, producing compelling analytical conclusions (Yin, 1998).

Creswell (2008) describes the features of qualitative data analysis as follows:

- It is inductive in form, going from the particular to the detailed data to the general codes and themes. This allows the researcher to produce broad themes and categories from various databases. This means Qualitative data analysts seek to describe their textual data in ways that capture the setting or people who produced this text on their own rather than in terms of predefined measures and hypotheses. The analyst identifies important categories in the data, as well as patterns and relationships, through a process of discovery.
- It involves a simultaneous process of analysing while also collecting data.
- The phases of data analysis are iterative. The researcher cycles back and forth between collection and analysis, more of a dynamic nature. Next to his field notes or interview transcripts, the qualitative analyst jots down ideas about the meaning of the text and how it might relate to other issues. This process of reading through the data and interpreting them continues throughout the project. The analyst adjusts the data collection process itself

when it begins to appear that additional concepts need to be investigated or new relationships explored. This process is termed **progressive focusing** (Parlett and Hamilton 1976).

- It involves reading the data several times and conducting an analysis each time, developing a deeper understanding for the information.
- There is no single accepted approach to data analysis.
- The researcher brings his/her own perception to the data analysis process, making it an interpretive process.

Going by the above features, the researcher will be applying Creswell's (2008) approach to data analysis to organise and interpret the information in a meaningful way. The phases included in the data analysis process include: organising the data and preparing it for analysis; reading through the data and making notes; analysing the data; identifying and describing themes, subthemes and representing the themes. The figure below represents the continuous process of qualitative data analysis throughout this research process.

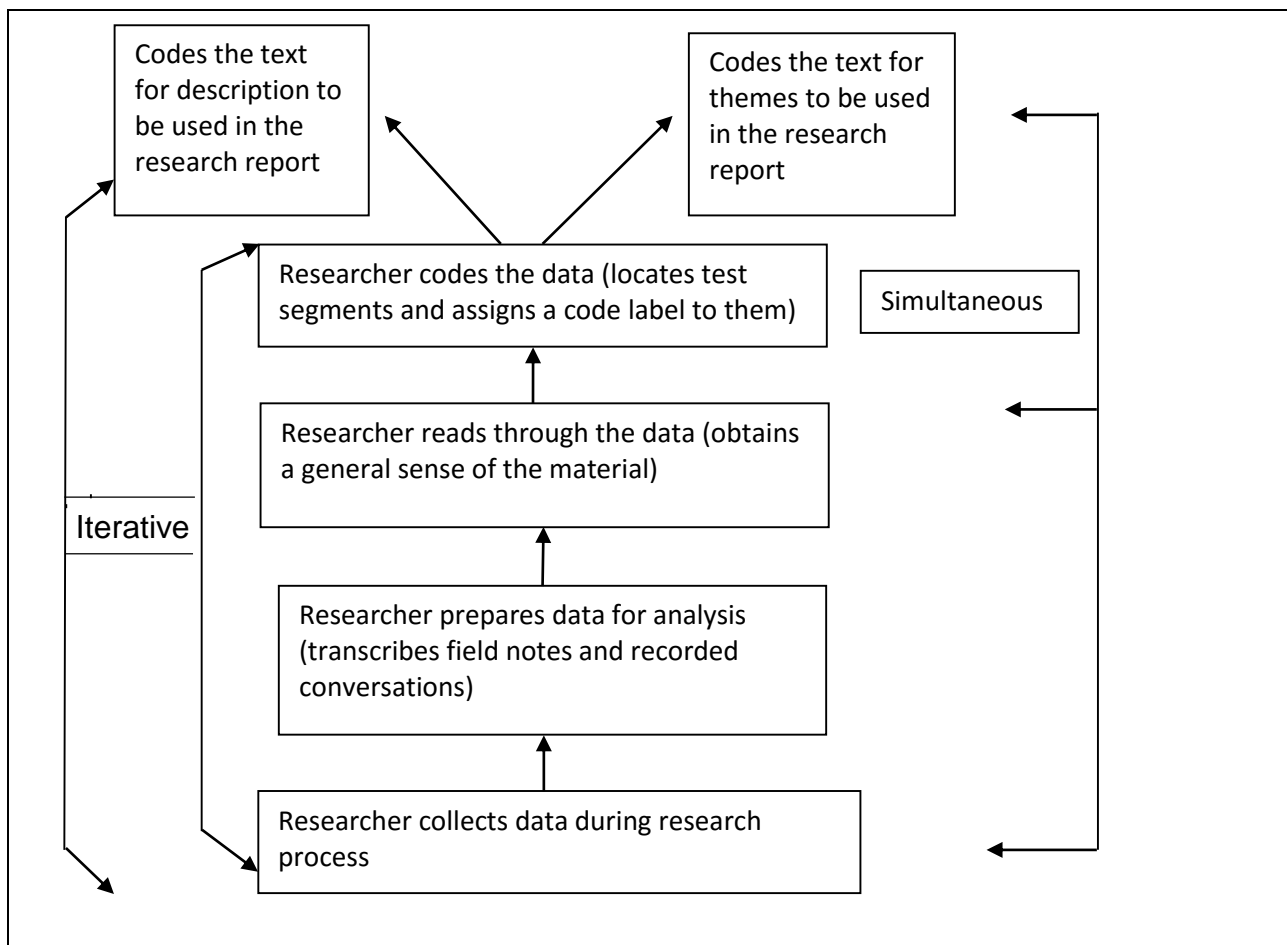


Figure 3.3: The Data Analysis Process (adapted from Creswell, 2008)

In qualitative data analysis behavioural pattern of participants in a research are assigned numeric identifiers known as behavioural coding, transforming these qualitative behaviours into quantitative data that can then be subject to statistical analysis for precision. However, applying behavioural coding to one's observations is extremely time consuming and expensive. In addition, only highly trained researchers are qualified to encode behaviour, hence the approach is cost prohibitive (Source: www.uxmatters.com).

In the use of qualitative data collection instrument (that is Observations, surveys and Audio or video recordings), after a careful observation by the researcher to determine the participants for the study, these participants will then be given survey questions that will involve attempting to answer the sections outlined in the questionnaire attached at the beginning of this study (that is Section 1 – 3) regarding:

- Participants' bio data, interests or hobbies, intentions to study and part-time work
- The motives of participants for entering higher education for a Pre-degree programme, and possibly to determine who/what influenced their decision to attend this programme.
- Lastly, to address the preparedness of students for higher education after their pre-degree programme.

After this, the researcher will engage the participants in a one-on-one interview, which will be recorded in writing by the respondents and verbatim transcription will later be done by the researcher. This interview will focus on the other sections (that is, Sections 4 & 5) in the interview schedule regarding,

- Students' attitude towards mathematics (focus on bridging mathematics) at the Pre-degree level, and possible reasons for their dismal performance in this module.
- Students' expectations of the bridging mathematics module, its operations at present, how confident they are about their studies here at the Midrand Graduate Institute (MGI) and how important it is for them to do well in their studies.

Quantitative data analysis on the other hand helps to draw meaningful results from a large body of qualitative data. The main beneficial aspect is that it provides the means to separate the large number of confounding factors that often obscure the main qualitative findings (Abeyasekera, Lawson-McDowall and Wilson, 2000).

Furthermore, quantitative data analysis allows the reporting of summary results in numerical terms to be given with a specified degree of confidence. The features of quantitative data analysis include the following:

- The researcher uses mathematics and statistical models as the methodology of data analysis.
- Data collection is typically numeric so that it can be quantified and subjected to statistical testing, which brings about reliability and validity in the outcomes.
- Researcher uses the inquiry method to ensure alignment with statistical data collection methodology.
- It involves statistical significance testing of hypotheses and establishing a theory or fact
- Quantitative data are socially constructed as those of the qualitative ones.
- It makes use of a linear model of relationship among the variables, which is fitted into the data, this leads to statistical summaries (such as means or explained variances) being obtained, and these are tested against the probability that values as high as those obtained could have occurred by chance.

The instrument that will be used for gathering data for statistical testing will be a questionnaire, prepared by the researcher using a 5-point Likert scale.

The questionnaire will focus mainly on the anxiety and motivation aspect of mathematics (bridging mathematics) using the self-report instrument known as Mathematics Anxiety Rating Scale (**MARS**), as originally designed by Richardson and Suinn (1972), which was a 98-item self-rating scale. The instrument was once considered as the best available measure of mathematics anxiety with the highest validity and reliability. The contemporary view (Hopko, Lejuez, Ashcraft, Eifert and

Riel, 2003; Bai, 2010) seems to be that MARS has two major shortcomings: i) it takes too long to administer and to score; and ii) it was developed with one-dimensional representation of negative affects towards mathematics.

To this end, in order to overcome the above-mentioned shortcomings researchers started developing several, multidimensional versions of MARS. For example, Betz's (1978) Mathematics Anxiety Scale (MAS), adapted from Fennema and Sherman's (1976) Mathematics Attitude Scale, was set up as a 10-items bi-dimensional instrument, also Bai (2010) Mathematics Anxiety Testing Scale which was a 14-item meant to capture also a bi-dimensional affective scale of measuring mathematics anxiety with high psychometric quality.

From the above statements, it has become imperative to adopt the Bai's 14-item Mathematics anxiety testing questionnaire with a 5-point Likert scale in order to capture the essence of the affective nature of students' anxiety on their mathematics performances.

There will be another questionnaire designed to test students' motivation and learning strategies towards mathematics. This questionnaire is adapted from the Motivational Strategies for Learning Questionnaire (MSLQ), it includes only three original factors (**value, expectancy and affect**) of the mathematics motivation scale, although 36 items were originally included in this scale. However, for the scope of this study we shall only be considering the **value** and **affect** factors. For the value factors, we shall be considering the angle of **intrinsic goal** (6 items), **extrinsic goal** (6 items), and **task value** (6 items). In addition, the **affect factor** will have a new item added in the questionnaire to test for the effectiveness of **teaching strategies** (6 Items) on motivation for learning and passing mathematics by students in addition to the **Test Anxiety** (7 items).

To test for validity and reliability using the MSLQ we shall be using inferential statistics, which includes, the practical mean and variance, the student t-test to analyse the difference between the different factor groups of motivation and with a Motivation for Academic Preference Scale (MAPS of $\alpha > 0.80$). This inferential statistical testing will also be applied to the anxiety scale test of Bai (2010). The

sequence of the presentation of the results will be in accordance with that of the hypotheses. In this study, three null hypotheses were tested for significance level at 0.05 margin error.

3.9 QUALITY ASSURANCE CRITERIA

As noted by Seale (1999:50), he argued that, “The quality of research is not automatically determined by the imposition of generalised quality criteria, but such schemes can help sensitise researchers to the issues that a particular project may need to be addressed.” However, we shall consider certain research criteria that can be used to judge the soundness and quality of any qualitative research, which can also serve as an alternative to more traditional quantitatively, oriented criteria.

For instance Guba and Lincoln (in Schwandt, 2007) developed four criteria for judging the quality and trustworthiness of qualitative research. They asserted that their four criteria better reflected the underlying assumptions involved in much qualitative research. Their proposed criteria and the analogous quantitative criteria are listed in the table below.

Table 3.2: Four criteria for judging the soundness of qualitative research- (Guba and Lincoln, 2006)

Traditional Criteria for Judging Quantitative Research	Alternative Criteria for Judging Qualitative Research
Internal Validity	Credibility
External Validity	Transferability
Objectivity	Confirmability
Reliability	Dependability

To this end we shall now discuss these criteria in detail.

3.9.1 TRANSFERABILITY

Transferability refers to the degree to which the results of quantitative research can be generalised or transferred to other contexts or settings. According to Schwandt (2007), it deals with issues of generalisation from case to case. As noted before, the objective of this study is to determine how anxiety and lack of motivation has led to poor performances among Pre-degree students considering also the poor teaching methods, by investigating the participants in their unique contexts. The aim is not to

generalise but rather to obtain meaningful information that can have a positive effect on further research in this area of study.

The person who wishes to “transfer” the results to a different context is then responsible for making the judgment of how sensible the transfer is.

3.9.2 CREDIBILITY

The credibility criterion involves establishing that the results of the quantitative research are truthful or believable from the perspective of the participant in the research. It addresses the issue whether the reconstruction and representation of the participant’s view fits with the participant’s interpretation of his/her experiences. In other words, it could be the degree to which the interpretation of data has the same meanings for the participant and the researcher so that they both agree on the description or composition of events, especially the meanings of events (McMillan and Schumacher, 2009). Since from this perspective, the purpose of qualitative research is to describe or understand the phenomena of interest from the participant’s viewpoint (anxiety, lack of motivation and teaching strategies affecting mathematics achievement), the participants are the only ones who can legitimately judge the credibility of the results.

In this study credibility will be achieved and enhanced by making use of triangulation and crystallisation in order to verify the data.

3.9.2.1 Triangulation

Triangulation as mentioned earlier in this study is a strategy that helps enhance the validity and reliability of the research as well as to evaluate the findings of a study. It involves various methods of data collection from a variety of sources (Golafshani, 2003; Stake, 2005). A number of triangulation types exist, four were identified by Knafl and Breitmayer (1989), namely:

- **Triangulation of data methods** (data are collected by various means and compared.)
- **Triangulation of data sources** (maximises the range of data that might contribute to complete understanding of the concept.
- **Theoretical Triangulation** (meaning that the ideas from diverse or competing theories can be tested.)

- **Investigators' triangulation** (occurs in a study in which a research team rather than a single researcher is used).

Other forms of triangulation methods as put forward by Cohen (2000) and his colleagues include:

- ❖ **Space Triangulation** (concerned with collection of data in various situations)
- ❖ **Methodological triangulation** (using the same method on different occasions or different methods on the same participant).

For this study, the triangulation of data methods have been adopted and used, as data are collected by various means and thereafter compared.

It is generally believed and accepted that the reliability and validity of any study would improve if the researcher uses several different types of sources that provide more insight into the same event and then cross-check the results against that of another procedure (De Vos et. al, 2005).

To this end, this proposed study will make use of methodological and investigator triangulation. The researcher will thus implement various techniques (observations, interviews, co-constructive conversations, surveys, focus groups, field notes and journals) to collect and verify the data. The researcher will engage an external coder if need be to code data collected from these sources and will discuss all the results throughout the process of data collection and analysis with his supervisor.

3.9.2.2 Crystallisation

This is the process of temporarily suspending the examining or reading of the collected data (Immersion) in order to reflect on the analysis experience and attempt to identify and articulate patterns or themes noticed during the immersion process.

Sociologist Richardson (1994), and St. Pierre, (2005) broadly introduced the concept of crystallisation to qualitative methodologists in Richardson (1994) classic essay, "*Writing as a Method of Inquiry.*" Richardson (1994) articulated crystallisation in qualitative research as the capacity for writers/researchers to break free of traditional generic constraints. Nieuwenhuis (2007) explains that because the constructivist perspective views the world as reality that is changing and maintains that there are

multiple realities depending on the person interpreting it, and posits that qualitative researchers have their own interpretation of data.

This means by making use of various methods of data collection and analysis, the researcher finds emerging patterns that represents a crystallised reality and thereby adds to the quality of the study. Therefore, the proposed study will engage the triangulation and crystallisation processes in order to have a deeper understanding of the phenomenon under study in a more trustworthy and dependable manner.

3.9.3 DEPENDABILITY

The third criterion for dependability, according to the quantitative view of reliability is based on the assumption of replicability or repeatability. What this refers to is whether we would obtain the same results if we could observe the same thing twice. Although, we cannot actually measure the same thing twice, by definition if we are measuring twice, we are measuring two different things. In order to measure reliability, quantitative researchers construct various hypothetical notions (for example the True Score Theory) to get around this fact. According to Trochim (2002:1), “The true score theory is thus a simple model of how the world operates, it maintains that every measurement is an additive composite of two components: **true ability or level** of the respondent on that measure; and the **random error** involved”.

According to Schwandt (2007:11), “Dependability requires the researcher to take responsibility for ensuring that the process followed during the study is logical, traceable and documented. The idea of dependability on the other hand, emphasises that the researcher should account for the ever-changing context within which research occur. The researcher is responsible for describing the changes that occur in the setting and how these changes affected the way they approached the study”.

The simple equation of: $X = T + e_x$, where X = True score, T = True ability or level and e_x = random error. This equation also has a parallel one at the level of the variance or variability of a measure that is across a set of scores, we assume that:

$$\mathbf{var (X) = var (T) + var (e_x)}$$

This can be interpreted in a more practical term that the variability of one’s measure is the sum of the variability due to true score and the variability due to random error.

It tells us that most measurements have an error component, which needs allowance to be made for.

3.9.4 CONFIRMABILITY

Confirmability refers to the degree to which the results of a research could be confirmed or corroborated by others. In other words, it means the degree to which the interpretation of data has the same meaning for the participant and the researcher so that they both agree on the description or composition of events and especially on the meanings of the events (McMillan and Schumacher, 2009).

There are a number of strategies for enhancing confirmability. The researcher can document the procedures for checking and rechecking the data throughout the study. Another researcher can play the “*devil’s advocate*” with respect to the results by actively searching for and describe any negative instances that contradict prior observations. After this study, one can conduct a data audit that examines the data collection, analyses procedures and make judgments about the potential for bias or distortion.

In this proposed study making use of triangulation and crystallisation in order to verify the data will enhance confirmability.

3.9.5 STRATEGIES TO ENHANCE TRUSTWORTHINESS OF A RESEARCH PROJECT

There exist several strategies that can be used throughout the research process to increase the worth of qualitative projects. Some of these strategies need to be addressed in the study design stage, while others are applied during data collection and after data are interpreted. These strategies are described under one of the four qualitative criteria for trustworthiness. Although some strategies are useful for establishing more than one criterion (for example triangulation and reflexivity), the strategies are defined under the criterion to which they are most frequently applied.

Most of these are outlined in Lincoln and Guba (1985), however, research was later conducted by McMillan and Schumacher (2009), which will be adapted to enhance the trustworthiness of this proposed study.

Table 3.3: Summary of Strategies with which to increase the Trustworthiness of this Research Project. (Adapted by McMillan and Schumacher, 2009)

Criterion Quality	Strategy	Description of my planned activities
Credibility	Prolonged Field work	Data will be collected over a period of 2 months. This lengthy data collection provides opportunities for interim data analysis and triangulation.
	Multi-method strategies (triangulation)	The Researcher will make provision for triangulation in both data collection and data analysis by making use of different methods.
	Verbatim accounts of participants' responses	An interactive session will be recorded verbatim using field notes and transcription.
	Multiple researchers	The researcher will have debriefing sessions with his supervisors regarding the descriptive data that will be collected on a continuous basis.
	Low inference descriptors	The researcher will ensure that descriptions from field notes and interviews are precise and detailed and in the language used by the participant so as to avoid misinterpretation.
	Mechanically recorded data	The researcher will make use of either a digital tape recorder or a video tape recorder to ensure accurate and complete records.
	Participant researcher	The researcher will endeavour to write down his own reflections, thoughts, perceptions and feelings about the process so that his subjectivity does not flaw his understanding of the participants' responses.
	Member checking	Member checks of data collected and interpretations/theories formed will be done by the researcher.
	Participant review	The researcher will be sure to clarify any unclear information with the participants before the data are interpreted. After this, participants will be asked to review the results.

	Discrepant data	Any discrepancies in the data that go against the pattern that emerges during data collection will be pointed out by the researcher.
Transferability	Provision of field data collected	Provision of background data to establish context of study and detailed description of phenomenon in question to allow comparisons to be made
Dependability	Description of Research Methodology	Employment of “overlapping methods” In-depth methodological description to allow study to be repeated
Confirmability	Multi-method strategies	Use of the Triangulation to reduce the effect of researcher’s bias
	Participant researcher	Admission of researcher’s beliefs and assumptions
	Discrepant data	Recognition of shortcomings in study methods and their potential effects
	Description of Research methodology	In-depth methodological description to allow integrity of research results to be scrutinised

3.10 ETHICAL CONSIDERATIONS

Ethics has become a cornerstone for conducting effective and meaningful research. As such the ethical behaviour of individual researchers is under unprecedented scrutiny (Best and Kahn, 2006; Field and Behrman, 2004; Trimble and Fisher, 2006)

In order to have effective and meaningful research conduction there is a need for ethical consideration by the researcher. Therefore, the Ethical Standards of the American Educational Research Association (AERA) states, “It is of paramount importance that educational researchers respect the rights, privacy, dignity, and sensitivities of their research populations and also the integrity of the institutions within which the research occurs. Educational researchers should be especially careful in working with children and other vulnerable populations” (*American Educational Research Association, 2002, p.3*).

