CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

According to Brink (1999), the aim of data analysis is to reduce and synthesise information to make sense out of it and to allow inference about a population, while the aim of interpretation is to combine the results of data analysis with value statements, criteria, and standards in order to produce conclusions, judgements and recommendations. The methods used to process the results, together with the methods used to analyse and interpret results, are discussed in this chapter. Initially the research design is described. This is followed by stating the population, the sample and sampling procedures. The chapter also outlines the methods of data collection and the plan for data analysis. Lastly issues related to the reliability, validity and bias are discussed.

3.2 RESEARCH DESIGN

According to Cormack (1996), the research design represents the major methodological thrust of the study, being the distinctive and specific approach, which is best suited to answer the research questions. The research questions, the aim and the objectives of the study thus influence the selection of the research design (Brink, 1999).

The purpose of the research design, as stated by Burns and Grove (2001), is to achieve greater control of the study and to improve the validity of the study by examining the research problem. In deciding which research design to use, the researcher has to consider a number of factors. These include the focus of the research (orientation or action), the unit of analysis (the person or object of data collection) and the time dimension (Bless & Higson-Smith, 1995).

In order to obtain a full picture of the factors that facilitate achievement in mathematics in historically disadvantaged schools, I have made use of triangulation. This is the process

whereby data is obtained from as many different sources as possible, using more than one method to secure the data. In this regard this study was conducted in three phases involving qualitative and quantitative data in the form of:

- Six weeks of classroom observations and interviews with teachers (**Phase 1: qualitative data);**
- Focus group interview sessions with learners (**Phase 2: qualitative data**);
- Questionnaires for both teachers and learners (**Phase 3: quantitative data**).

All three phases will be discussed in detail in section 3.7

3.3 RESEARCH QUESTIONS

The objective of the study is to trace factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. There are several factors that facilitate achievement in mathematics that relate to the learners, the teachers, difficulty of the subject, the curriculum, school, society, and learning and instructional methods. Based on this objective and following the review of the related literature, five main research questions and their hypotheses were constructed as follows:

RESEARCH QUESTION 1

What are the attitudes and competencies of mathematics teachers in high-performing and in under-performing schools?

Question 1 of this study focuses in particular on the role of the teachers as agents of mathematics facilitation, their qualifications and background, the teachers' way of teaching and their ideas about mathematics, its value and usefulness, and what they consider as vital in mathematics teaching, particularly in Grade 12 classes. The question also investigates teachers' attitudes towards their learners and towards teaching in general as well as their explanations of learners' successes and/or failures in mathematics.

RESEARCH QUESTION 2

What are the learners' attitudes towards mathematics and their perceptions of their successes and / or failures in mathematics?

Question 2 of this study is particularly concerned with establishing learners' affinity for mathematics, their future plans, perceptions of mathematics, beliefs regarding mathematics and its usefulness, beliefs concerning success and failure in mathematics, and most importantly the role of peer influences in mathematics.

RESEARCH QUESTION 3

What factors facilitate successful classroom practices in mathematics in Grade 12 schools?

Question 3 of this study focuses on establishing the way in which classroom practices promote positive or negative mathematics beliefs for achievement and persistence.

3.4 SAMPLING OF SCHOOLS

The participants in this research were grade twelve teachers and learners from historically disadvantaged schools from similar socio-economic backgrounds. Gender was not considered. Ten rural schools in Limpopo (Vhembe District) participated in the study. All of them were government schools. Although this was a convenience sample, with schools selected on the basis of their accessibility and performance, all schools were from the Vhembe district, and represent high-performing schools (HPS) and low-performing schools (LPS) in mathematics. Five high-performing schools and five low-performing schools participated in the study.

3.5 DEFINING THE SAMPLE

For the purpose of this study a purposive or judicious sample was used. This type of sample is based entirely on the judgement of the researcher in that a sample is composed of elements that contain the most characteristic, representative or typical attributes of the

population (Neuman 1994; Strydom & De Vos, in De Vos, 2001). In this regard all schools were located in historically disadvantaged communities.

3.6 ORGANISATION OF THE STUDY

The study was conducted in three phases. The first and the second phase were concerned with a qualitative design and the third phase of data collection with a quantitative design. In the following section I outline a brief overview of some characteristics of qualitative and quantitative research methodology and their benefits to the current study, followed by an explanation of why triangulation was the important choice for the research design.