Due to the importance of ethical consideration, the researcher promises to undertake the ethical guidelines as set out in the following paragraphs.

3.10.1 INFORMED CONSENT

Consent is the sole right of an individual to choose to participate in a research or not. It is the duty of the researcher to ensure that the participants have a complete understanding of the purpose and methods to be used in the study. Thereafter, the participants may decide to give his/her written permission in full knowledge of the purpose of the research and the consequences of taking part in the research (Piper and Simons, 2005).

The researcher of this proposed study will obtain informed consent and will provide all the information required on the objective of the research, the procedures that will be followed, possible advantages, disadvantages and dangers to which the participants might be exposed, as well as the researcher's personal details and credibility as a researcher to both the participant and his/her parent/guardian if he/she is not of legal age to consent (Strydom, 2002) (see Appendices A and B)

The participant will also be informed that he/she has the right to withdraw from the study at any point that he/she feels that he/she does not want to continue anymore and there will be no consequences to him/her if that happens. According to Drew and Hardman (2007), from a legal standpoint, for informed consent to be effective it must involve three elements namely, **capacity** (that is ability of respondent to acquire and retain knowledge) **information** (that is Determination of whether information has been communicated to a participant in an effective manner based on both *substance* and *manner*), and **voluntariness** (that is individual's ability to exercise the free power of choice without the intervention of force, fraud, deceit, duress, or other forms of constraint or coercion).

3.10.2 PROTECTION FROM HARM

The most basic concern in all research is that no individual is harmed by serving as a participant, as suggested by American Psychological Association (APA) and American Educational Research Association (AERA) codes of ethics.

In the context of research ethics, harm may be broadly defined to include extreme physical pain or death, but also involving such factors as psychological stress, personal embarrassment or humiliation, or myriad influences that may adversely affect the participants in a significant way.

As the researcher in this proposed study, protection from harm indicates that I will protect my participants from physical, emotional or any other kind of harm (Strydom, 2002). The researcher will only focus on the research questions during the study and not delve into other aspects of the participants' lives.

3.10.3 PRIVACY, CONFIDENTIALITY AND ANONYMITY

In this study the researcher will uphold the right to privacy and confidentiality of the participants. Privacy as we know is defined in terms of a person having control over the extent, timing and circumstances of sharing oneself (physically, behaviourally, or intellectually) with others. It is the right of the participant to limit access by others to aspects of their person that can include thoughts, identifying information, and even information contained in bodily tissues and fluids.

From this perspective, it means that the researcher will endeavour to keep the participant's identity protected and safe, whilst ensuring that his/her personal privacy is not infringed upon by means of any electronic device such as a hidden camera or tape recorders (Strydom, 2002). Throughout the study the participant's identity will be kept confidential as a matter of trust not to divulge such information to others without their permission. In addition to this the participant's real name will not be shared in any part of my research. A pseudonym may be used in the report and publication thereof, with the data collected being kept in a safe place (Piper and Simons, 2005).

Confidentiality is the process of protecting an individual's privacy. It implies that the researcher will in no way reveal information that will allow other people to connect

the participant in any way or reveal information that the participant does not want published (Cohen, Manion and Morrison 2000; Piper and Simons, 2005). According to Piper and Simons (2005:57), "the process of protecting privacy and confidentiality of participants in a research is known as anonymisation". The researcher will ensure the anonymity of participants and also ensure that no information is revealed that can lead to them being identified.

In conclusion, the researcher will ensure that he provides the participants with the opportunity to read and comment on any aspect of the research report that infringes on their confidentiality before sending to the printers for final publishing and later for public consumption. This will be a sort of double-checking in order to prevent misinformation and also to ensure correct interpretation of data.

3.11 SUMMARY

This chapter has highlighted the research process that will be followed by the researcher in the proposed study. It started with an introduction, "Why the need to research into the non-cognitive aspect (that is anxiety and motivation) of mathematics performance by students in private higher institutions?" Thereafter we looked at the assumptions or beliefs underlying previous studies in this area of research, which is the transformative paradigmatic perspective from which the researcher intends approaching in this study. The methodology inference tends to reveal the potency of combining both the qualitative and quantitative methods; leading to a brief discussion on the various types of paradigms involved in the mixed method of research but with particular emphasis on the paradigm guiding the study and the research design to be used.

Furthermore, we looked at the methods of conducting both qualitative and quantitative researches, and the roles of a researcher in this type of study, amongst which is the techniques of data collection taking cognisance of the importance of quality assurance criteria. Finally, the issue of the ethical consideration that will guide the research to a truthful and unbiased conclusion was dealt with. To this end, a flow chart is hereby presented to give a clearer, more concise form of the summary to this chapter.

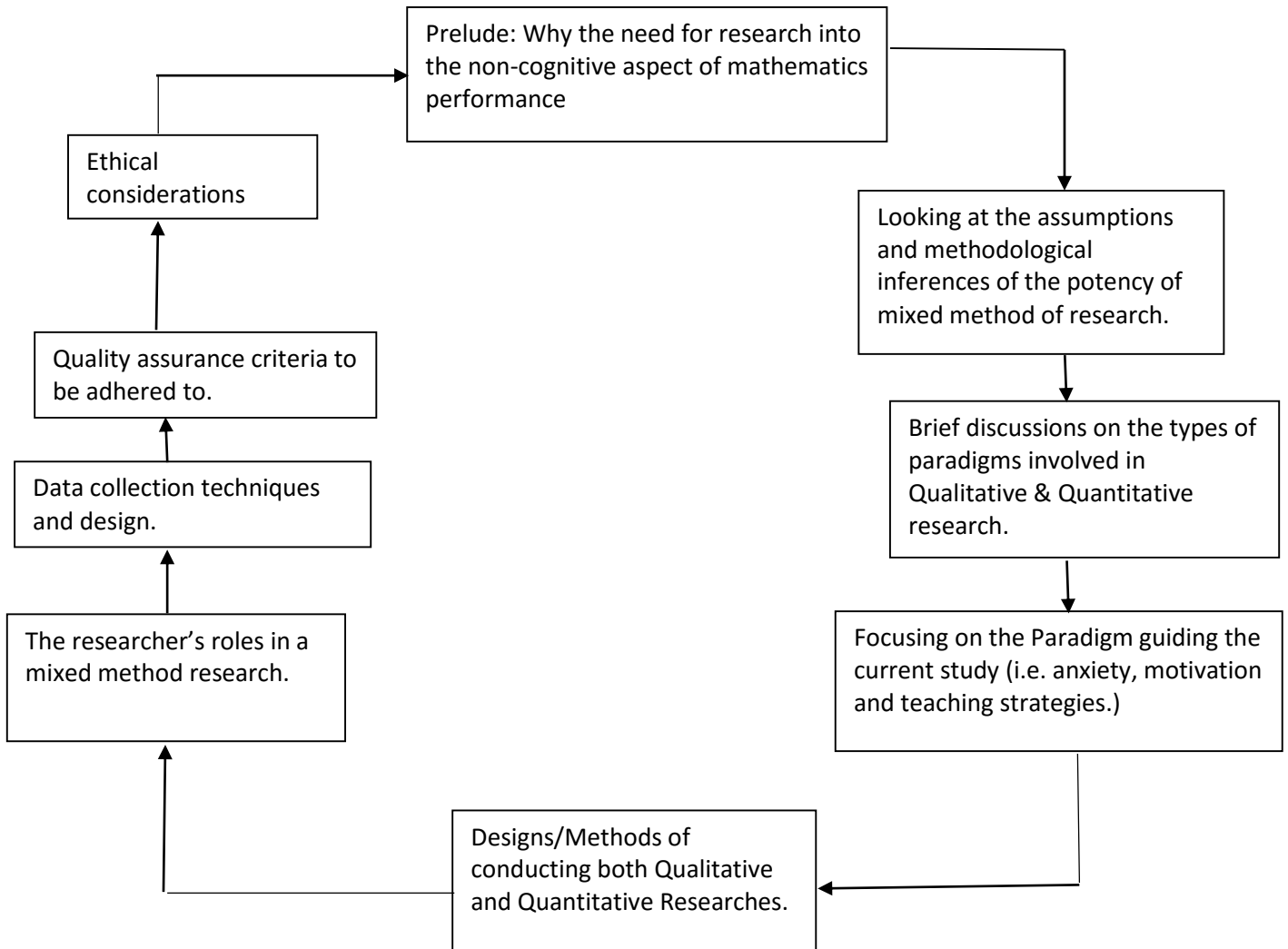


Figure3.4: A Mind map showing processes of the Research Methodology

CHAPTER FOUR

DATA ANALYSES AND INTERPRETATION OF EMPIRICAL FINDINGS

4.1 INTRODUCTION

From the previous chapter it was mentioned that this research would be using the transformative paradigm involving the use of the mixed method design. It further reiterates the process of data collection, participants sampling, data analysis to be used as well as the various quality assurance criteria applicable in the research. Therefore this chapter will be looking at the process involved in transforming the data collected in to condensed, small analysable units through coding and the results of the statistical analyses of the study.

The title of the study is the anxiety and lack of motivation factors affecting success rates in bridging mathematics. We shall now look at the various sections to which this chapter has been subdivided.

Firstly, Section 4.2 provides a summary of the results obtained from the preliminary data analysis, which includes the coding and tabulation of the data. The demographical information of the participants, and the frequency distribution in table formats of the six sections are presented, namely: Learning attitude/experience in mathematics in early school years; Anxiety affecting students' performances; Mathematics Motivation (Intrinsic Goal Orientated); Mathematics motivation (Extrinsic Goal Orientation); Mathematics motivation (Task Value) and Teaching Strategies in mathematics.

Section 4.3 outlines the results obtained from the demographic information of participants as presented in graph formats where the first number represents the frequency and the second number the percentage. The information measured here include the following: Race, gender, age, nationality, proposed field of study, best/worst subject in high school, type of school attended, subject offered at high school (mathematics or mathematics literacy), reasons for choosing this subject and finally the matriculation year.

Section 4.4 is the Reliability analyses of the questions in the six sections mentioned above. Prior to hypothesis testing, in Section 4.5 a confirmatory factor analysis of the scale is carried out which is a method for investigating whether a number of variables of interest are linearly related to a smaller number of unobservable factors. In addition also the descriptive inferential statistics discussed in this section are formulated, discussed and tested.

Furthermore, Section 4.6 displays the descriptive statistics with a summary of the data in a more meaningful and presentable way for prediction. In section 4.7, the hypothesis testing, which is the result of the second part of the analysis, namely the open-ended questions, is presented in table formats. All the analyses are carried out using SPSS (Statistical Package for Social Sciences) version 13 for Microsoft Windows.

In continuation of this chapter, in Section 4.8, we look at the qualitative sampling procedures and the report derived from the in-depth interviews with the participants, the data procedure used was the concurrent triangulation design, forms of data collection which fitted the mixed method design of this study. This implies that both quantitative and qualitative data were collected at the same time and analysed separately, any issues observed would be addressed by the researcher after a careful comparison and combining of the results of the quantitative and qualitative analyses. This made the two forms of data collected to be related.

Finally Section 4.9 and 4.10 highlight the responses of the focus group consisting of the Pre-degree lecturers interviewed and a synopsis of this chapter regarding what entails in the analysis respectively.

4.2 DATA GATHERING PROCESS

In Chapter 3, permission was required from the Research Ethics Board of the University used for my case study with full disclosure of the data collection as much as possible. To this effect after receiving this approval, 120 self-administered questionnaires were distributed to the students of this private higher institution, either before or after lectures. The questionnaire consisted of 44 items and 12 Questions on demographic information of the respondents. The 44 items were grouped into 6

sections as specified above in the different scales (A – F), and the last section G was for the biographic data of the respondents. Section A, consists of 6 items, which measured the participants learning attitude/experience in mathematics in early school years, and Section B, consists of 15 items, which measured how participants' anxiety affects their performance in mathematics. Section C comprises of 5 items, measuring participants' mathematics motivation factors (Intrinsic Goal Orientation), while section D also comprises of 5 items, measuring their mathematics motivation factors (Extrinsic Goal Orientation). Section E measures the participants' mathematics motivation in terms of task value. The final section, Section F comprises of 8 items, which measure the teaching strategies of the lecturers in mathematics as it affects performance of the participants. The final questionnaire used for this study consisted of eight pages. The first page was a cover page indicating the title of the research, the school to which the researcher will present the report, the degree pursued and the full names of the researcher. The second and third pages included the consent letter, the aim and purpose of the study, stating that the interviewee will not be under any duress of any sort with respondents' right to privacy being upheld. The main questionnaire starts from pages 4 to 6, with a brief introduction of the researcher thanking the respondents for taking time out to answer the questions and also intimating to them the reason for the topic of the research. The questions as earlier mentioned are categorised in to 6 sections with the response format ranging from 1 to 5, with 1=Strongly Disagree, 2= Disagree, 3= Natural, 4= Agree, 5= Strongly Agree (See Appendix F). Finally is Page 7 and 8 consisting of interviewing questions on the topic of research for all the respondents as well as their biographical data (See Appendix G).

Of the 120 questionnaires distributed to the participants, 117 completed questionnaires were deemed useable; this translates to a response rate of about 97.5 percent. The following section provides an overview of the tabulation of data obtained throughout this questionnaire.

4.3 PRELIMINARY DATA ANALYSIS

Preliminary data analysis is a brief description by graphical and numerical representation of the data collected in the survey. It involves the process of a graphical display of each variable, by coding or recoding categorical data,

transforming continuous data in to another continuous variable and recoding continuously in to categorical data. Preliminary data analysis includes coding, editing and representation of data format (Bajpai, 2011:204). The following gives an overview of the coding, the data gathering process and the tabulation employed in this study

4.3.1 CODING

Coding is referred to as a systematic way in which to condense extensive data sets into smaller analysable units through the creation of categories and concepts derived from the data (Lockyer, 2004). It could also mean the process by which verbal data are converted into variables and categories of variables using numerical codes so that data can be entered into computers for analysis (Bourque 2004).

The questionnaire used in this study was subdivided into 7 sections, 6 of which were tested. The first section, A was used to gather data concerning the participants learning attitude/experience in mathematics in early school years. Sections B, C, D, and E comprised 30 items regarding the participants' level of anxiety and lack of motivation as affecting success rates in mathematics. Section F, comprised 8 items relating to teaching strategies in bridging mathematics.

Section G is attached to the questionnaire, which requires the participants' demographical data (see appendix F). To this end, table 4.1 below presents the variables and codes used in Section A – G of the final questionnaire.

Table 4.1: Coding Information

Scale A: Learning attitude/experience in mathematics in early school years		
Item	Construct Measured	Code
Item 1	Mathematics was my least favourite subject back in school	A1
Item 2	Anything numeric is a struggle for me	A2
Item 3	My early school years performance in mathematics was below average	A3
Item 4	Mathematics lessons are not inspiring to me	A4
Item 5	Mathematics literacy was easier than mathematics for me in high school	A5
Item 6	Teacher's negative attitude leads to my disinterest in mathematics	A6

Scale B: Anxiety affecting Students' mathematics performance		
Item	Construct Measured	Code
Item 1	Mathematics is interesting	B1
Item 2	Mathematics tests get me uptight	B2
Item 3	Mathematics is useful in future for me	B3
Item 4	Lacks clarity always during mathematics tests	B4
Item 5	Mental block during mathematics tests	B5
Item 6	Mathematics is a daily routine for me	B6
Item 7	Mathematics becomes worrisome if I cannot solve a problem	B7
Item 8	Not getting a correct answer is worrisome when doing mathematics	B8
Item 9	Bridging mathematics is challenging	B9
Item 10	Nervous tendencies when doing bridging mathematics	B10
Item 11	Love doing more mathematics lessons	B11
Item 12	I generally feel uneasy when doing mathematics	B12
Item 13	Bridging mathematics is one of my favourite subjects	B13
Item 14	I enjoy learning mathematics	B14
Item 15	I get confused when doing mathematics	B15

Table 4.1: Coding Information (continued...)

Scale C: Mathematics motivation (Intrinsic Goal Orientation)		
Item	Construct Measured	Code
Item 1	Material for bridging mathematics should be challenging	C1
Item 2	I have to understand the content of my learning material	C2

Item 3	More projects and assignments help me learn more mathematics	C3
Item 4	Logical thinking improves by doing mathematics	C4
Item 5	Hard work leads to better scores in mathematics	C5

Scale D: Mathematics motivation (Extrinsic Goal Orientation)		
Item	Construct Measured	Code
Item 1	I want to improve my bridging mathematics grades	D1
Item 2	I can better my class mates' marks in bridging mathematics	D2
Item 3	Better grades in mathematics help me prove my capability to my peers	D3
Item 4	I desire a mathematics related course	D4
Item 5	Better grades in mathematics helps me get recognition from people	D5

Scale E: Mathematics motivation (Task Value)		
Item	Construct Measured	Code
Item 1	Skills in bridging mathematics is applicable in other disciplines	E1
Item 2	Bridging mathematics learning materials interest me	E2
Item 3	Topics in bridging mathematics are useful	E3
Item 4	I have an interest in all topics and materials of bridging mathematics	E4
Item 5	Poor performance in mathematics leads to a morale booster to study harder	E5

Scale F: Mathematics Motivation (Teaching strategies in Mathematics)		
Item	Construct Measured	Code
Item 1	Bridging mathematics lecturers are always well prepared for classes	F1
Item 2	My teacher's teaching style is good enough	F2
Item 3	Ineffective teaching strategies lead to poor performance in bridging mathematics	F3
Item 4	Learning materials for bridging mathematics are self-explanatory	F4
Item 5	Lack of patience by lecturers affects students' interest in mathematics	F5
Item 6	Teaching styles should be varied in bridging mathematics	F6
Item 7	Poor teaching methods is obvious in my mathematics lecturer	F7
Item 8	Show-and-tell' approach should be continued	F8

Scale G: Demographical data		
Question	Construct Measured	Code
Question 1	Race	G1
Question 2	Gender	G2
Question 3	Age category	G3
Question 4	Nationality	G4
Question 5	Proposed field of study	G5
Question 6	Matric year	G6
Question 7	Best subject in high school	G7
Question 8	Worse subject in high school	G8
Question 9	Hobbies	G9
Question 10	Type of school attended	G10
Question 11	Subject offered (mathematics or mathematics literacy)	G11
Question 12	Reason for offering mathematics or mathematics literacy	G12

4.3.2 TABULATION: ALL VARIABLES

In reference to how the data are coded in 4.2 below, we shall now tabulate the data. Tables, 4.3 - 4.7 represent the frequencies obtained from the total sample, for all sections of the questionnaire which is aimed at measuring the anxiety and lack of motivation as factors affecting success rates in bridging mathematics.

Table 4.2: Frequency distribution of learning attitude/experience in mathematics in early school

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
A1	19	18	30	27	25	119
A2	24	31	30	19	16	120
A3	24	30	30	26	9	119
A4	29	42	24	16	9	120
A5	13	9	24	34	37	117
A6	29	28	18	28	16	119

Table 4.2 represents the frequencies obtained from the total sample for Section A of the questionnaire aimed at measuring the learning attitude/experience in mathematics at school. The discrepancies in the total sample for each construct was due to reasons such as failure by respondents to complete the questionnaires given to them or lack of clarity in responses given.

Table 4.3: Frequency distribution of anxiety affecting students' mathematics performance

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
B1	6	17	32	43	21	119
B2	17	23	30	31	18	119
B3	11	10	15	41	40	117
B4	17	39	29	23	12	120
B5	24	40	29	15	10	118
B6	10	23	36	34	16	119
B7	11	12	23	32	40	118
B8	18	23	27	35	17	120
B9	12	16	28	36	28	120
B10	11	31	26	27	25	120
B11	7	9	16	35	52	119
B12	16	33	28	27	15	119
B13	25	20	31	23	21	120
B14	12	14	36	31	26	119
B15	24	30	25	19	16	114

Table 4.3 represents the frequencies obtained from the total sample for Section B of the questionnaire aimed at measuring how anxiety affects students' mathematics performances.

Table 4.4: Frequency distribution of mathematics motivation (Intrinsic Goal Orientation)

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
C1	7	5	41	31	35	119
C2	3	3	10	31	67	114
C3	8	4	29	36	42	119
C4	5	6	6	39	60	116
C5	4	1	4	36	73	118

Table 4.4 represents the frequencies obtained from the total sample for Section C of the questionnaire aimed at measuring how lack of motivation (Intrinsic Goal Orientation) affects students' mathematics performances.

Table 4.5: Frequency distribution of mathematics motivation (extrinsic Goal Orientation)

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
D1	3	1	3	27	84	118
D2	6	3	21	36	52	118
D3	5	12	26	26	49	118
D4	23	15	22	18	40	118
D5	26	25	22	19	25	117

Table 4.5 above represents the frequencies obtained from the total sample for Section D of the questionnaire aimed at measuring how lack of motivation (Extrinsic Goal Orientation) affects students' mathematics performances.

Table 4.6: Frequency distribution of mathematics motivation (Task Value)

Table 4.6 represents the frequencies obtained from the total sample for Section E of the questionnaire aimed at measuring how lack of mathematics motivation (Task Value) affects students' mathematics performances.

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
E1	7	7	33	45	26	118
E2	10	4	41	46	17	118
E3	6	7	20	53	30	116
E4	19	26	34	23	12	114
E5	5	10	30	41	28	114
E6	13	14	15	36	38	116

Table 4.7: Frequency distribution of teaching strategies in mathematics

Code	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
F1	2	3	7	32	73	117
F2	2	6	15	35	58	116
F3	64	34	8	10	1	117
F4	6	17	34	31	29	117
F5	41	21	25	16	14	117
F6	6	9	12	27	63	117
F7	55	39	10	9	3	116
F8	10	5	19	36	46	116

Table 4.7 represents the frequencies obtained from the total sample for Section F of the questionnaire aimed at measuring how teaching strategies in mathematics affects students' mathematics performances.

4.4 DESCRIPTIVE ANALYSIS (Demographical Information)

Descriptive statistics reports generally include summary data tables and graphics (for example, charts) and texts to explain what the charts and tables are showing (DeCaro, 2003). Statistical analysis is when a researcher measures the frequency with which an occurrence happens, in addition to the link between two variables (Iacobucci and Churchill, 2010:590). Descriptive statistics help researchers detect sample characteristics that may influence their conclusions.

However, this section of the report tends to look at the demographical information of the sample and the reliability and validity of the scale via the reliability analysis conducted. To this end, a further discussion regarding how anxiety and lack of motivation affect success rates among Pre-degree students will be included.

Section G of the questionnaire relates to the demographic information of the total sample, which refers to the participants that is the Pre-degree level students of a Private Institution of higher learning. The information required includes the following:

- Race (White, Coloured, Black, Indian, Others)
- Gender (Male or Female)
- Age (15-19years; 20-24 years; 25 years and above)
- Nationality
- Proposed Field of Study
- Matric Year
- Best Subject in High School
- Worst Student in High School
- Hobbies
- Which type of high school attended (Rural, Urban, city or Suburban)
- If Mathematics or Mathematics Literacy was offered at Grade 12
- Reason for offering Mathematics or Mathematics Literacy at Grade 12

Figure 4.1 below shows a summary of the distribution of the participants' racial information as highlighted above in the Pre-degree Faculty of this Institution of higher learning. According to this Pie Chart, it can be seen that 94% of the participants are Blacks, this shows majority of the participants are black. 5.1% are coloured and about 1% are white. The disparity in the total number of sample being less than one was due to the fact that one of the participants left out the space for filling of the gender type.

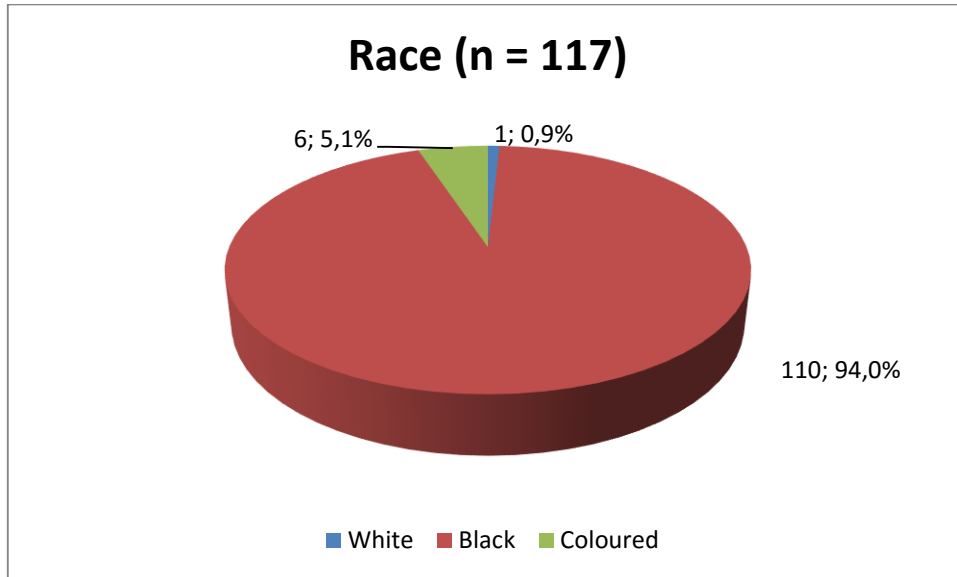


Figure 4.1: Frequency distribution of race of respondents

Figure 4.2 below shows the classification of information related to participants' gender, there was no biasness as to the distribution of the questionnaire as sample indicated more females than males in the Pre-degree faculty of this higher institution of learning. The females were about 73% and the males about 27%.

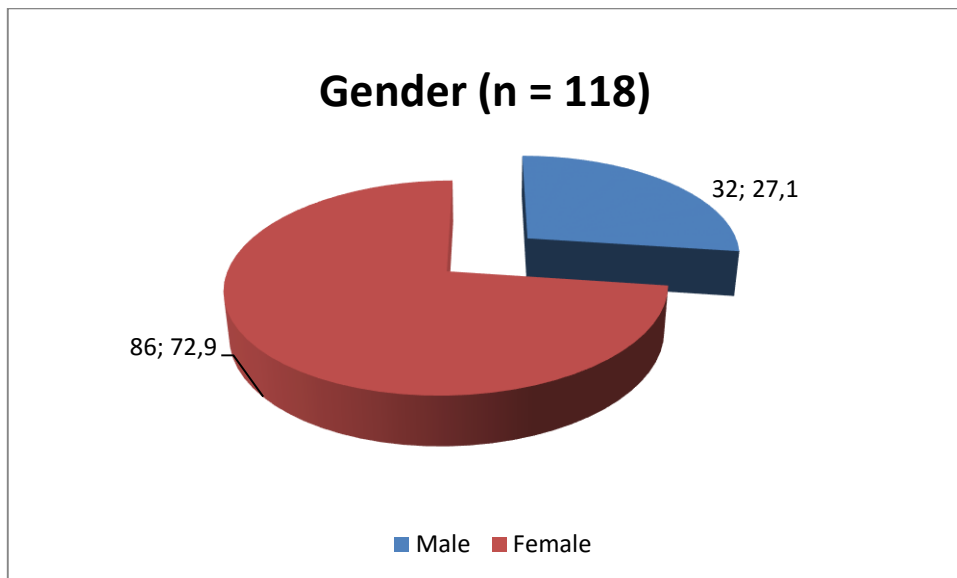


Figure 4.2: Frequency distribution of gender of respondents

According to Figure 4.3, the majority of the students' age's fall within the category 19-24 years representing about 59.3% of the total sample. The age category of 15–19 and above comes after with 39.8% (about 40%) and those within 25 and above years were so minimal accounting for about 1% of the total sample.

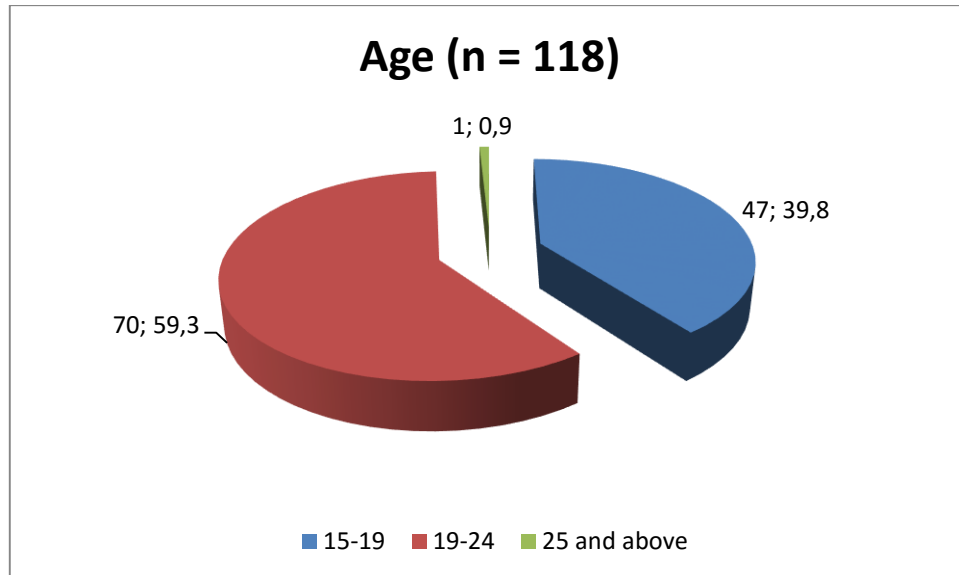


Figure 4.3: Frequency distribution of age groups of respondents

Table 4.4 exemplifies the demographic information in bar graph format pertaining to the participants' Nationality. The majority (74.1%) of the participants were South African Nationals either by birth or descent, followed by the participants Zimbabweans, with a value of 5.4%, and then Namibians with about 4.5%, the Angolans with 3.6%. Nigerians and Zambians have the same value of 2.7% each. Participants from Swaziland and Malawi both had 1.8% each. Finally, down the ladder are the following countries' participants Kenya, Equatorial Guinea, Gabon and Central African Republic, each with 0.9%.

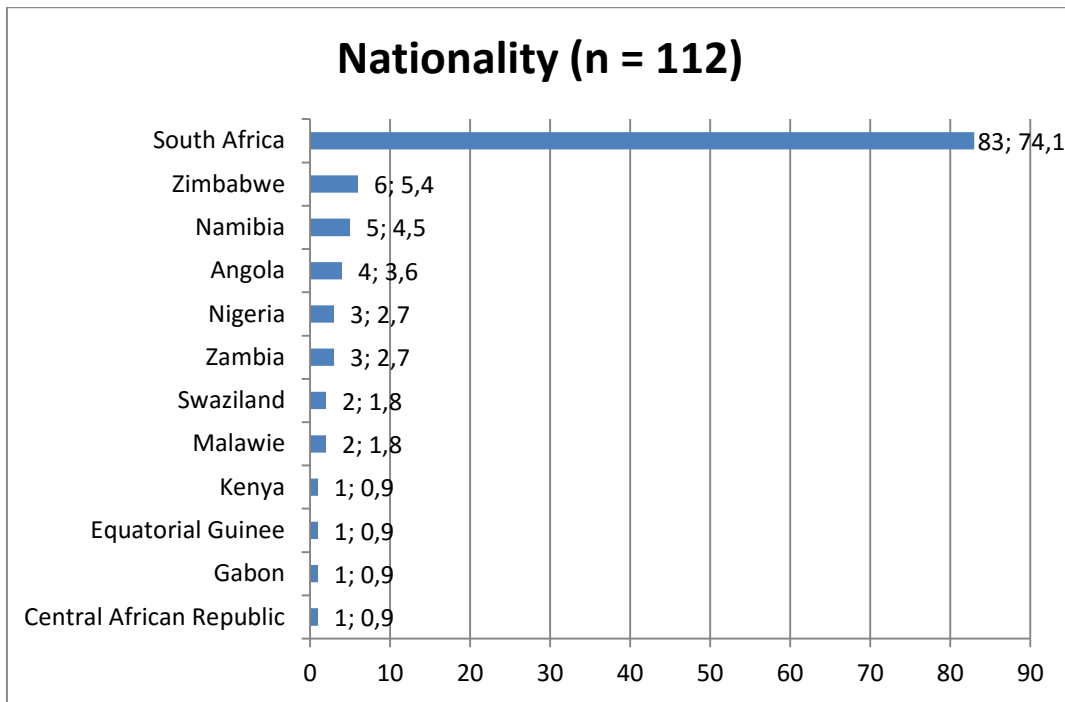


Figure 4.4: Distribution of countries of origin of respondents

Figure 4.5 provides us with a bar chart also of the participants proposed field of study, as we can see only 110 students responded, 8 students did not complete this section of the data, may be due to uncertainty as to which course they would prefer to do in their degree levels. The majority of the participants would like to pursue Bachelor of Commerce (B.com) degrees such as Law, Marketing, Accounting Finance, Tourism and Bachelor in Business Administration (BBA) with a total of 65 out of 110, gives us 59.1%, while those with a proposed field of study in the Social Sciences include, Psychology, Human Resource Management and Journalism with a total of 19 out of 110 giving a 17.3%, and finally the Bachelor of Sciences (BSc) degrees, such as Biomedicine, Biotechnology, Computer Sciences, Engineering and IT sums up to 26 out of 110, that is 23.6% of the total sample.

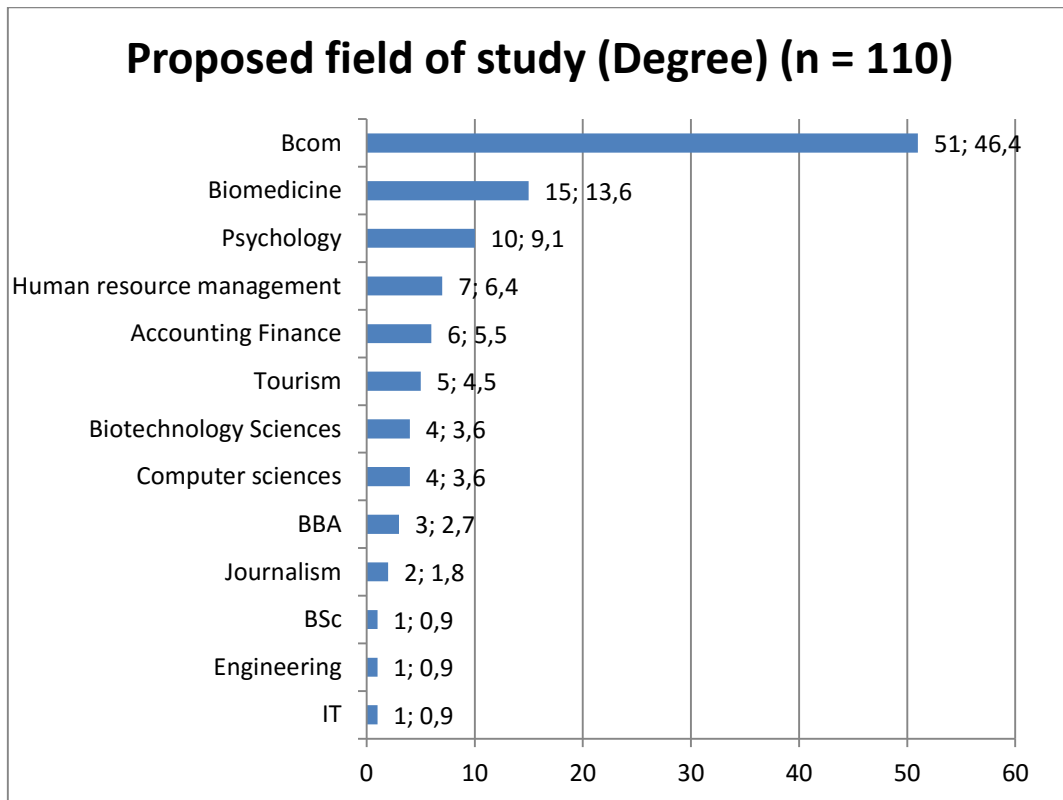


Figure 4.5: Frequency distribution of proposed field of study

The demographical information pertaining to the best subject of the participants in high school is presented in Figure 4.6. This shows that participants' best subject was Business studies with a 16.8 % hence the reason why most of the participants are looking into studying Bachelor of Commerce degrees. English followed this with 15.9%, Life Sciences 11.5%, History 9.7%, Mathematics and History having 9.7% each.

Others in line are Accounting with 8.0%, Economics 6.2%, Tourism 5.2%, Life-Orientation 4.4%, Geography and Agricultural Science each with 3.5%, Afrikaans 2.7%, while subjects like Consumer studies, Electrical Technology and Mathematics Literacy each has 0.9%.

We can see that the number of participants' best interest in mathematics in relation to the total sample was not so bad. This implies that some students loved mathematics right from their high school days, but why the sudden change in interest and performance? This will be a research that would be looked into in future.

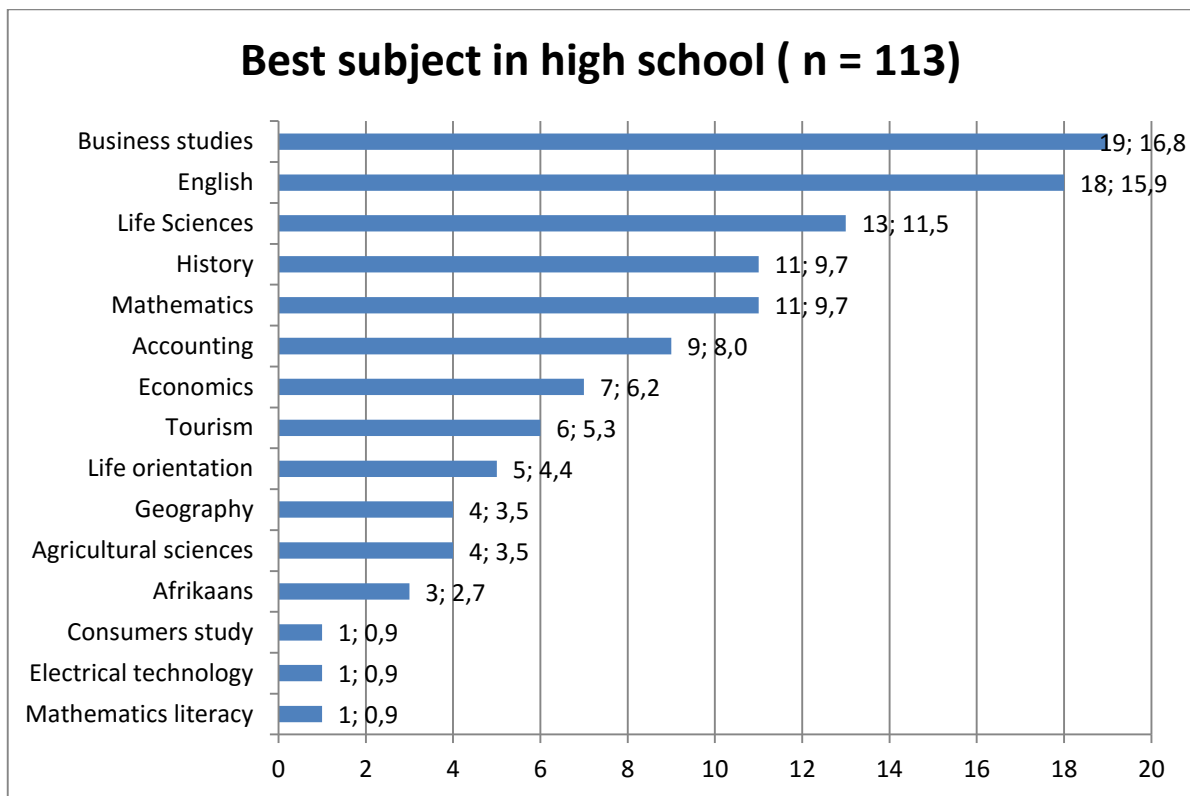


Figure 4.6: Frequency distribution of best subject in high school

Judging from the above data we needed also to look at the participants' worst subject right from high school to see if there was any correlation. It was revealed without any doubt that Mathematics and Mathematics Literacy were their worst subject with 47.3%, followed with a wide margin by Afrikaans with 10.7%, and then Physical Sciences with 6.3%, closely followed by None (No worst subject at all), then Accounting and History with 4.5% each. Others included IT, Economics, and Geography each with 3.6%, Life Sciences with 2.7%, Life Orientation, French, Philosophy, each with 1.8%, and finally with Tourism, Business studies and Bible studies each with 0.9% .