3.6.1 Qualitative research methodology

McMillan and Schumacher (2001) outline the following characteristics that define qualitative research. They are:

- Explicit description of data collection and analysis.
- Detailed description of the phenomenon.
- Inductive reasoning applied to evidence gained from sources.
- Synthesised interpretation.
- Extensions of understandings by others.

Creswell (1994:150) lists the advantages of using qualitative research methodology as follows:

- The researcher has firsthand experience of the participant during observation.
- Information can be recorded as it occurs during observation.
- The researcher can control the line of questioning in an interview.
- Qualitative research is value laden.
- Unusual aspects can be noted during observation.
- It saves the researcher transcription time.
- The participants can provide historical information.

It needs to be stated that we do not fully agree with all of these claims. For example, transcription can take much more time than the primary data.

In the qualitative part of this research classroom observations, focus group interviews and individual interviews for teachers were used. The various steps included in the three phases of qualitative data collection of this study design were as follows:

- **Phase 1:** Six weeks of classroom observations and interviews with teachers
- **Phase 2**: Focus group interview sessions with learners
- **Phase 3**: Questionnaires for both teachers and learners

3.6.1.1 Phase 1

3.6.1.1.1 Part 1: Classroom observation

According to Moyles (2003) one area that has important implications for the improvement of teaching and learners' achievement is the use of classroom observation methods to investigate processes and behaviour that actually occur in classrooms. Some of the major strengths of using classroom observations are that they:

- permit researchers to study the process of education in natural settings,
- can be used to stimulate change and verify that the change occurred (Anderson and Burns, 1989).

The descriptions of instructional events that are provided by this method have also been found to lead to improved understanding and better models for improving teaching (Good and Biddle, 1988).

In this regard of classroom observation was conducted in four schools for six weeks. Two of the schools were high-performing and two were low-performing. The classroom observations were limited to four schools to permit repeated observation and comprehensive interviews with each of the teachers observed. While recognising that selection of these four schools and teachers limited my ability to generalise to other populations, I believe that the findings provide information for use by practitioners who work with learners from disadvantaged schools.

(a) Facts that were true in all the classrooms

In this section I wish to introduce the reader to the classrooms that I studied and the background characteristics of the teachers I have observed and worked with. The names of the schools and participants have been changed in order to preserve confidentiality. I observed six mathematics lessons in each classroom. This was done once a week for six weeks at times agreed on with the teachers. For each lesson I sat either at the back or the front of the class observing what was happening in the class and wrote observation notes that described the classroom activities. Some of the observations include:

- Learners solving problems on the chalkboard
- Teacher – learners interaction
- Learners helping each other in exercises
- Teacher attitudes towards learners
- Language used during discussions
- Teacher's mathematical knowledge

Details of the observation checklist are in Appendix C. Each learner in all four classrooms had a chair, table or a desk and the seating arrangement remained the same throughout the data collection period and, in fact, throughout the year. In three schools learners were not grouped according to standard grade or higher grade for teaching purposes. In only one school learners were grouped as higher or standard grade and kept in separate classrooms.

The typical school day in each of the schools began at around seven thirty in the morning. The first lesson began around 07:30 in all schools. All schools had a total of twelve periods, with four periods before short break (ten minutes) followed by four periods before lunch. The lunch break was half an hour. There were four periods after lunch in all schools. In most schools mathematics was taught during the early part of the morning, either during the first, second or third period. The reason for this, according to the teachers, was that learners are more alert and attentive to mathematics in the early parts of the day.

The following table shows days and topics observed in each school.

(b) Topics observed in each school

Table 3.1 Days and topics observed

Day/Topic	School A High-performing	School B High-performing	School C Low-performing	School D Low-performing
Day 1	Exponential functions	Quadratic equations	Logarithms	Sequence and series
Day 2	Nature of the roots	Trigonometry graphs	Distances and mid-points	Trigonometric ratios
Day 3	Curve sketching in calculus	Nature of the roots	Solving inequalities	Reduction formula
Day 4	Maxima and minima	Remainder and factor theorem	Geometry of the circle	Exponents revision
Day 5	Sine and cosine rules	Ratio and proportion revision	Application of differential calculus	Calculus curve graphs
Day 6	Mid-points and line segments	Height and distances	Exponents Revision	Maxima and minima

Six mathematics lessons were observed in each low-performing and six in each high-performing school in mathematics. For each group, two lessons were conducted in March, two in September and two in October. Two lessons in each school were video-taped. The videotapes focused on interactions between the teachers and the class. Lessons ranged from thirty-five to seventy minutes.