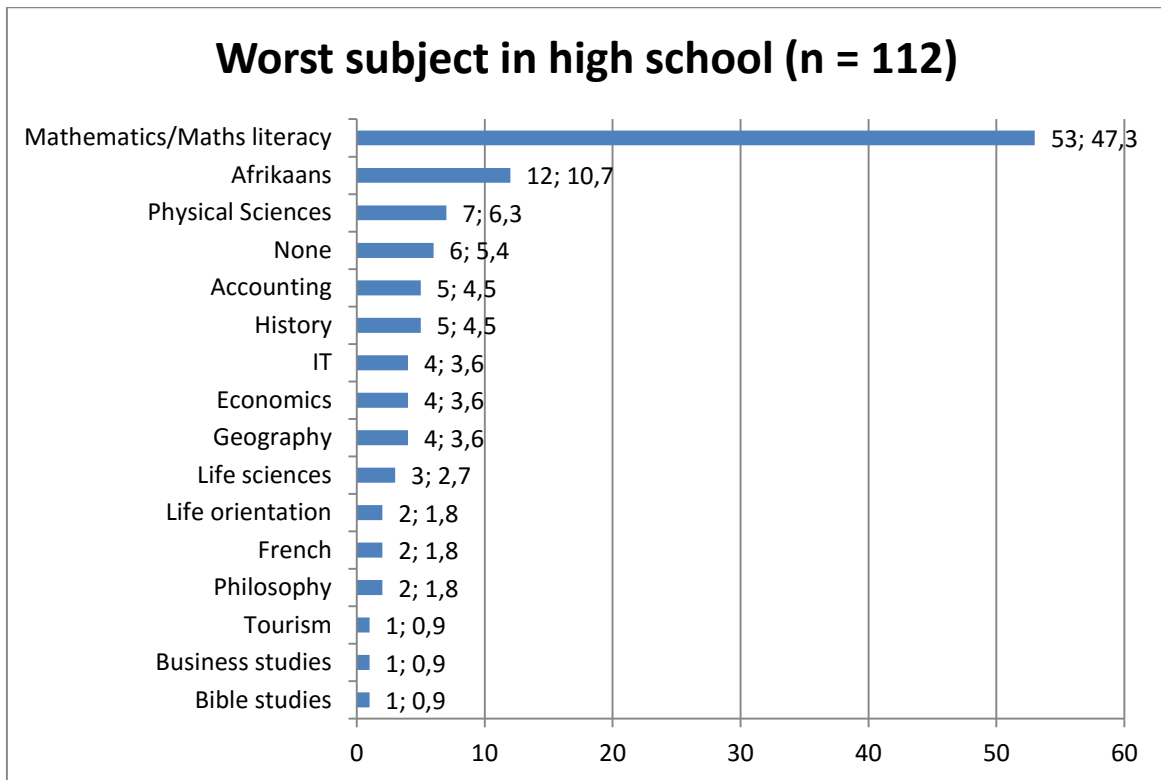


Figure 4.7: Frequency distribution of worst subject in high school

Figure 4.8 presented the demographic information related to participants' type of high school attended. This will inform us if the bulk of students performing well are from the cities or urban areas, Model C type of schools with good educational facilities. As we can see city schools have the largest value of 44.8%, followed closely by the suburban school with 43.1% and then lastly the rural schools with only 12.1%. This indicates a larger percentage of the participants are from the cities so we should expect better performances in their mathematics scores.

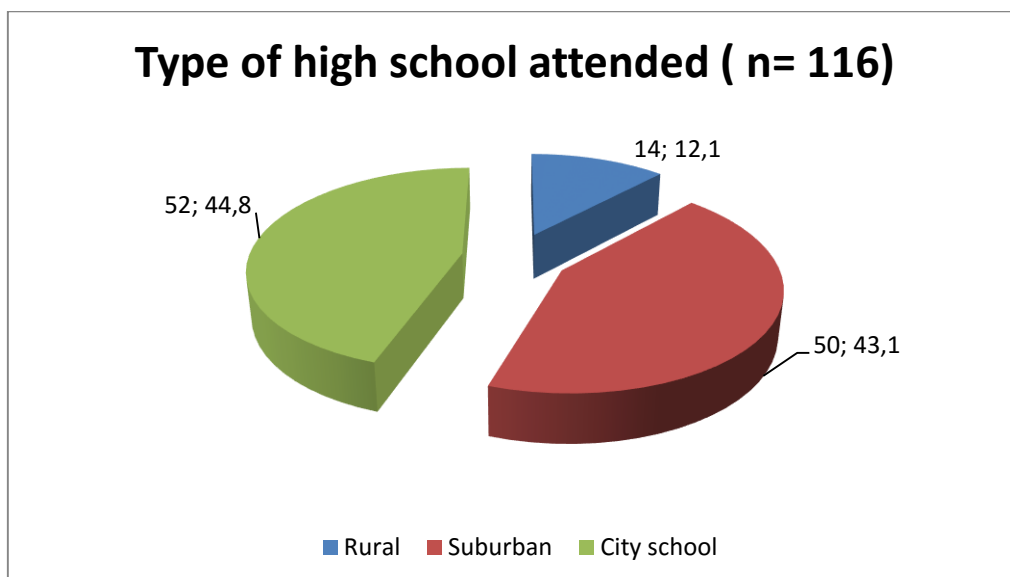


Figure 4.8: Frequency distribution of type of high school attended

Figure 4.9 below shows the ratio of the number of the participants' that chose Mathematics or Mathematics Literacy in their Grade 12 prior to their admission to the higher institution for their Pre-degree programme. This pie chart indicated more of the participants chose pure Mathematics (55.2%) compared to Mathematics Literacy (44.8%). This poses the question, why should success rates in mathematics be low if more students chose mathematics as opposed to mathematics literacy in high school?

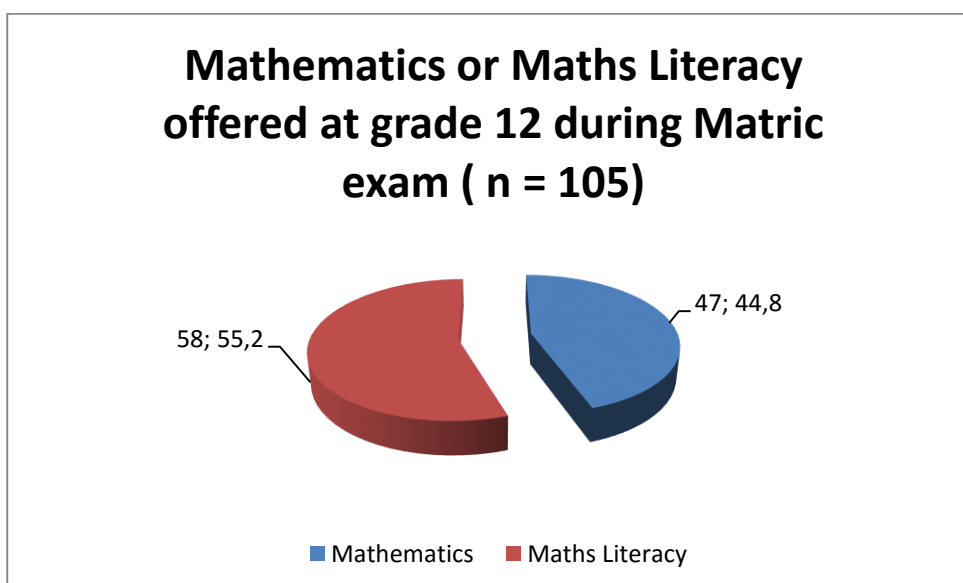


Figure 4.9: Distribution of number of respondents who chose Mathematics or Mathematics Literacy

Figure 4.10 was necessary to show why participants chose mathematics literacy as opposed to mathematics. This is to determine if some other psychological or external factors are responsible for their choices back then. This question was included to determine if certain psychological factors such as anxiety, lack of motivation, or negative attitude affected their decisions back in primary or high school, or if they are external factors such as poor teaching methods or parents' decisions etc. were responsible. From this we see that, the participants believed mathematics literacy was easier compared to mathematics (37.0%), while some feel they had to do mathematics literacy because it was best suited for their line of career (25.0%). Others were advised to opt for mathematics literacy by their parents who felt they themselves were not good in mathematics (12.0%). Some respondents just prefer doing mathematics literacy to mathematics (12.0%). There were those who had to do mathematics literacy as a directive from the school (6.0%); some believed it was due to poor teaching strategies adopted by their lecturers back in high school. Finally, a small fraction attributed this decision to fear of failing it at Matric level (2.0%), some also believed they were not hard-working enough to do mathematics (1.0%).

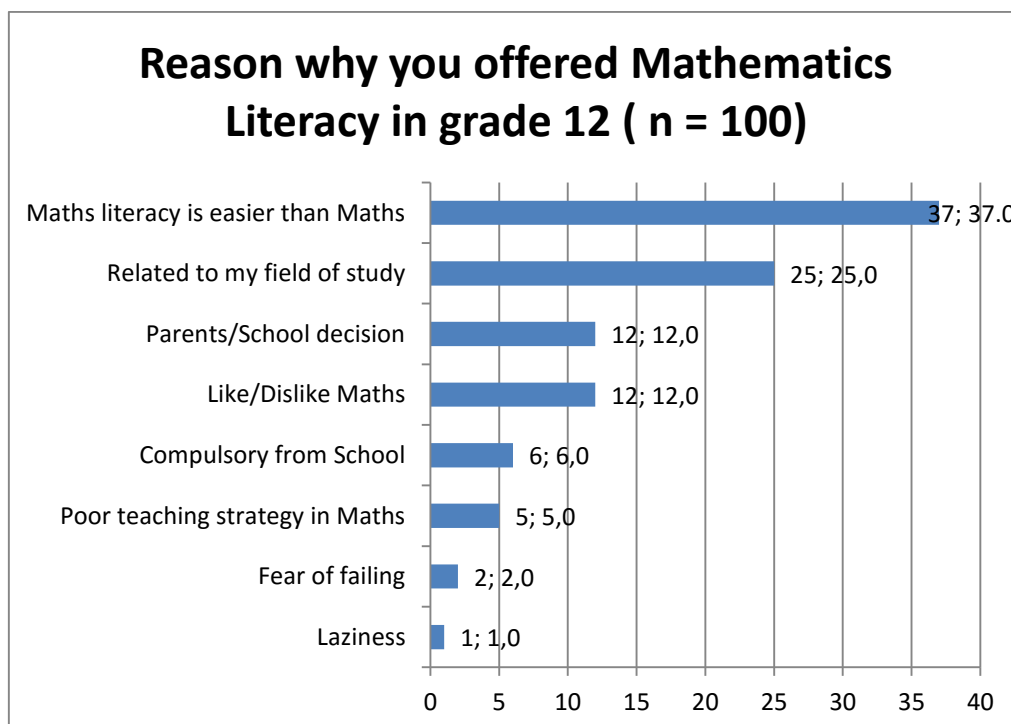


Figure 4.10: Distribution of reason why Mathematics Literacy was offered in grade 12

Finally, Figure 4.11 portrayed the demographic information related to the participants' matriculation year. Most of the participants matriculated in 2012 (70.1%), followed by the 2011 batch with 16.8%, the 2010 batch with 5.6%, the 2009 batch with 2.8%. The 2013 and 2008 batches each had 1.9% and lastly 2007 batch was only 0.9%.

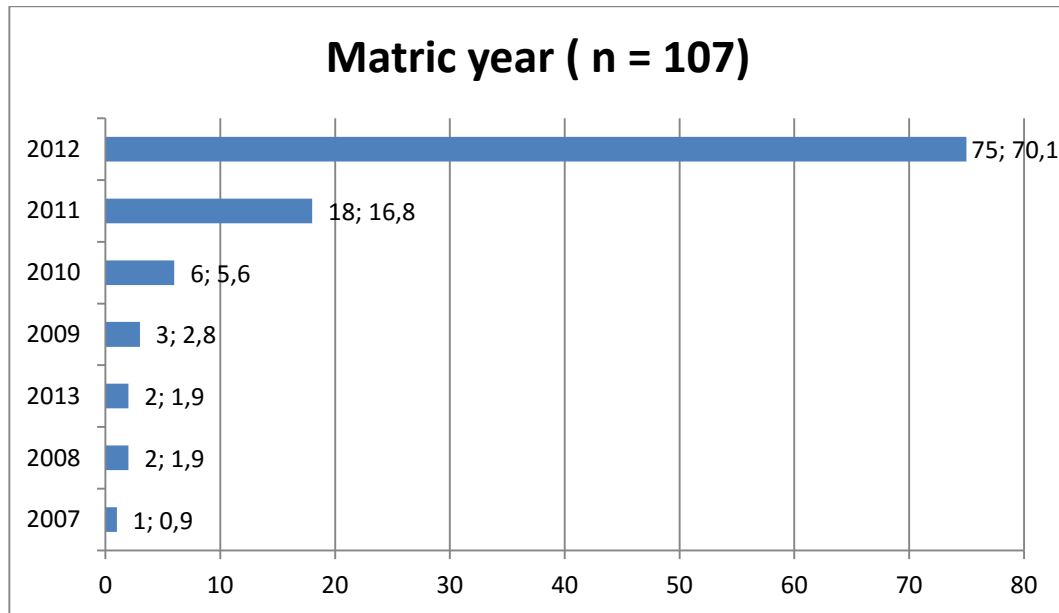


Figure 4.11: Frequency distribution of year of matric obtained

In the section above, the demographical information regarding the total sample used in this study have been discussed and presented in various graphical representations for a clearer understanding. The following section however, will provide a discussion of the reliability and validity of the questionnaire employed for the main study.

4.5 RELIABILITY ANALYSES

Reliability analysis measures the overall consistency of the items (questions) that are used to define a scale. Using reliability analysis, we can determine the extent to which the questions in the questionnaire are related to each other. That is, reliability analysis answers the question: “Does the questionnaire measure Pre-degree Students’ anxiety and lack of motivation as factors affecting success rates in bridging mathematics in a useful way?” One of the most popular reliability statistics still being used today is Cronbach's alpha (Cronbach, 1951). Cronbach's alpha determines the internal consistency or average correlation of items in a survey.

A commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha is as follows:

Cronbach's alpha internal consistency

$\alpha \geq 0.9$ Excellent

$0.7 \leq \alpha < 0.9$ Good

$0.6 \leq \alpha < 0.7$ Acceptable

$0.5 \leq \alpha < 0.6$ Poor

$\alpha < 0.5$ Unacceptable

Table 4.8 below indicates the reliability analyses of the questions in the 6 sections of the questionnaire. It can be seen that reliabilities range from good to poor, except for teaching strategies in mathematics questions with a Cronbach's Alpha of 0.40

Table 4.8: Reliability analyses of the 6 sections

Section	Number of questions	Cronbach's Alpha coefficient
Learning attitude/experience in mathematics in early school years	6	0.50
Anxiety affecting students' mathematics performance	15	0.68
Mathematics motivation (Intrinsic Goal Orientation)	5	0.76
Mathematics motivation (Extrinsic Goal Orientation)	5	0.68
Mathematics motivation (Task Value)	6	0.57
Teaching strategies in mathematics	8	0.40

4.6 FACTOR ANALYSES

Factor analysis is a method for investigating whether a number of variables of interest are linearly related to a smaller number of unobservable factors. In this section, factor analysis is carried out prior to hypothesis testing to reduce the number of variables into a smaller number of factors. The validity of a scale is determined to ensure that the measurement scale measures what it is intended to measure (Wilson and MacLean, 2011:73). In order to ensure the reliability and validity of the research instrument, this section will report on the outcome of the Cronbach alphas and average inter-item correlations of the scale in Section A to Section F of the research

instrument utilised for this study. Thus the results of factor analysis of this study are presented in Tables 4.9 to 4.13 below.

Table 4.9: Factors of learning attitude/experience in mathematics in early school years

Total variance explained: 71.4%	Factor		
	1	2	3
Mathematics is my least favourite subject back in my school days A1	0,865	0,097	0,055
Anything Numerical is a struggle for me A2	0,806	0,072	0,034
My early school year's performance in mathematics is below average A3	0,789	0,063	-0,073
Mathematics lessons are not inspiring to me A4	0,068	0,865	-0,187
Mathematics literacy was easier than mathematics for me in high school A5	0,147	0,608	0,474
Lecturers negative attitudes lead to my disinterest in mathematics A6	-0,038	-0,076	0,908

Tables 4.9 to 4.10 indicate the factors of learning attitude in mathematics in early school years and the anxiety affecting students' mathematics performance. There are three factors in learning attitude, brought down to two factors, as we cannot have a factor with one variable. The numbers in the columns of the factor analysis tables represent the loadings (correlations) of variables with factors. For example, in Table 4.9, struggling with anything involving numeracy (0.806) is highly related to factor 1 (poor mathematics performance since early school affects interest in mathematics, Table 4.15) while mathematics not being interesting due to teacher's negative attitude to teaching the subject is highly related (0.865) to factor 2 (negative attitude towards mathematics, Table 4.15).

As shown in Table 4.9, the scale for Section A, pertaining to factors of learning attitude/experience in early school years returned a total explained variance value of 0.714 for the entire scale. This was a high total variance explained about 71% indicating that the test is 71% more valid and reliable. The variable of 'mathematics lessons not inspiring' and 'mathematics literacy was easier than mathematics in high school' is highly related to factor 2 (negative attitude towards mathematics in table 4.15). As all of these values exceeded the acceptable level of 0.6 (Malhotra, 2010:319), this scale is deemed reliable and can be accepted.

The newly created factors formed by averaging the variables loaded in factors are presented in Table 4.14.

Table 4.10 Factors of anxiety affecting students' mathematics performance

	Factor		
	1	2	3
Total variance explained: 60.9%			
I find bridging mathematics challenging B1	0,767	0,228	-0,246
Bridging mathematics generally makes me feel nervous B2	0,709	0,338	-0,111
Bridging mathematics makes me feel uneasy B3	0,649	0,375	-0,361
I would like to take more mathematics classes	0,614	0,004	0,475

B4			
I get uptight during bridging mathematics tests	0,599	0,280	-0,080
B5			
My mind goes blank whenever I write my bridging mathematics tests	0,102	0,877	-0,085
B6			
I am unable to think clearly whenever I write my bridging mathematics test	0,190	0,838	0,022
B7			
Bridging mathematics makes me feel confused	0,373	0,647	-0,277
B8			
I get a sinking feeling when I try to do bridging mathematics problems	0,443	0,590	-0,193
B9			
I worry about my ability to solve mathematics problems	0,413	0,581	-0,047
B10			
I find bridging mathematics interesting	-0,218	-0,106	0,779
B11			
I think that I will use mathematics in the future	0,058	0,056	0,703
B12			
Bridging mathematics is one of my favourite subjects	-0,436	-0,259	0,673
B13			
I generally enjoy learning mathematics n	-0,320	-0,141	0,668
B14			
Bridging mathematics relates to my day to day life	0,025	-0,093	0,601
B15			

From the above table 4.10, the scale for Section B relating to factors of anxiety affecting mathematics performance returned a total explained variance of 0.609 for the entire scale. This shows that about 61% of the total variance was explained and the test is 61% more valid and reliable. The variable, “I find bridging mathematics challenging” -B1 (0.767); “Bridging mathematics generally makes me feel nervous” - B2 (0.709) up to B5 (0.599) shows that they are all highly related to factor 1 (bridging mathematics is challenging).

In table 4.10 we also observe that the variables from construct B6 (My mind goes blank whenever I write my bridging mathematics tests) to construct B10 (I worry about my ability to solve mathematics problems) are all highly related to factor 2 (Anxiety causes inability to think clearly). For constructs B11 (I find bridging mathematics interesting) to B15 (Bridging mathematics relates to my day to day life) all these are highly related to factor 3 (Interest in bridging mathematics). From the analysis above, this suggests that anxiety is a strong factor influencing success in bridging mathematics and with a Cronbach alpha coefficient of 0.68.

Table 4.11: Factors of mathematics motivation (Intrinsic Goal Orientation)

Total variance explained: 52.5%	Factor
	1
Learning mathematics as a student can improve my logical thinking C1	0,865
In a bridging mathematics class, I would like to have more projects and questions' for homework, which will help me learn more, even though this would not improve my scores C2	0,773
I will work harder to get better scores in mathematics C3	0,761
My greatest wish as a student is to understand the content of the learning material in a mathematics class C4	0,643
In the bridging mathematics class I would like to have some challenging materials that would encourage me to learn more C5	0,536

In the above table 4.11, the scale for Section C relating to factors of mathematics motivation (Intrinsic Goal Orientation) returned a total explained variance of 0.525 for the entire scale. This means about 53% of the total variance was explained and the test is 53% more valid and reliable. The variables C1, "Learning mathematics as a student can improve my logical thinking." (0.865) up to C5 "In the bridging

mathematics class I would like to have some challenging materials that would encourage me to learn more” (0.536) are highly related to factor 1 (Mathematics motivation Intrinsic Orientation). From this we can conclude that lack of Motivation (Intrinsic Goal Orientation) can have a strong influence on the success rate in bridging mathematics with a Cronbach alpha coefficient of 0.76.

Table 4.12: Factors of mathematics motivation (extrinsic Goal Orientation)

	Total variance explained: 67.1	
	Factor 1	Factor 2
I'd like to have higher grades in bridging mathematics in order to get other peoples' recognition D1	0,844	0,056
I want to get higher scores in bridging mathematics class because I want to demonstrate my capability to my other classmates D2	0,743	0,322
My wish is to choose a mathematics related course (for example Engineering, Accounting, etc.) in my degree programme here at MGI D3	0,644	0,218
My desire is to get better grades in my bridging mathematics class D4	0,086	0,874
I believe I can get higher grades than my classmates in bridging mathematics D5	0,219	0,836

In table 4.12 above the scale for Section D relating to factors of mathematics motivation (extrinsic Goal Orientation) returned a total explained variance of 0.671 for the entire scale. This means about 67% of the total variance was explained and the test is 67% more valid and reliable. The variables D1 “I'd like to have higher grades in bridging mathematics in order to get other peoples' recognition” (0.844) up to D3 “My wish is to choose a mathematics related course (for example Engineering, Accounting, etc.) in my degree programme here at MGI” (0.644) are highly related to factor 1 (Extrinsic motivation in doing mathematics). From D4 (0.874) to D5 (0.836),

these variables are more closely related to factor 2 (Aspiration of higher grade in mathematics).

All these point to the fact that lack of motivation (extrinsic Goal) can have a strong impact on success in bridging mathematics with a Cronbach alpha coefficient of 0.68.

Table 4.13: Factors of mathematics motivation (Task value)

Total variance explained: 59.2%	Factor	
	1	2
I feel the learning materials or topics in bridging mathematics are useful E1	0,788	-0,059
What I learn in the bridging mathematics class can be useful in daily life E2	0,699	-0,091
I am always interested in the learning material in bridging mathematics E3	0,661	0,493
The skills I learn from bridging mathematics can be applied in other classes E4	0,658	0,218
I like every topic and content in the bridging mathematics class E5	0,525	0,471
My poor performance in the bridging mathematics test negatively affects my morale to study harder E6	0,104	-0,870

In table 4.13 above the scale for Section E relating to Factors of mathematics motivation (task value) returned a total explained variance of 0.592 for the whole scale, which explains about 59% of the variance. This means 59% of the test is more valid and reliable. The variables E1 “I feel the learning materials or topics in bridging mathematics are useful” (0.788) up to E5 “I like every topic and content in bridging

mathematics class” (0.525) are all highly related to factor 1, mathematics motivation (tasks and skills related). This implies that mathematics motivation (task value) has a strong relation to the success rate in bridging mathematics with a Cronbach alpha coefficient of 0. 57).

Table 4.14: Factors of teaching strategies in mathematics

Total variance explained: 64.4%	Factor		
	1	2	3
My poor performance in bridging mathematics is as a result of my lecturer's ineffective teaching strategy F1	0,797	-0,036	-0,069
My bridging mathematics lecturer cannot explain mathematics concepts easily enough for me to understand F2	0,741	-0,248	-0,032
Lecturers' lack of patience to encourage struggling students in mathematics classes makes them feel uncomfortable, enough to dislike the subject F3	0,609	0,014	0,345
The bridging mathematics materials (for example study guides, textbooks) for learning are self-explanatory enough for success F4	0,252	0,771	0,088
My lecturer's method of teaching bridging mathematics is good enough and needs no improvement F5	-0,362	0,755	-0,149
My bridging mathematics lecturer is always well prepared for his/her lessons as can be noticed in his/her execution of the topic in the classroom F6	-0,350	0,710	0,166

Lecturers should at least use more than one approach to teaching topics in bridging mathematics, especially when students are struggling to understand F7	0,061	0,121	0,849
Lecturers should always adopt the “show-and-tell” approach to solving mathematics problems F8	-0,004	-0,031	0,793

Finally, as indicated in table 4.14 above, the scale for Section F relating to Factors of teaching strategies in mathematics returned a total explained variance of 0.644, which is strong and explains about 64% of the variance. The test validity and reliability is 64% .The variables F1 “My poor performance in bridging mathematics is as a result of my lecturer’s ineffective teaching strategy,” (0.797) up to F3 “Lecturers’ lack of patience to encourage struggling students in mathematics classes makes them feel uncomfortable, enough to dislike the subject,” (0.609) are all highly related to factor 1, “Ineffective teaching strategies affect poor performance in mathematics”.

In contrast, variables from F4 to F6 are all highly related to factor 2, “Appropriate teaching and learning materials”. The variables from F7 to F8 are also highly related to factor 3, “Flexibility and variability in teaching approaches to bridging mathematics”. This shows no relatedness in the variables used in this scale, as different factors can be attributable to the various items, with almost the same Cronbach alpha. Thus, we can say that teaching strategies in bridging mathematics is not a strong factor affecting the success rates of the participants in bridging mathematics as depicted by its low Cronbach alpha coefficient (0.40).

In this study the various factors affecting achievement in mathematics such as, learning attitude, anxiety, and motivation and teaching strategies have been labeled with new variables that were observed in the process of research. These labels ranges from 1 to 3, under each of these labels are various numbers of variables loaded i.e. coded titles given to observe behavioural patterns from the questionnaires administered.

Table 4. 15: Creation and labels of new variables (Factors)

Section	Factor	Labels	Number of variables loaded
Learning attitude/experience in mathematics in early school years	1	Poor mathematics performance since early school affects interest in mathematics	3
	2	Negative attitude towards mathematics	3
Anxiety affecting students' mathematics performance	1	Bridging mathematics is challenging	5
	2	Anxiety causes inability to think clearly	5
	3	Interest in bridging mathematics	5
Mathematics motivation (Intrinsic Goal)	1	Mathematics motivation (Intrinsic Goal Orientation)	5
Mathematics motivation (Extrinsic Goal Orientation)	1	Extrinsic motivation in doing mathematics	3
	2	Aspiration of higher grade in mathematics	2
Mathematics motivation (Task value)	1	Mathematics motivation (tasks and skills related)	6
Teaching strategies in mathematics	1	Ineffective teaching strategies affect poor performance in mathematics	3
	2	Appropriate teaching and learning materials improve interest in mathematics	3
	3	Flexibility and variability in teaching approaches to bridging mathematics	2

4.7 DESCRIPTIVE STATISTICS

Descriptive statistics tends to describe a big hunk of data with summary charts and tables but do not attempt to draw conclusions about the population from which the sample was taken (DeCaro, 2003).

During the course of this study, measures of location variability and shape were calculated across all the Likert scaled items. The numerical presentation of the questionnaires that were completed is shown as Valid N in the table below. Given the five-point Likert scale used ranging from 1= Strongly Disagree to 5 = Strongly Agree, the two major types of statistics used to describe the data are the Measures of Central tendency (including Mean, Mode and Median) and the Measures of Dispersion (Range, Quartiles, Variance and Standard Deviation).

In this study the mean and the standard deviation values along with the mean difference of the 12 labels mentioned in table 4.14 above are presented from the computation of a 1 sample T-test (at 95% Confidence Interval) comparing means of factors to the test value of 3.

Higher mean values (in column 4) below, are associated with greater agreement levels to the statement or label, indicating less perceived influence, and lower mean values are associated with greater disagreement levels to the statements, indicating more perceived influence.

Table 4.16: Results of one sample t-test in comparing means of factors to the test value of 3.

Labels	Valid N=118						
	Test Value = 3						
	t	P-value	Mean	Standard Deviation	*Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Poor mathematics performance since early school affects interest in mathematics L1	-1,215	0.887	2,88	1,077	-0,12	-0,31	0,075
Negative attitude towards mathematics L2	-0,136	0.554	2,99	1,007	-0,01	-0,19	0,17
Bridging mathematics is challenging L3	3,969	0,000	3,33	0,903	0,33	0,17	0,49
Anxiety causes inability to think clearly L4	-0,255	0,601	2,98	0,983	-0,02	-0,20	0,15
Interest in bridging mathematics L5	4,342	0,000	3,35	0,885	0,35	0,19	0,51
Mathematics motivation (Intrinsic Goal Orientation) L6	16,247	0,000	4,11	0,746	1,11	0,97	1,24
Extrinsic motivation in doing mathematics L7	3,770	0,000	3,37	1,062	0,37	0,18	0,56
Aspiration of higher grade in mathematics L8	17,242	0,000	4,33	0,836	1,33	1,17	1,48
Mathematics motivation (task and skills related) L9	8,775	0,000	3,51	0,636	0,51	0,40	0,63
Ineffective teaching strategies affect poor performance in mathematics L10	-12,480	0,000	2,02	0,852	-0,98	-1,14	-0,83
Appropriate teaching and learning materials improve interest in mathematics L11	14,429	0,000	4,05	0,790	1,05	0,91	1,20
Flexibility and variability in teaching approaches to bridging mathematics L12	10,851	0,000	4,00	1,001	1,00	0,82	1,19

From the above table 4.15, the values of the mean computed for all the labels are below 5. The mean values of these 4 labels are observed to be very high; L8 (4.33) was the highest, followed by L6 (4.11), thereafter L11 (4.05) and L12 (4.00). This suggests that the participants perceive “Aspiration of higher grade in mathematics,” (L8) (Mean= 4.33) to be most influential on their success rates in bridging

mathematics, followed by “Mathematics motivation (Intrinsic Goal orientation)” (L6) (Mean=4.11), and then “Appropriate teaching and learning materials improve interest in mathematics”, and finally, “Flexibility and variability in teaching approaches to bridging mathematics”.

Furthermore, the participants perceive “Mathematics motivation (tasks and skills related)” (L9) (Mean= 3.51), to have a higher influence on their success rates in bridging mathematics, followed by “Extrinsic motivation in doing mathematics” (L7) (Mean= 3.37), thereafter, “Bridging mathematics is challenging”, (L3) (Mean= 3.33). Other factors closely followed those mentioned, “Negative attitude towards mathematics” (L2) (Mean= 2.99), “Anxiety causes inability to think clearly” (L4) (Mean= 2.98), and “Poor mathematics performance since early school affects interest in mathematics”, (L1) (Mean= 2.88) also affects the participants’ success rates in bridging mathematics. Lastly the participants perceive, “Ineffective teaching strategies affect poor performance in mathematics” as least influential on the success rates in bridging mathematics, hence, the low Cronbach alpha earlier computed.

From this table also (that is, Table 4.15) we can observe the standard deviation column, which denotes how widely spread the scores in the distribution are and measures how far it is from the mean value (Gravetter and Wallnau, 2010:105). Standard deviation is a statistic that tells you how tightly all the various examples are clustered around the mean in a set of data (Niles, 1995). A very high standard deviation indicates more dispersion of agreement among the participants; this was true of the label, “Poor mathematics performance since early school affects interest in mathematics” (Label 1) (Std. Dev. =1.077). This means most participants have a varied agreement regarding this factor. This was followed closely by, “Extrinsic motivation in doing mathematics” (Label 7) (Std. Dev. =1.065). “Negative attitude towards mathematics”, (Label 2) (Std. dev. = 1.007) was next in that order as can be seen from the table. The Lowest standard deviation, indicating less dispersion of agreement amongst the participants was recorded for the influence of “Mathematics motivation (tasks and skills related)”.

The *Mean difference measures the difference between the mean computed value and the test value of 3.

4.8 HYPOTHESIS TESTING

A hypothesis testing is a systematic method used to evaluate data and aid the decision making process (Mayo, 2004). It is a statement made by the researcher regarding a particular problem in a specific population, to be tested by an empirical study and then be accepted or rejected (Salkind, 2012). In order to achieve the empirical objectives as set out in chapter 1 of this study, comparative analyses were employed in the form of correlation analysis, regression analysis and a one-sample t-test. The reason for using a comparative analysis is to determine the degree of difference, or no difference between the participants' perceptions regarding the influence of anxiety and lack of motivation as factors affecting success rates in bridging mathematics.

4.8.1 REGRESSION ANALYSIS

Regression analysis was undertaken in this study in order to determine whether anxiety, lack of motivation and teaching strategies influence success rates in bridging mathematics.

To this end, three hypotheses were tested for significance level at a $p= 0.05$:

H₀₁: Mathematics anxiety is independent of academic performance of students in the mathematics bridging course (Rejected).

H₀₂: Lack of motivation is independent of academic performance of students in the mathematics bridging course (Rejected).

H₀₃: Teaching strategies is independent of academic performance of students in the mathematics bridging course (Accepted).

All these hypotheses will be tested using the one-sample T-test, mainly the one-tailed test. We test whether, on average, the factors are significantly greater than 3, which is the neutral alternative of the Likert scale used in the 6 sections. Any factor that is significantly greater than 3 ($P\text{-value} < 0.05$) implies that students are in agreement to that factor.

Table 4.15 (see page) indicates the results of the one-sample T-test. It can be seen that students significantly agreed to the following factors, as their P-values are less than 0.05:

- Bridging mathematics is challenging (p-value = 0.000)
- Interest in bridging mathematics (p-value = 0.000)
- Mathematics motivation (Intrinsic Goal Orientation) (p-value = 0.000)
- Extrinsic motivation in doing mathematics (p-value = 0.000)
- Aspiration of higher grade in mathematics (p-value = 0.000)
- Mathematics motivation (tasks and skills related) (p-value = 0.000)
- Ineffective teaching strategies affect poor performance in mathematics (p-value = 0.000)
- Appropriate teaching and learning materials improve interest in mathematics (p-value = 0.000)
- Flexibility and variability in teaching approaches to bridging mathematics (p-value = 0.000)

From the above analysis, there is an indication that $p\text{-value} < 0.05$ for all these labels. The first two bullets, (that is bridging mathematics is challenging and Interest in bridging mathematics) indicated the labels for Section B regarding Anxiety as a factor influencing success in bridging mathematics ($p < 0$ and significance level for the variables is $0.609 > 0.5$). Therefore, there is sufficient evidence to accept H_1 . This suggests that anxiety affects success rates in bridging mathematics and is dependent on it and hence it is statistically significant.

The next four bullets (that is Mathematics motivation; Intrinsic and Extrinsic Goals; Aspiration of higher grade and mathematics motivation tasks and skills related) indicated the labels for Section C, D and Motivation influence on success in bridging mathematics ($p < 0$ and significance levels for the variables 0.525, 0.671 and 0.592 are all greater than 0.5). This means there is sufficient evidence to accept H_2 , that lack of Motivation affects success rates in bridging mathematics, or in essence success rates in Bridging Mathematics is significantly dependent on motivation. These values of the Cronbach alpha indicate a large effect and are practically significant factors to be considered for success rates in bridging mathematics.

Finally, the last three bullets in the above analysis (that is Ineffective teaching strategies affect poor performance in mathematics; Appropriate teaching and learning materials improve interest in mathematics and Flexibility and variability in teaching approaches to bridging mathematics) indicated the labels for Section F and on teaching strategies influence on success in bridging mathematics ($p < 0$ and significance level for the variables is $0.40 < 0.50$). Due to its Cronbach value less than 0.50, there is no sufficient evidence to accept H_3 , that poor teaching strategies affect success rates in bridging mathematics. It has a small effect and can be said to be a practically insignificant factor.

The following section will focus on the qualitative sample of the participants in the study.

4.9 QUALITATIVE SAMPLE

The qualitative portion of this research was based on in-depth interviews with the participants of a private higher institution in Gauteng studying the Pre-degree programme in 2013. The participants were all students that took bridging mathematics as a prerequisite module either in their first or second semester. The researcher distributed questionnaires to 120 students of this institution and conducted interview questions thereafter with majority of them as a second data collection. The explanatory and the exploratory approaches will be used to analyse these responses.

The participants' ages ranged from 18 years to a little over 25 years. There was a racial mix of black, white and coloured students, from different nationalities. The participants' responses were categorised as attitudinal/bad experience students; anxiety affected students; motivationally affected students (intrinsic, extrinsic or task related) and students affected by teaching strategies. These categories stemmed from the classification used in the quantitative aspect of this study. The selection of the students was a mixture of those who attended rural, suburban or urban schools. The interviews lasted between 30 minutes and 1 hour; once they obtained permission from their lecturers, the participants agreed to fill in their responses in writing mostly after their normal classes. These responses were collected for transcription purposes.

This implies that both the quantitative and qualitative data were collected and analysed, any issues observed would be addressed by the researcher after a careful combination and comparison of the results. This is in accordance with the concurrent triangulation design forms of data collection as mentioned in the introduction. Therefore, the two forms of data collected were related.

To assess the impact of anxiety and lack of motivation on success rates in bridging mathematics among Pre-degree students, we used a frequency distribution table and graphs to represent the demographic data of the respondents. In addition, factor analyses were used and hypotheses were tested using a one-tailed T-test with a 95% confidence level. There was also the regression analysis of anxiety, lack of motivation and poor teaching strategies on success in bridging mathematics. The results of these tests have been discussed earlier in the quantitative approach.

In this section, we shall consider the participants' individual responses to see if anxieties, lack of motivation and possibly poor teaching strategies have affected their success rates in bridging mathematics and what they think should be done to ameliorate this.

To do this extent we shall explore some of the participants' responses in the interviews conducted below using the grounded theory, which consists of a systematic yet flexible guideline for collecting and analysing qualitative data, and to construct theories from the data. It begins with inductive data, involving going back and forth between data, analysis using comparative methods and keeping you as the researcher interactive and involved in your data (Charmanz, 2007a).

In addition to this, the Narrative inquiry method will be employed, which is a type of qualitative research whereby the investigator attempts to explore the concrete experiences of people by asking them to answer questions based on the research topic of interest, in the form of storytelling (Avdi and Georgaca, 2007). These stories are then given in a reported format by the investigator (Creswell, 2005).

4.9.1 THEMES EMERGING FROM THE INTERVIEWS WITH PARTICIPANTS

To illustrate why students' success rates in bridging mathematics are affected, we refer to the interview data, in table 4.14 regarding the 10 questions asked in the questionnaire. The 6 themes represent the crux of the interview and the 12 subthemes represent individual responses as categorised.

4.9.1.1 Experiences with mathematics

In my interview with the participants, they responded enthusiastically, participated freely and were in a relaxed mood with me as the researcher. Most of the respondents recalled bad experiences such as 'name-calling', negative words, and impatience, to mention a few. For example, Diamond, one of the participants said her bad experience with mathematics in the past dates back to her high school. They were supposed to go on Winter and Summer camps, the school insisted that they first had to write a mathematics test as a prerequisite to attending the camp, anyone that got less than 50% will not attend. "This was horrible; every student should have been allowed to attend the camp." They always categorised me in the 'stupid people' group and made me answer questions they knew I wouldn't be able to answer". These bad experiences of Diamond, made her avoid mathematics ever since.

According to Zinzi, another participant, she had a bad experience with her mathematics teacher in Grade 11. "She was very mean and discouraging and made me hate mathematics. This gave me low self-esteem because she constantly shouted at us when we failed to understand the topic at hand".

As for Mariam, when asked if any of her past lecturers either in primary or high school ever made her to dislike mathematics, she replied, "Yes, because if any of the 'good' students in her class understood her way of teaching mathematics, she was less concerned about the others who were struggling to understand the topic. Most students are not motivated to want to do mathematics because it requires a lot of practising and thinking and while most students are too lazy".

Some participants like Princess said she has always had problems with mathematics right from her high school days. She confessed to her failing mathematics from 2010 up to 2012. Her reason for this was attributed to her teacher's lack of patience when

explaining any topic. Mary another participant also felt that her teacher was too fast when explaining a topic and therefore, assumed mathematics is difficult.

Diana, responded, “I failed all my mathematics tests in Grade 9.” Most of her friends wanted to drop mathematics in high school; she was embarrassed to say she enjoyed the subject. Another negative experience from Carol, said, “I found it hard to grasp mathematics when I was in Grade 9,” because of a bad experience in Grade 3 class with her teacher who called her “Stupid” as a result of her not understanding long division. This made her avoid anything involving calculation since then.

Precious said, “My grade 9 experience in Mathematics was the worst, as my teacher was very discouraging saying negative words about me, and failed to explain to us in a manner that we would all understand.” This led her to changing over to mathematics literacy.

Gift said he did not perform well in grade 9 because, “I found mathematics to be very challenging at the time. I often had low marks; many of my friends experienced the same challenges, forcing us all to change to mathematics literacy for fear of failing.” He was not particularly sure what led to his dismal performance in mathematics.

4.9.1.2 Attitude and lack of motivation to do mathematics

In an interview with Khetiwe one of the respondents, she said, “I have never had a bad experience with mathematics, but I have a bad attitude towards it. Mathematics was just difficult and due to this perception of mine I have never thought to change my way of thinking.”

When some of the participants were asked, what in their opinion made students unmotivated to want to do mathematics related courses? These were some of the findings. Stan feels, “Students have a negative attitude towards the subject, but lecturers could make the subject interesting.” Ovalar, agrees with Stan, “The subject is boring sometimes and it would be nice if group work is allowed in class to make for sharing of ideas.”

Phosta, Mariam and Kikhulu asserted that, “Students are not motivated to do mathematics related courses because it involves numbers; anything with numbers is challenging and involves a lot of practice with logical thinking.” However, they feel students must be encouraged to do more projects with more practices for success. Mariam personally feels, there should be a top-10 list for every class test done as motivation.

Another participant, Mariam, feels, “Mathematics is tricky and students find it difficult to practice because they are lazy.” She said mathematics should be fun but she does not know how to make it fun.

4.9.1.3 Mathematics versus mathematics literacy

Carol pointed out that the basic teaching in high school is no longer the same; she feels there should not be mathematics literacy, only mathematics. She thinks a lot of the students who perform badly in bridging mathematics are from the mathematics literacy group. She said, “If mathematics is taught basically as mathematics and not anything else right from high school, then students will have a better understanding of what is expected of them because of a good foundation.” Another participant Hossy, said, “Mathematics should be compulsory during high school years, not a choice.”

Hope on the other hand, responded by saying that, “Most students here at the Pre-degree programme chose mathematics literacy in high school and the fact that now they have to switch to university mathematics is not only challenging but more complicated. Students need to change their perception that because its ‘university mathematics’, it’s more difficult, but rather think of how they can excel in the module by seeking assistance from their lecturers for consultation times or telling lecturers to spend more time on specific topics for clarity.”

4.9.1.4 Teaching Strategies and Learning Resources

With regards to the lecturers’ methods of teaching, the use of mathematics study guides and text books, the participants were asked if they felt either of these could be improved upon to encourage better success rates in bridging mathematics. The following were just some of the comments made.

Lerato, a participant, stated that, “The textbook used for bridging mathematics is not explicit enough in its explanations, so I prefer taking notes in class and using the study guide.” She said further that, “The lecturers are not the problem, its the resources being used.”

Judging from all the mixed comments regarding the study materials, some participants feel that the study materials are “good and can be rated 8 out of 10”, “they are up to standard”, others believe “it gives guidelines and has various challenging questions required to be done as exercises”. Someone said, “They are just informative and straight to the point”, or “they are very good and self-explanatory”. On the other hand, some comments included, “the study guide is almost useless in my opinion, it does not fully explain a topic”, or “the red textbook does not explain clearly, so I prefer taking notes from the study guides”.

With regards to the teaching methods of the lecturers, and what needs to be done by them, the participants had the following to say: “The more varied methods we are taught to solving a problem the better”, “...show us other ways because not everyone has the same learning method”, other responses included, “I think one method is fine, I get easily confused when too many methods are being explained”, “...our lecturers are very pushy, I love that”, or “they are not spending enough time with us they should add more periods to the timetable”. One participant tried to view the question from another angle, “The lecturers are doing all they can, it is the students who are not willing to put in their best”. Another response given was that “...there is nothing left for my lecturer to do, they are doing their best” as well as, “Time management is a problem, they do not spend a lot of time on a topic and do not give 100% of their attention”.

4.9.2 A SUMMARY OF THE QUANTITATIVE AND QUALITATIVE DATA

From these various comments, qualitative data was constructed in table form to itemise all that has been said, putting them into different subthemes as mentioned earlier. From these comparisons of the various data, both quantitative and qualitative aspects will be computed.

The table below represents an analysis of the participants' responses and viewpoints regarding bridging mathematics as a prerequisite in their Pre-degree programme and any past experiences with mathematics in general.

Table 4.17: Bridging mathematics as a prerequisite module/experience in mathematics

A. Bridging mathematics is necessary as one of the pre-requisite courses to a degree programme at MGI		
	Frequency	Percentage
Yes	79	84.0
No	15	16.0
Total	94	100.0
B. Reasons why bridging mathematics is necessary as one of the pre-requisite courses to a degree programme at MGI		
	Frequency	Percentage
Pre-requisite to my degree	30	62.5
Not important	4	8.3
The most important	11	22.9
Very challenging	2	4.2
Addition to my logical abilities	1	2.1
Total	48	100.0

C. Have you ever had a bad experience with mathematics in the past?		
	Frequency	Percentage
Yes	69	75.0
No	23	25.0
Total	92	100.0
D. What made it a bad experience?		
	Frequency	Percentage
Poor teaching strategies in mathematics	10	15.6
Always have low marks	38	59.4
Mathematics is always challenging	11	16.2
Teacher lacks patience with struggling students	3	4.7
Had negative attitude towards mathematics	2	3.1
Total	64	100.0
E. Did any of your past lecturers in mathematics (either at Primary or high school) ever make you to dislike the subject?		
	Frequency	Percentage
Yes	50	54.3
No	42	45.7
Total	92	100.0

The table below represents an analysis of the participants' responses regarding what factors affect their motivation to succeed in bridging mathematics as a pre-requisite in their Pre-degree programme

Table 4.18: Demotivating factors to mathematics related courses and suggested solutions.

F. How did your past lecturers in mathematics make you dislike the subject?		
	Frequency	Percentage
Poor teaching strategies in mathematics	17	34.7
Discouragement	18	36.7
Mathematics is always difficult	1	2.0
Lack of patience for underperforming students	9	18.4
Absenteeism	2	4.1
Bad presentation	2	4.1
Total	49	100.0
G. Reasons why most students are not motivated to do mathematics related courses at university		
	Frequency	Percentage
Bad experience in the past	15	16.7
Challenging subject	48	53.3
Laziness	5	5.6
Fear of failing	4	4.4
Not important	4	4.4
Bad advice from lecturers	1	1.1
Bad attitude towards mathematics	11	12.2
Do not know	2	2.2
Total	90	100.0
H. Ways of motivating students to want to do mathematics related courses and pass them		
	Frequency	Percentage
Career guidance	18	20.9
Good teaching strategies	22	25.6
Do not know	7	8.1
Mathematics should be compulsory	5	5.8
Make it practicable	4	4.7
More practice	15	17.4
Positive attitude towards mathematics	10	11.6
Make it less difficult	4	4.7
Teach mathematics in Home language	1	1.2
Total	86	100.0

The table below represents an analysis of the participants' responses regarding task related materials and teaching strategies as contributing factors to success in bridging mathematics in the Pre-degree programme

Table 4.19: Task related materials and teaching strategies to bridging mathematics reviewed.

I. Rating of the standard of mathematics study materials for the pre-degree programme at MGI		
	Frequency	Percentage
Very bad	4	4.7
Bad	4	4.7
Neither good nor bad	5	5.8
Good	32	37.2
Very good	41	47.7
Total	86	100.0
J. Mathematics lecturers should teach more than one method of solving a problem and allow students to choose the method they understand		
	Frequency	Percentage
Yes	68	77.3
No	20	22.7
Total	88	100.0
K. At any given time mathematics is my preferable subject		
	Frequency	Percentage
Yes	70	76.9
No	21	23.1
Total	91	100.0

L. Reason why mathematics is my preferable subject		
	Frequency	Percentage
Always get better marks	13	20.6
Good teacher	19	30.2
Like working with numbers	9	14.3
Makes you creative	4	6.3
Because of one specific topic	4	6.3
I understand it	12	19.0
I have a positive attitude towards mathematics	2	3.2
Total	63	100.0
M. What are mathematics lecturers not doing to bring out the best in their students		
	Frequency	Percentage
They are doing their best	46	56.8
Not helping students succeed	4	4.9
Not following up on students individually	4	4.9
No opinion	4	4.9
Not teaching many methods	3	3.7
Not focusing on struggling students	2	2.5
Not motivating students	8	9.9
Not patient	10	12.3
Total	81	100.0

N. Are boys more intelligent in mathematics than girls		
	Frequency	Percentage
Yes	23	26.1
No	65	73.9
Total	88	100.0

Table 4.20: Gender Consideration as a factor for success in mathematics

The table below represents an analysis of the participants' responses of regarding gender as a determining factor for success in bridging mathematics in the Pre-degree programme.

O. Reason why you think boys are more intelligent in Mathematics than girls		
	Frequency	Percentage
Boys are more logical thinkers than girls	6	37.5
Boys take mathematics more seriously than girls	4	25.0
Boys are ready for challenges	1	6.3
Girls are distracted most of the times	3	18.8
Do not know	1	6.3
All inventions and discoveries are made by men	1	6.3
Total	16	100.0

4.9.2.1 Narration on Participants' responses of the qualitative data collected

From the above tables, one theme that emerged is the fact that about 75% of the students said "Yes" to having at least one bad experience in mathematics in the past; either through poor teaching methods, low marks, lack of patience with lecturers, discouragement etc. This reveals that negative experiences, attitudes or anxiety is a strong factor affecting performance and success rate in bridging mathematics.

Furthermore, the table revealed that 53.3% of the total respondents felt that mathematics was challenging, because it involves lengthy processes of calculations most times, with abstract use of variables. There is so much interconnectivity in what was learnt years back in high school, say in Grade 9, compared to what is now being learnt, they cannot remember these concepts. These and many other factors inhibit their learning, which demotivates them, and then they do not do well in the subject, hence, low success rates in bridging mathematics. Other reasons for low success rates in bridging mathematics were attributed to laziness (5.6%), bad experiences in the past (16.7%), their bad attitude towards mathematics (4.4%), fear of failing the subject/not important subject (4%), while some did not know why (2%). This

corresponds to type 1 regression hypothesis (H_1) that mathematics anxiety, and attitude affects students' performance in mathematics.

This qualitative data is further supported by the computation of the mean values of some labeling, such as the fact that 'Bridging mathematics is challenging' (3.33), 'Negative attitude towards mathematics' (2.99), and finally, 'Anxiety causes an inability to think clearly' (2.98).

The participants also advised on methods they feel can be implemented to improve students' motivation in bridging mathematics as a subject. They recommended good teaching strategies (25.6%) by making the subject and class less boring, career guidance (20.9%) making them aware of the positive influence mathematics will have on their career choice. In addition, involving them in more practice time in classes (17.4%), a positive attitude (11.6%) on the part of the students will also go a long way in improving their motivation. Other reasons advocated include making mathematics compulsory (5.8%), making it less difficult (4.7%) or better still teach mathematics in their home language (1.2%). This corresponds to type 2 regression hypothesis (H_2) that poorly motivated students perform badly in mathematics.

These results are corroborated with the calculation of the mean value in table 4.15 where the highest values of 4.33 and 4.11 were derived from, "Aspirations to do mathematics" and "Internal goal motivation". This shows that motivation is a key to success in mathematics performance.

The bridging mathematics study materials were not judged well by 37.2% of the participants and 47.7% said it was very good. This shows the effectiveness of study material and reveals that it is not a factor affecting low success rates in bridging mathematics. Of the participants, 77.3% agreed that lecturers should adopt more than one method to solving a problem in mathematics if possible. Mathematics as a subject was preferable to most of the respondents (76.9%), with only 23.1% saying "No", this reveals that students have an interest in the subject but are helpless on how to make a success of this. The reason for this was found to be due to good lecturers (30.2%), followed by the ability to get better marks (20.6%) or easy to understand if explained well (19.0%), others like working with numbers (14.3%),

interest/likeness for some specific topics (6.3%), and having a positive attitude towards mathematics (3.2%).

Regarding lecturers and their methods bringing out the best in their students, most participants feel the lecturers are doing their best (56.8%), this corresponds to Hypothesis 3 (H_3), which was rejected to show that teaching strategies are not really significant in affecting students' performances in mathematics. Some believe lecturers are not patient enough (12.3%), others feel they are not motivating students enough (9.9%), or they are not helping students succeed or following up individually (4.9% each), and some participants prefer not to include too many methods (3.7%), while some differ in their opinion that lecturers do not focus on struggling students (2.5%).

Finally, there was need to ascertain if boys are perceived to be naturally more intelligent than girls. The responses differ as most participants feel that boys are more logical than girls (37.5%), some feel boys take mathematics more seriously than girls (25.0%), and others feel, girls are distracted most times with other feminine issues that consume their time (18.6%), other reasons are that boys are more ready for challenges than girls (6.3%), or that all inventions and discoveries are made by men (6.3%).

From the above discussion it is clear that both the quantitative and qualitative aspect of this analysis predicts that anxiety and lack of motivation are two important psychological factors that affect success rates in bridging mathematics amongst Pre-degree students.

4.10 FOCUS GROUP REPORT

For the focus group five lecturers participated in the interviews conducted, all in the Pre-degree faculty of the private institution. There was also a short interview with the head of the faculty at this private institution. The teaching staffs were mostly trained in the field of mathematics education, three to be precise, and one was trained in the Food Science Curriculum Studies field, while the other teacher was trained in Business Management. Their level of academic degrees ranged from Bachelors to Doctorate with teaching experiences from three to ten years.

The lecturers were first asked to describe their style of teaching in class. One of the Lecturers said, "I use cooperative learning as a teaching strategy where I give 10 minute intermittent presentations to my students. Consequently, I divide them into groups to have hands-on experiences with their learning". He also states that, "I use a problem-based learning approach to drive my learning." Another member of staff, said, "I use the mentoring and tutoring approach, the problem-based and academic support approaches to teaching my students." A third lecturer asserted that, "My teaching style is to help students enhance their foundations by allowing them to see mathematics as an object and not a structure." His teaching style is to focus more on the 'Why' part instead of only focusing on the 'how' part'.

Secondly, lecturers were asked to place their students on an intelligence level, although no formal scale was given, a teacher said, "I would rate them as 'below average' as many of them failed to do well in their Matric mathematics that the schools admits." Another teacher also agrees to this, but said, "We eventually bring them up to achieve better through intensified teaching approaches." Another lecturer feels, "It is very difficult to assess our students' 'level of intelligence' since there was no formal instrument used to measure this therefore, I would not use 'level of intelligence' to measure or identify our students' performance."

The next question was to ask what teaching strategies they could adopt to help a struggling student in bridging mathematics. The responses were varied; Lecturer A said, "I prefer encouraging them to take responsibility for their learning by engaging them in a one on one basis for consultation." Lecturer B says "Engaging students in a problem-based learning approach, with mentoring and tutoring in addition to the school assisting them with the academic support programme would be ideal."

Another lecturer also feels that, "We all learn in different ways and various methods and approaches can be adopted but before this, we need to know where their problems lie, simplify it to their understanding and move ahead." Finally, the last lecturer begged to differ by saying that, "There is no 'perfect' teaching strategy." He recommends lecturers should rather master what is best for them and continue to refine it by reflecting constantly on the manner in which the lessons have been going.

The next question regarding how the lecturers plan to help motivate a positive attitude towards mathematics in their students; the following points were made. Lecturer A, talks about communicating to students positively that they can achieve any goal they set out for themselves, this can be done by engaging them to the point of self-efficacy or by role modelling". Lecturer B, said, "I will tackle what led to their negative attitude towards mathematics in the first place, moving forward from there and possibly having a reward system to encourage them to do the work." Another Lecturer said, "I would rather engage the students in mathematics that has to do with real life situations, although selection of a real life situation should be carefully done, because it must be selected according to the students' meta-level and not that of the teacher."

The next question was geared towards what steps they would take as lecturers to help develop an interest towards problem solving in order to improve their students' abilities in mathematics. Lecturer A believes in relating contexts to their backgrounds by using concepts that will interest the students in explaining the mathematics. Another lecturer agreed but added that enhancing student-lecturer relationships and giving an opportunity for feedback in a non-coercive manner will help. One lecturer opted for them to develop their thinking and hands-on skills, to tenaciously confront their challenges. A different lecturer feels problem solving should not be the only way to determine students' competency; engaging the 'Five Strands of Mathematics Proficiency' would be most appropriate".

Finally, they were asked whether assessments by means of class tests, assignments and exams are the best ways for determining the strength of their students' knowledge. Lecturers differed in their responses in this area as well, Lecturer A and B believed that formal assessment has been a proven way to test student understanding in the past and that the only way to know if students are learning is to assess their learning trajectories. Other Lecturers disagreed by saying that formal assessment adds a certain amount of pressure on students that result in some of them having a nervous breakdown, but if the same questions are asked in an informal, more relaxed environment they are likely to obtain the correct answer. One of the lecturers further reiterated that assignments are somewhat tricky, as some of the students can pay someone else as mercenary to do the work for them.

To this end, they further suggest that assessments should not only be to test for conceptual and procedural fluency but for strategic competence, adaptive reasoning and productive dispositions of the students”.

4.10.1 INTERVIEW WITH FACULTY HEAD

In an interview with the Faculty head of the Pre-degree programme of this institution, she pointed out that the number of intakes has been increasing over the years right from its inception in 2006. The programme has helped to bridge the gap between the high school and the tertiary level mathematics. One of the major challenges of the programme has been that most students admitted had completed Mathematics literacy in their National School Certificate (NSC) and are struggling to meet the necessary levels required in bridging mathematics to continue with their studies in Commerce, Information Technology and Science particularly.

Several of the remote sites of this private institution have expressed anxiety regarding the mathematics skills and abilities of their students. In addition to this, results of this bridging mathematics module have shown a bi-polar distribution, in which a proportion of the students do well that is those in the Science pre-degree have a higher mathematics entrance requirement, and a proportion of students, that is the normal mathematics literacy students perform poorly or barely scale through.

To this end, a proposal was sought to address the needs of a proportion of the students (approximately 20%) in the Pre-degree programme whose lack of skills and understanding in bridging mathematics A (BMAT 011) often leads to the repetition of this module and increased anxiety regarding the module. This proposal was designed for those students whose overall performance would be improved upon through additional intervention from an Academic Support perspective.

To this end, in my interview with her she referred to this report entitled “*Senate Report on Proposal, MGI Pre-degree Extended BMAT 011, August 2012*”, from where the following additional information emerged.

The proposal stipulated that the current BMAT011 curriculum would be split into two streams covering the same outcomes. The first stream would follow the existing BMAT 011 curriculum and a contact time of 4 lectures per week with 1 or 2 tutorial

periods per week. This was prepared for students who have passed mathematics with a mark of 40% or higher or mathematics literacy with mark of 55% or higher.

The second stream was meant to absorb those students with a mark in mathematics below 40%, or a mark in mathematics literacy below 55%. The existing BMAT 011 curriculum will have an additional two lecture periods per week that is 6 lectures per week with 1 or 2 tutorial periods per week. This was done to allow for more contact sessions with the weaker students building the basic or pre-requisite knowledge and skills for the module whilst covering additional exercises. This would also help to address students with mathematics anxiety problems or other common obstacles to success such as lack of motivation. These students would be required to complete the same assessments to finish the module at the same exit levels with the other stream.

Furthermore, in the same survey conducted in 2012 by this private higher institution, it was revealed that 20% of the respondents specifically mentioned the reason why they are doing the Pre-degree programme which was because of their poor performance in mathematics hence; they cannot get admission in to their choice of degree at any higher institution.

With the introduction of the extended mathematics curriculum, the faculty head believed that this was a step in the right direction as outcomes of the throughput rates from 2012 to date has increased tremendously in the bridging mathematics module. The extended stream has showed an improvement both in terms of pass rates and average marks received, resulting in an approximately 4 to 5% increase in overall throughput (*Source: Senate Report on Proposal, MGI Pre-degree Extended BMAT 011, August 2012*).

Semester 1 in 2012 the Due Performance (DP) rate improved to 94% in bridging mathematics, with the pass rate (PR) at 71% and throughput rate (TR) at 67%. This was a tremendous improvement over 2011 before the introduction of the extended mathematics module BMAT 011. An improvement was noticed in the bridging Module for Semester 2, DP improved from 79% in 2012, to 87% in 2013; pass rate improved from 42% in 2012, to 75% in 2013; and the throughput rate (TR) also increased from 33% in 2012, to 65% in 2013. Although, it is to be noted that the introduction of the extended mathematics curriculum is not only the contributive factor to improved performance in bridging mathematics but is believed by most of

the mathematics team that it is a significant factor that cannot be ruled aside (*MGI, Pre-degree Faculty Report, 2012 and 2013*).

4.11 SUMMARY

This chapter presented the findings, which resulted from the study that was carried out on how anxiety and lack of motivation affects success rates in bridging mathematics.

- In Section 4.2 a summary of the results obtained from a preliminary data analysis was presented. The presentation gave an insight in to the coding and tabulation of data collected.
- A descriptive analysis of the demographic information of the participants was presented in Section 4.3 in the form of pie graphs and bar charts.
- The following section, which is Section 4.4, presented the reliability analyses of the questions categorised in to 6 sections regarding the study. These 6 sections are: Learning attitude/experience in mathematics in early school years; Anxiety affecting students' mathematics performance; Mathematics motivation (Intrinsic Goal Orientation); Mathematics motivation (Extrinsic Goal Orientation); Mathematics motivation (Task Value) and Teaching strategies in mathematics. This section also highlighted the reliability and validity of the results obtained from the main survey questionnaire.
- In Section 4.5 a confirmatory factor analysis of the scale was executed to examine whether a number of variables of interest are linearly correlated to a small number of unobservable factors. In addition, descriptive inferential statistics were formulated, discussed and tested for reliability.
- Section 4.6 indicated the descriptive statistics showing a data summary of the results of a one-sample t-test in comparing means of factors to the test value of 3. This includes a one-tailed t-test using a confidence level of 95%.
- In Section 4.7, was the Hypotheses testing, where correlation and regression analyses were employed in order to test the hypotheses formulated in Chapter 1 of this study, to determine whether any significant differences can be found between anxiety, lack of motivation and teaching strategies on success rates in bridging mathematics.

- Finally Section 4.8 looked at the qualitative sampling techniques employed in this study and the report derived from interviews and questionnaires conducted with the participants.

In the next chapter we shall be considering the overview of this research study, its findings, limitations, recommendations, a suggestion for further research and the conclusions inferred from this study.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

In the previous chapter, an analysis of the impact of anxiety, lack of motivation and teaching strategies was presented through quantitative techniques such as the calculation of reliability analyses, factor analyses, descriptive statistics, correlation and regression analysis. In addition to this, qualitative sampling techniques such as the interviews and questionnaires were also analysed using triangulation.

To this end, the researcher will link the literature review with the research data. It provides insight into the effect that affective teaching and learning of mathematics impacts on students' achievement in bridging mathematics. From the questionnaire and interviews done, a summary of the findings, deductions, recommendations and conclusion regarding the research will be discussed in this chapter.

Furthermore, this chapter will also show how the research data contributed to the aims and objectives of the study. From these discussions specific recommendations with regard to future research will then be formulated.

The following outlines a breakdown of subheadings that will be discussed in this chapter.

Firstly, the chapter presents a summary of the study (Section 5.1), followed by a short overview of the first four chapters of this study (Section 5.2). Thereafter we shall consider again the research questions (Section 5.3) and their answers from the study, a discussion on the limitations as encountered in the study (Section 5.4). Furthermore, we shall look at the contributions of this study to the research field (Section 5.5), with recommendations for opportunities regarding future research and training (Section 5.6). Lastly, the conclusions to the study will be discussed (Section 5.7).

5.2 OVERVIEW OF THE STUDY

In order to motivate unbiased conclusions and recommendations for this study, the information gathered and presented in the previous chapters (1-4) are necessary to be considered again. This presents a review of the aims of the study in Section 5.2.1, followed by the literature review guided by the theoretical objectives review in Section 5.2.2. In Section 5.2.3, the empirical objectives are reviewed involving the research methodology used in the study.

5.2.1 AIMS OF THE STUDY

In conclusion to the empirical data gathered from the literature review, the researcher will now link the outcomes of this study to previous literature reviews to discuss the achievement of the objectives outlined in chapter one.

Thus, for a proper and comprehensive picture of the topic being studied, namely “Anxiety and lack of motivation as factors affecting success rates in bridging mathematics”, the researcher has provided in chapter 1, an introduction to the study, and a summary of the problem statement is provided accentuating the need for conducting the research. The primary objectives of this study were set out in this chapter (Section 1.3) namely as:

- i) To establish which contributing factors lead to low performance in mathematics among Pre-degree students.
- ii) To determine what teaching and learning strategies in the classroom may lead to curbing mathematics anxiety among students?
- iii) Lastly, to test if poor teaching methods or pedagogical contents of mathematics lecturers influence anxiety or demotivates students leading to their poor performance in mathematics.

The hypothesis was formulated after this (Section 1.4) to test for the significant difference in the influence of mathematics anxiety, motivation and teaching strategies on academic performance of students. Furthermore, the proposed research designs and methodologies of the study were reviewed (Section 1.5), which involved the use of the mixed model method which is an integration of quantitative and qualitative methods of data collection with an explanation on the research process using the paradigmatic perspective and the selected research design.

The ethical consideration was described with how written consent will be taken from the respondents, the consent from the case study university where the research will

be done (Section 1.6) as well as with the clearance certificate from the Research Ethics Committee of UNISA where the researcher is presently studying.

The clarification of key concepts was presented after this (Section 1.7). Finally, a summary of the chapters as the plan of the study was mentioned as a guide to the research (Section 1.8).

5.2.2 THEORETICAL OBJECTIVES

In chapter 2 the researcher explored the main themes of the study, namely anxiety, motivation and teaching strategies as factors affecting performance in bridging mathematics across higher institutions (Section 2.1). There was a review of the historical perspective of the bridging programme in higher institutions both locally and internationally (Section 2.2).

The need for a bridging programme in our higher institutions was discussed (Section 2.3) as well as the Constructivists' view of the bridging programme (Section 2.4). This summary provided the view that knowledge is actively constructed in the mind of the learner on the basis of his/her pre-existing cognitive structures. As students construct their knowledge, the bridging course provides academic support in four ways namely, diagnostic assessments, individualised instructions, short term learning goals and independence of students by applying Vygotsky's Zones of Proximal Development.

South African higher institutions involved in bridging Programmes were discussed in detail both in the Private and Public Sector (Section 2.5). An insight in to the Pre-degree as a foundational programme at the Midrand Graduate Institute, a private higher institute, was highlighted after this (Section 2.6).

Thereafter, a definition of mathematics anxiety and its implications were explained in Section 2.7. According to Daniel Ansari, the principal investigator for the Numerical Cognition Laboratory at the University of Western Ontario, London stated, "When engaged in mathematics problem-solving, highly mathematics-anxious individuals suffer from intrusive thoughts and ruminations; this takes up some of their processing and working memory. It is very much as though individuals with mathematics anxiety use up the brainpower they need for the problem on worrying."

Section 2.8 discussed mathematics anxiety as a key concept in the vicious cycle of mathematics avoidance. Anxiety is not innate but is acquired and developed (Ertekin

et al., 2009). The influences that develop mathematics anxiety incorporate several different variables such as attitude, motivation, learning and teaching styles.

According to Geist (2010:24), "Many elementary lecturers have mathematics anxiety and are uncomfortable teaching mathematics; this negative attitude influences students." Linking this view of Geist (2010) to the data outcomes in chapter 4 revealed that most students attributed poor performance in bridging mathematics today to negative attitudes passed on by their lecturers in primary school, as well as a lack of motivation intrinsically and extrinsically.

The outcomes of this study were further corroborated by Tsanwani (2009) and (Khatoon & Mahmood, 2010; Leppavirta, 2011) which stated that mathematics anxiety is an irrational and impedimental dread of mathematics. This term is used to describe the panic, helplessness, mental paralysis and disorganisation that arise among some individuals when they are required to solve a problem of a mathematics nature. The literature further indicates that mathematics anxiety refers to a person's feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in a wide variety of ordinary and academic settings.

The students admitted to studying bridging mathematics dread the subject so much due to their panic and helpless state manifested from past negative experiences with mathematics in primary and secondary school. These feelings of tension and anxiety impede their thinking abilities with the manipulation of numbers and solving of mathematics problems.

McAnallen (2010) conceptualised mathematics anxiety as an effective response that includes avoidance of mathematics, subsequent failure to learn mathematics skills, leading to poor school-related decisions and fewer career options.. From the data analysed in chapter 4, most students found mathematics generally challenging and due to their past negative experiences with their lecturers, they tend to go blank when doing bridging mathematics and are not able to think straight. This mathematics anxiety makes them avoid any mathematics related course or any skills related to it.

From this the researcher looked at the other key factor in the study, motivation and how it can help improve behaviours for successful mathematics outcomes (Section 2.9). Further in the study, (Section 2.10) past and present studies on motivation for achievement in mathematics was highlighted.

An individual's intrinsic motivation is mediated through the types of goal structures he or she has created (Meece, Blumenfeld, & Hoyle, 1988). In particular, possession of a mastery goal orientation will positively mediate intrinsic motivation that one can become more actively involved in a cognitive task. An ego goal orientation (that is, primarily seeking social recognition) has much less effect on one's developing active cognitive engagement patterns and this may lead to poor performance.

Relating this to the data collected and analysed, it was observed that most students would want to have higher grades in bridging mathematics just to gain other peoples' recognition or to demonstrate their capability to their other classmates. Although many of the students believe that bridging mathematics can improve their logical thinking, their biggest wish was to understand the content of the learning material. However, due to the external motivational reasons of ego goal orientation (that is, primarily seeking social recognition), their active cognitive development abilities will thus be affected thereby impinging on their success rates in bridging mathematics.

Finally in Section 2.11, the researcher summarised the need for further research into mathematics anxiety and lack of motivation among pre-degree students in future.

5.2.3 EMPIRICAL OBJECTIVES

The research methodology employed in the study was that of a transformative paradigm, which involved the use of the mixed method of analysis (that is the Qualitative/exploratory and the Positivist/interpretive research designs) as discussed in Chapter 3. A discussion of the research designs which is quantitative, qualitative, descriptive and exploratory in nature (that is a mixed method) via the use of a case study known as the transformative paradigmatic perspective was included in Section 3.2.

The paradigm guiding the current study was a combination of ethnography and case study research which falls under the interpretive paradigm. It also employed the use of empirical observations of individual behaviour via a quantitative methodology in order to predict general patterns of human behaviour (Section3.3).

The workings of the research design were through concurrent triangulation designs of data collection which worked with the mixed method for this study (Section 3.4). In addition, a discussion of the research site was done (Section 3.5), this was at the Midrand Graduate Institute (a private university in Johannesburg).

The role of the researcher in the study was discussed (Section 3.6), which was to empower the researcher to enter into a collaborative partnership with the participants in order to collect and analyse data with the sole purpose of creating an understanding (Maree & Van der Westhuizen, 2007). Data collection techniques used (Section 3.7) addressed the research questions or hypotheses developed. This requires using procedures drawn from either concurrent forms of data collection, in which both the quantitative and qualitative data are collected concurrently, or from the sequential forms of data collection in which one type of data is collected and analysed prior to a second data collection.

The data analysis (Section 3.8) involves the process of collecting data during the research process, prepares data for analysis (transcribes field notes and recorded conversations), reads through the data (obtains a general sense of the material), codes the data (locates text segments and assigns a code label to them) and codes the text for descriptions or themes to be used in the research report.

Furthermore, quality assurance criteria for a reliable study was also discussed (Section 3.9), this is to judge the soundness and quality of the research work. From a quantitative aspect it must have internal and external validity, objectivity and reliability. Qualitative research must have credibility, transferability, dependability and confirmability.

Finally, an explanation of the ethical considerations (Section 3.10) which includes respecting the rights, privacy, dignity, sensitivities of the research populations and the integrity of the institutions within which the research occurs..." (American Educational Research Association, 2002:.3)

5.3 ANSWERS TO THE MAIN AND SUB RESEARCH QUESTIONS

The quantitative, interpretive, qualitative, and exploratory nature of this study has helped to contribute to the rich in-depth investigation of this research topic, namely, “Anxiety and lack of motivation as factors affecting success rates in bridging mathematics”. The following conclusions, as it relates to the empirical objectives formulated in chapter 1 were observed:

In order to answer some of the research questions asked in Chapter 1, the researcher shall categorise these under three different factors such as:

Research questions related to anxiety and negative experiences factors:

- i) Why has most South African students’ interest dwindled on the learning of mathematics over the years?
- ii) What triggers the high level of anxiety amongst high school students when it comes to writing mathematics tests or examinations?
- iii) To what extent do the lecturers’ methods or strategies impact on students’ performances and their mathematics anxiety?

This research study pointed out these observations, which have been supported by literatures in the past.

- The description of the relevant case study revealed that learning attitude/experience in mathematics in primary or secondary school years have a strong effect on their falling short of the required rates in bridging mathematics due to lecturers’ negative attitude; from their early school years through to struggling with anything involving numbers or poor marks in high school, to their choice of mathematics literacy, etc. In addition, these factors have also brought about the dwindling interest of most South African students in the learning of mathematics over the years.
- The high level of anxiety among high school students when it comes to writing mathematics tests or examinations is often triggered by poor performances in the past with the subject as most of the participants commented, and the fact that they have already programmed their minds that mathematics is challenging are the main reasons given for this. Based on this study and those of other researchers, mathematics anxiety has a direct effect on performance of mathematics tasks (Sheffield & Hunt, 2007).

Research questions related to motivational factors

- iv) What do lecturers do to curb students' low self-esteem and attitude towards learning mathematics and performing well in it?

The following were the deductions gathered from this study regarding this question.

- In helping students with low self-esteem and negative attitude to mathematics, lecturers who were interviewed in the focus group suggested trying to relate to the student's bad experiences in the past with mathematics, would be a good starting point. This would help forming a foundation of understanding the problem and then think of a reward system to encourage students to do the work. Other lecturers feel we need to motivate students to take responsibility for their learning and assist possibly with consultations, or by engaging with them that they can achieve any goal set out with positive thinking.
- v) Can a lack of motivation be attributable to Pre-degree students' poor performance in mathematics? The deductions gathered from the research revealed the following:
- The issue of lack of motivation as affecting Pre-degree students' poor performance in mathematics is a very important factor. The participants believe mathematics can improve their logical thinking abilities, and they would want to improve their mathematics grades if the lecturers can devote more time to helping them succeed and if they used more than one method to solving problems would be helpful.

Research questions related to teaching strategies factors:

Other research questions in Chapter 1 concerned teaching strategies, and lecturers' preparations:

- vi) How well do mathematics lecturers plan and prepare for their lessons before executing them?
- vii) To what extent do the lecturers' methods or strategies impact on students' performances and their mathematics anxiety?
- viii) What teaching strategies should lecturers/lecturers adopt to teach 'mathematics anxiety students' in order to improve their success rates?

The following summarised participants' responses to these questions:

- Bridging mathematics' lecturers are mostly well prepared for their lessons, as suggested by the majority of the participants. "Lecturers are doing their best", was the comment from most of the participants; however the students

themselves also have to play their part. They agree that lecturers give enough homework, assignments and past questions for practice.

- Lecturers' strategies do not have a strong impact on students' success rates in bridging mathematics, as revealed by this study. The participants feel lecturers' methods of teaching are good enough most times, but would prefer varied methods of solving problems in mathematics to be encouraged. Good teaching strategies would only motivate them to want to do mathematics related courses.
- The focus group interview involving the lecturers revealed that a cooperative learning style can be helpful for an anxious mathematics student. Others recommended a problem-based learning method, or an individual one on one approach, going around checking for those who are struggling with the concepts and trying to help them succeed.
- The lecturers advised engaging the students contextually, use contexts related to their background in solving problems, allowing for feedback from the students to determine their level of knowledge, giving consultations, and ensuring that they develop thinking and hands-on skills.

The study consisted of a case study and the researcher needs to take the limitations of this into consideration.

5.4 LIMITATIONS TO THE STUDY

The following are some of the limitations observed in this study:

- There is only one case study that was investigated in this research.
- From the above premise therefore, the possibility of generalising the findings and results are limited since we cannot regard only one case study as representative of the whole population of Pre-degree students taking bridging mathematics at all higher institutions in South Africa. Although, the research study could have included other higher institutions of learning, from other provincial areas in South Africa. In addition, a comparison of students' anxiety and lack of motivation to bridging mathematics could have been investigated to show any correlation. This study was conducted using a sample of mostly South African students within a private higher institution of learning again, it could have included equal participation of non-South

African students for the purpose of comparison. However, the findings may still be generalisable to other higher institutions of learning.

- Considering the specific quality assurance criteria that were mentioned earlier in the study and having adhered to them in order to enhance credibility and reliability of my research, as the researcher, one must still regard your own subjective interpretation which other researchers might interpret differently.

5.5 CONTRIBUTION OF THE STUDY

In the field of mathematics very few studies have been done on the affective domain impact in mathematics learning and success rates, especially relating to emotions, beliefs and attitudes. To this end, this study has delved into showing the impact of how students' beliefs, emotions and lack of motivation as mathematics students' influence their academic performance at Pre-degree level.

This has become important in our present day, because of the poor performance of students and their apathy towards any mathematics related course. This study shows the importance of affective factors (such as anxiety, negative attitude, lack of motivation) in determining the success or failure of mathematics learning, with the intention of promoting and encouraging positive traits, attitudes and beliefs in the students. These may transform into better performances and expectations of achievement in bridging mathematics.

The major findings from this research study provide an insight in to the significance of affective factors on mathematics learning and success rates among Pre-degree students in South Africa. It shows the importance of good relationships between lecturers and students in order to create for healthy cohabitation in the classrooms. Lecturers should use constructive words to help the students get a firm grip of mathematics.

In addition, teaching strategies for mathematics must be effective and varied as much as possible to meeting the students' diverse needs. Lecturers are enjoined to know their students well, and their mathematics backgrounds in order to see how to assist them effectively to success.

The suggested recommendations from the statistical results in this study, regarding anxiety and lack of motivation as it affects success rates in bridging mathematics, can pave the way forward for different sites of higher education, as well as the Department of Education to effectively deal with these affective traits in order to achieve success in mathematics.

5.6 RECOMMENDATIONS

The suggested recommendations can be used with regards to training, practice and future research.

The importance of anxiety and lack of motivation as affective factors on success rates in mathematics, is emphasised by various researchers (Pintrich, Anderman & Klobucar, 1994; Kloosterman, 2002; Skaalvik & Skaalvik, 2011; Blanco et al., 2010; De Bellis & Golding, 2006; Zakaria & Nordim, 2008). All these authors agree that anxiety interacts negatively with cognitive and motivational processes and invariably affects students' overall performance.

From these researchers, students who attribute success to internal causes and to control, were less anxious and had greater expectations of success. They were more oriented towards mastering the subject, more self-reliant and metacognitive and perform better (Ignacio, Nieto, & Barona, 2006).

5.6.1 TRAINING

To this end, there is a need for lecturers and lecturers to be trained in how to be aware of the effect of anxiety on students' achievement and motivation. The lecturers are advised to lessen the anxiety level in these students by applying the following recommendations as put forward by Woodard (2004):

- Create an environment in which students do not feel threatened and are more relaxed.
- Use cooperative learning groups often, this helps to assure students that some of their peers have the same problems as they do.

- Endeavour as a teacher/lecturer to teach at a slower pace, this can help create a better understanding of the material being taught.
- Provide extra tuition sessions to help those left behind academically.

From this current study however, it became obvious that various challenges of the affective domain (anxiety, attitude and motivation) can be handled through mentoring, getting to know the students' mathematics backgrounds and helping via therapeutic processes to best overcome these traits. This mentoring programme or "Emotional literacy session" should be developed in schools with the aim of promoting a change in students' beliefs, attitudes and emotions towards the subject mathematics, and championing a course of success for them. In addition to this, before there can be an improvement in attitude, there has to be a change in image, that is, the methodology of teaching has to improve, and the relationship between teachers/lecturers and students must be cordial, sincere and caring.

Furthermore, it will be recommended that mathematics lecturers liaise with their institution's educational psychologist regarding the affective domain field given its impact on academic performance. This will enable the department of pre-degree studies to come up with prevention and intervention strategies to help stimulate and activate students' desire in the subject; to ultimately improve attitudes, beliefs and emotional reactions they experience while learning mathematics. Training in the theory of managing anxiety affected students can be given by the educational psychologist at the beginning of the semester for the lecturers in order to enable them to know who these students are in their classes and the therapeutic interventions that can be used in addressing these issues.

5.6.2 PRACTICE

With regards to Practice, mentoring/counselling can be implemented to identify the underlying factors that play a role in personal development, emotional and cognitive regulation as well as career choice and development of the students. All these can be reprocessed in the form of life experiential stories that will further assist others in future who may experience similar problems by having a better understanding of their perceptions and how to overcome such traits.

The Department of Education should endeavour to organise various seminars on a regular basis for the educators in schools on how best to handle such situations of anxiety burdened students in mathematics.

5.6.3 FUTURE RESEARCH

Although there has not been an effective impact of these aforementioned recommendations in South Africa, the following possibilities can be considered for Future research as suggested:

- There should be a comparative study where more than one case is investigated, preferably three or four higher institutions offering bridging mathematics (a mix of public and private higher institutions)
- The possibilities of including an equal ratio of participants from different countries not majorly South Africans, with different races and genders.
- The likelihood that good teaching is not always responsible for good success rates in mathematics among higher education students
- The impact that gender could have on the relationship between students' attitudes and emotional reactions to mathematics.
- Students' declining interest in mathematics beginning in primary school, to high school, and leading to Tertiary institutions in South Africa, is a reason for concern.

5.7 CONCLUSION

The effect of anxiety and lack of motivation on success rates in bridging mathematics was investigated in this research project and the findings were critically evaluated on the basis of a case study using private higher institution Pre-degree students for the 2012/2013 academic session. From this case study a mixed method research approach was used, combining quantitative and qualitative methods. It was observed that anxiety as a result of negative attitude and bad experiences in addition to lack of motivation (either intrinsically, extrinsically, or task oriented) have a potential impact on success rates in bridging mathematics among the students. We find that many pupils generate negative attitudes towards mathematics throughout the course of their academic lives, and on occasions present an authentic aversion to the discipline. For most pupils the subject is not a source of satisfaction, but rather one

of frustration, discouragement, and anxiety. Many of them, even some of the most able, find mathematics to be just a tiresome chore (Ignacio, Nieto, & Barona, 2006). It is confirmed that students who attributed success to intrinsic motivational factors were less anxious about mathematics; they had greater expectations of success, as they were more geared towards mastering the subject, being self-reliant and working independently for success. However, those who attributed their failure in mathematics to anxiety, bad experiences/negative attitude and extrinsic motivational factors (such as fear of parental apathy, peer pressure satisfaction etc.) were less oriented to mastering the subject, and they showed poorer academic performance.

The issue of teaching strategies was however not of a strong impact on success rates in bridging mathematics among the students as their lecturers were commended to be on top of the subject. To this end, the third hypothesis that was proposed earlier on in chapter 1, is rejected, that teaching strategies do significantly impact on success rates in bridging mathematics. Hence, the affective domain factors, students' anxiety, motivation and attitudes can enhance, inhibit or sometimes prevent active learning. Lecturers are therefore enjoined to be aware of these traits in their students and help them overcome it for improved performances in bridging mathematics.

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APPENDIX A

APPLICATION FOR CONDUCTING RESEARCH AT MIDRAND GRADUATE INSTITUTE

1 Blouhalk Street
118 Havana Estate
Celtisdal
Centurion

Date-----

The Principal

I, Samson Oluwaseun Sofowora, a student of the University of South Africa am pursuing a Masters' degree that specializes in Mathematics Education of which a part includes completing a significant and factual research project.

The purpose of my research project is to investigate how factors such as anxiety, lack of motivation, and possibly poor teaching strategies affect success rates in bridging mathematics (A case study of Pre-Degree students).

I wish to ask for permission to conduct this research within your institution of higher learning. In order for me to collect my data, I would need to do the following

- To interview 120 low performing students (repeaters in particular) of bridging mathematics module, and 5 lecturers during the month of August to September, 2013.
- Observe these special 120 students during their normal class lessons to see how they are actively involved in the process of learning mathematics. All the necessary arrangements have been made regarding the research (to this end all ethical issues have been considered and precautions have been taken to prevent any unfair or unethical practices. All information will be handled in strict confidence).
- To guarantee that the names of the lecturers, students of this tertiary institution will not be mentioned in my research report and that the interviews with the students will be audio-taped and transcribed for reference and analysis purposes.

I would appreciate it, if you would grant me permission to conduct the research at your institution.

Thank you for your attention.

Yours sincerely

SOFOWORA, S.O. (Researcher)
(0840344396).

Prof. Anne Dicker
Supervisor

APPENDIX B

INFORMATION/LETTER OF CONSENT

1 Blouhalk Street
118 Havana Estate
Celtisdal
Centurion.

Date-----

Dear student,

RE: ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATES IN BRIDGING MATHEMATICS (A CASE STUDY OF PRE-DEGREE STUDENTS).

I, Samson Oluwaseun Sofowora, a student of the University of South Africa am pursuing a Masters' degree that specializes in Mathematics Education of which a part includes completing a significant and factual research project.

The purpose of my research project is to investigate how factors such as anxiety, lack of motivation, and possibly poor teaching strategies affect success rates in bridging mathematics (A case study of Pre-Degree students).

This letter is to inform you that you have been purposefully selected to take part in the research that is being conducted at your institution. The research will form part of my Master's degree that specialises in Mathematics Education. To this end,

- The aim of the project will be to clarify how some psychological terminologies (for example anxiety and motivation) and teaching strategies deal with your academic performance in bridging mathematics at the school and your schooling experiences in general.
- the research is voluntary and should not take more than 20-30 minutes. If you do not want to take part in the research because of any of these issues that I have made known to you, you can withdraw at any time. Your choice to withdraw will not result in any consequences. All information will be handled in strict confidence.
- Your name will not be used in the research report. Your interview will be recorded and transcribed for reference purposes. I would like to also let you know that my project supervisor will be given all the data obtained from you for safe keeping for a period of about 10 years.
- To get in contact with you, your lecturers' one on one will call you privately to book an appointment with you to participate in the interview after your normal lecture hours. If you have any questions or concerns regarding the research please ask

Once again, your confidentiality is strictly held in high esteem. If you feel uncomfortable to proceed before, during or after any of the sessions, please feel free to say so.

Yours sincerely

SOFOWORA, S.O
RESEARCHER
0840344396

PRINCIPAL

✂-----

I, _____ in year _____ hereby agree to take part in the research that will be conducted at the school regarding the impact of anxiety and lack of motivation on the success rates of students in bridging mathematics.

Student Signature and cell number

Date

APPENDIX C

INFORMATION/CONSENT LETTER TO PARTICIPATE IN MASTERS' RESEARCH

1 Blouhalk Street
118 Havana Estate
Celtisdal
Centurion

Date-----

Dear Lecturer,

RE: ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATES IN BRIDGING MATHEMATICS (A CASE STUDY OF PRE-DEGREE STUDENTS).

I, Samson Oluwaseun Sofowora, a student of the University of South Africa am pursuing a Masters' degree that specializes in Mathematics Education of which a part includes completing a significant and factual research project.

The purpose of my research project is to investigate how factors such as anxiety, lack of motivation, and possibly poor teaching strategies affect success rates in bridging mathematics (A case study of Pre-Degree students). To this end,

- This research becomes necessary now as we need to ascertain the likable causes for poor performances in Mathematics at the Pre-degree level
- There are such psychological factors (anxiety & motivation) in addition to teaching strategies that have had great impact on students' poor performances in mathematics, and the management of these factors will help our scholars in South African Higher education and overseas to better their understanding of mathematics as a subject not to be scared of.
- We hope that the results of the study will be used in further advancing the achievements of the entire school, the lecturers inclusive.
- The name of the school and the names of all the participants will remain strictly confidential. We wish to point out that despite one's effort to maintain absolute confidentiality and anonymity; there is hardly any qualitative study that can guarantee absolute confidentiality. Your name will not be mentioned in the course of writing this research report; a pseudonym (false name) will be used to replace your real name.
- During class observation, the goal is not to evaluate your practice as a lecturer, but to have a better understanding of how learning of mathematics takes place in your class. In addition, we would not give your lecture notes/PowerPoint presentation to any authority concerned.
- There will be a maximum of 5 lecturers in the focus group interviews in which you are being invited to attend. This group of 5 lecturers (4 from Pre-degree and 1 from the Science/Engineering department) will be separately interviewed in a focus group interview session for a time limit of between 20-30mins.
- Be informed that, should you feel uncomfortable about divulging certain information, you are free to request that the tape recorder be switched off and your request will be honoured. Similarly, should you at any time feel uncomfortable about the research; you are free to opt out.

Thank you so much.

SOFOWORA, S.O.
RESEARCHER
0840344396

PRINCIPAL

✂-----

I, _____ lecturer of _____
for year _____ hereby give my permission to take part in the research being conducted at
the tertiary institution.

Lecturer

APPENDIX D

AGREEMENT TO UPHOLD CONFIDENTIALITY BY PARTICIPANTS IN THE FOCUS GROUP

Address:

Subject: RE: Focus group confidentiality form

Research Title: Anxiety and Lack of Motivation As Factors Affecting Success Rates In Bridging mathematics (A Case Study Of Pre-degree Students).

I hereby undertake to keep any information discussed in the focus group for this research confidential, and I undertake not to reveal any such information to any person outside the group.

(Signature)

(Date)

(Print Your Name Here)

**RESEARCHER:
SAMSON O. SOFOWORA
(0840344396)**

APPENDIX E

INFORMATION/CONSENT LETTER TO PARTICIPATE IN MASTERS RESEARCH

1 Blouhalk Street
118 Havana Estate
Celtisdal
Centurion.

Date-----

Dear head of faculty/Programme,

RE: ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATES IN BRIDGING MATHEMATICS (CASE STUDY OF PRE-DEGREE STUDENTS).

I, Samson Oluwaseun Sofowora, a student of the University of South Africa am pursuing a Masters' degree that specializes in Mathematics Education of which a part includes completing a significant and factual research project.

The purpose of my research project is to investigate how factors such as anxiety, lack of motivation, and possibly poor teaching strategies affect success rates in bridging mathematics (A case study of Pre-Degree students). To this end,

- I would like to learn about the impact of anxiety, lack of motivation and possibly poor teaching strategies on students' successes in bridging mathematics. I feel that there are such psychological factors (anxiety & motivation) in addition to teaching strategies that have had great impact on students' poor performances in mathematics.
- The management of these factors mentioned above will help our scholars in South African Higher education and overseas to better their understanding of mathematics as a subject not to be scared of. More importantly, we hope that the results of the study will be used in further advancing the achievements of the entire school.
- The name of the school and the names of all the participants will remain strictly confidential. We wish to point out that despite one's effort to maintain absolute confidentiality and anonymity; there is hardly any qualitative study that can guarantee absolute confidentiality. Your name will not be mentioned in the course of writing this research report; a pseudonym (false name) will be used to replace your real name.
- There will be a maximum of 2 faculty heads in the focus group interviews, of which you are being invited to attend for a time limit of between 20-30 minutes.

Please be informed that, should you feel uncomfortable about divulging certain information, you are free to request that the tape recorder be switched off and your request will be honored. Similarly, should you at any time feel uncomfortable about the research; you are free to opt out.

Thank you so much.

SOFOWORA, S.O.
RESEARCHER
PRINCIPAL
0840344396

✂-----

I, _____ head of faculty of _____
hereby give permission to take part in the research being conducted at the tertiary institution.

Head of faculty

APPENDIX F (QUESTIONNAIRE)

RESEARCH TOPIC: ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATE IN BRIDGING MATHEMATICS

INTRODUCTION: A word of appreciation to anyone taking time to complete this questionnaire. The researcher wishes to thank you in advance for your input in making this research a reality. The questionnaire is drafted in both qualitative and quantitative form. It is divided into one qualitative section and five quantitative sections. A Likert scale has been used with a wide range of 1 to 5; 5 being *strongly agreed* and 1 being *strongly disagree*.

WHY STUDENTS FAIL BRIDGING MATHEMATICS AT THE PRE-DEGREE LEVEL

It has been observed that some students still fail bridging mathematic even after giving all the necessary assistance by their lecturers coupled with the learning resources and extra tutoring given at the pre-degree level. The central question to the research is evaluating the effects of major factors such as anxiety, lack of motivation, and possibly poor teaching strategies on these students' poor performances in Bridging Mathematic.

Response Format: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5= Strongly Agree

Instruction: Please tick the suitable box in the questionnaire below

A	Learning Attitude / Experience in Mathematic at early school years	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.1	Mathematic as a subject during my Primary & High School years was my least favourite					
1.2	I have always struggled with anything that involves numeracy from my Primary School days.					
1.3	My performances in Mathematic during my early school years was hardly above average					
1.4	I often don't look forward to Mathematic' lesson periods because it bores me.					
1.5	I feel Mathematic Literacy during my high school years was easier to understand compared to Mathematic					
1.6	Mathematic during my early school years has never been interesting due to my teachers' negative attitude to teaching the subject					

B	Anxiety affecting Students' Mathematic performance	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.1	I find bridging mathematic interesting					
1.2	I get uptight during bridging mathematic test					
1.3	I think that I will use mathematic in the future					
1.4	I am unable to think clearly whenever am doing my bridging math test					
1.5	My mind goes blank whenever am doing my bridging mathematic test					
1.6	Bridging mathematic relates to my day to day life					
1.7	I worry about my ability to solve Math problems					
1.8	I get a sinking feeling when I try to do bridging mathematic problems					
1.9	I find bridging mathematic challenging					
1.10	Bridging mathematic generally makes me feel nervous					
1.11	I would like to take more Math classes					
1.12	Bridging mathematic makes me feel uneasy					
1.13	Bridging mathematic is one of my favourite subject					
1.14	I generally enjoy learning mathematic					
1.15	Bridging mathematic makes me feel confused					
C	Mathematics Motivation (Intrinsic Goal Orientation)					
1.15	In bridging mathematic class I would like to have some challenging materials that would make me as a student to learn more.					
1.16	My biggest wish as a student is to understand the content of the learning material in a mathematic class					
1.17	In bridging mathematic class, I would like to have more projects and questions' homework which will help me learn more, even though this would not improve my scores					
1.18	Learning mathematic as a student can improve my logical thinking					
1.19	To get better score in mathematic I will work harder					

D	Mathematics Motivation (Extrinsic Goal Orientation)	Strongly	Disagree	Neutral	Agree	Strongly Agree
1.20	My desire is to get better grades in my bridging mathematic					
1.21	I believe I can get higher grades in bridging mathematic than my classmates					
1.22	I want to get higher scores in Bridging mathematic class because I want to demonstrate my capability to my other classmates					
1.23	My wish is to offer a Math related course (e.g. Engineering, Accounting, Computer Science, e.t.c.) in my degree programme here at MGI					
1.24	I like to have higher grades in bridging mathematic in order to get other peoples' recognition.					
E	Mathematics Motivation (Task Value)					
1.25	The skills I learn from the bridging mathematic class can be applied in other classes					
1.26	I am always interested in the learning material in Bridging Mathematic class					
1.27	I feel the learning materials or topics in Bridging Mathematic are useful					
1.28	I like every topic and content in Bridging Mathematic class					
1.29	What I learn in Bridging Math class can be used in daily life					
1.30	My poor performance in Bridging mathematic test negatively affect my morale to study harder					
F	Teaching Strategies in Math					
1.31	My Bridging Mathematic teacher/lecturer is always well prepared always for his/her lessons as can be noticed in his/her execution of the topic in the classroom.					
1.32	My lecturer's method of teaching Bridging Mathematic is good enough and needs no improvement.					
1.33	My poor performance in Bridging mathematic is as a result of my lecturer's ineffective teaching strategy.					
1.34	Bridging Mathematic' materials for learning (e.g. study guides, textbooks) are explanatory enough for success.					
1.35	Lecturers' lack of patience to encouraging struggling students in mathematic classes makes them feel uncomfortable as to dislike the subject.					
1.36	Teachers/Lecturers should use at least more than one approach to teaching most topics in bridging mathematic especially when students are struggling to understand.					
1.37	My bridging mathematic lecturer cannot explain mathematic concepts easily enough for me to understand.					
1.38	Lecturers should always adopt the 'show and tell" approach to solving mathematical problems.					

RESPONDENTS' BIODATA:

1. Race : White Coloured
Black Indian
2. Gender : Male Female
3. Age : 15 – 19 yrs 19 – 24 yrs 25yrs and above
4. Nationality:.....
5. Proposed field of study (Degree) :.....
6. Matric Year:
7. Best subject in High School:.....
8. Worst subject in High School:.....
9. Hobbies
10. Which type of high school did you attend?(Rural, suburban or city school)
.....
11. Did you offer Mathematic or Mathematic Literacy at grade 12 during your matric exams.....
12. Give a reason why you offered your choice of mathematic in 11) above
.....
.....

APPENDIX G

INTERVIEW QUESTIONS FOR RESEARCH ON ANXIETY AND LACK OF MOTIVATION AS FACTORS AFFECTING SUCCESS RATES IN BRIDGING MATHEMATIC (A CASE STUDY OF PRE-DEGREE STUDENTS).

Section A (Pre-Degree Students Only)

1. How do you see Bridging Mathematic as one of your pre-requisite courses to your degree programme here at MGI? Do you think it is necessary?
2. Have you ever had a bad experience with Mathematic in some time in the past? How was it?
3. Did any of your past teachers in Mathematic (either at Primary or High school) ever made you to dislike the subject? If so, how?
4. Why do you think most students are not motivated to want to do Mathematic related courses here at the University?
5. What in your opinion do you think will motivate students to desire to want to do Mathematic related courses and pass them?
6. How in your opinion would you rate the standard of our Mathematic study materials (e.g. study guides, textbooks, past questions e.t.c) at the Pre-degree programme here at MGI?
7. Do you think Mathematic Lecturers should teach you more than one method of solving a problem and allowing you to make your choice, or you feel it may be asking for too much thereby leading to confusion?
8. Have you ever at any time liked Mathematic? If so, what caused it?
9. What in your opinion do you think our Math Lecturers are not doing to bring out the best in their students?
10. Do you agree that boys are more intelligent in Math than girls? If so, why?

Section B (Bridging Mathematic' Lecturers Only)

1. Could you please introduce yourself briefly, your ***name (optional), Nationality, Career or Profession, year(s) of teaching experience, highest qualification degree, years of lecturing at MGI e.t.c.***
2. How would you describe your teaching style to bridging mathematic in class here at MGI?
3. What level of intelligence on the average would you place most of our Mathematic students here at the Pre-degree programme? (*Use options in 2 above*)
4. What teaching strategies in your own opinion should we adopt as lecturers at the Pre-degree level to help struggling students in 'Bridging Mathematic'?
5. How would you as a Lecturer help a 'Math anxiety' student in your class to change their attitude positively towards math.
6. What steps would you take as a lecturer to help your students' develop interest in problem solving in order to improve their abilities in mathematics?
7. Do you think assessment by means of class tests, assignments, and exams are the best ways of determining the strength of your students' knowledge in mathematic, YES or NO? (give us reasons)