Attention was on the teacher-directed activity around the mathematical tasks, either with the whole class or small groups. The researcher was well known to both the learners and teachers as a result of the many visits. During the lessons when events were videotaped there was almost no interaction between me and the activities in the class. The learners and teachers were accustomed to supervisors from the teacher training college who make regular visits and observe, take notes, and put questions to their student teachers. This familiarity minimised distraction caused by my presence while my non-participation allowed for uninterrupted documentation.

I did the documentation of the observation using a video camera, a small JVC Handycam. The videotape method was chosen for documentation for two main reasons: firstly, it

allow for an extended period of time to analyse the data without losing any details. This helped to eliminate any premature categorisation scheme that would bias the observer in later observation (Erickson, 1986). Secondly, given the interpretative nature of the research, it allowed for sharing the total experience of the classroom lesson with other researchers who were not present at the time.

The four teachers were told that the videotapes would be analysed for research purposes but not used in any other way without their consent. The researcher's relationship with teachers and principals was one of trust, with all offering their full co-operation.

3.6.1.1.2 Part 2: Interviews with teachers

Interviews are one of the most important tools of qualitative research. When properly used, researchers often get a better response from these than from other data-gathering instruments. The reason for this is that people usually feel more comfortable talking than writing (Best & Kahn, 1998). In fact, it has been suggested that in unstructured interviews the interviewer is free to move the discussion in any direction of interest that may come up and that this technique is particularly useful for exploring a topic under discussion broadly (Trochim, 2002).

In addition to data classroom observation, unstructured interviews were held with four teachers involved. The objective of the interviews with teachers was to explore findings observed during the lessons.

In these interviews teachers were asked to respond in an open-ended fashion to the following issues.

- The most important factors that contribute to learners' good performance in mathematics.
- The most important factors that contribute to their learners' poor performance in mathematics.
- How teachers motivate learners in mathematics.

3.6.1.2 Phase 2: Focus group interviews

Focus group interviewing is described as a purposive discussion of a specific topic or a related topic, taking place between four to twelve people per group with a similar background and common interest (Cohen, Manion & Morrison, 2000). Traditionally focus groups were used in the business world and recently more often in psychology and education (Coker, 2003). According to Vaughn, Schumm, and Sinagub (1996:4)

> *One of the characteristics that distinguish focus groups from other qualitative interview procedures is the group discussion. The major assumption of the focus groups is that with a permissive atmosphere that fosters a range of opinions, a more complete and revealing understanding of issues will be obtained.*

According to Schurink and Poggenpoel in De Vos (1998:324) focus group interviews are useful for:

- Conducting research at a relatively modest cost and in a relatively brief period of time.
- Allowing the moderator to probe and create the flexibility that is so important for exploring unanticipated issues.
- Developing themes, topics and schedules for subsequent interviews and/or questionnaires.
- Providing speedy results.
- Shedding light on little-known phenomena and social processes.

Focus groups may develop concepts or theoretical explanations of what was observed (McMillan and Schumacher, 2001). Focus groups purposefully determine the perceptions, feelings and thoughts of participants. People are the product of their environment and are influenced by other people. Learners may need to listen to opinions and perceptions of other people, particularly their own peers, to become aware of factors that facilitate achievement in mathematics. The limited published research on factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools, in particular grade twelve makes the use of a focus group a practical method for this research.

According to Cohen, Manion and Morrison (2000: 288) the following should be considered when one conducts focus group interviews:

- Deciding on the number of focus groups for a single topic. One group is not enough.
- Over-recruiting by as much as twenty percent taking into account people who may not turn up.
- Keeping the meeting open-ended but to the point.
- Deciding on the size of the group. A group of four to twelve is suggested.
- Ensuring that participants have something to say and feel comfortable enough to say it.

Cohen, Manion and Morrison (2000) furthermore suggest that focus groups can either be used to triangulate with more traditional forms of interviewing, questionnaire and observation methods or as a stand-alone method of inquiry when conducting educational research.

In the following section I discuss the sample size and the homogeneity of participants.

Size and homogeneity of the groups: Three focus group sessions were conducted. A total of eighteen learners (twelve males and six females) from ten schools participated in the focus group interviews. Focus group interviews comprised only grade twelve learners and explored learners' experiences in the subject, focusing on issues observed in phase one and individual teachers' interviews concerning among other factors motivation, work patterns and help-seeking behaviour of learners. Homogeneity of the participants was considered in order to obtain a sample with a range of mathematical skills. In this regard teachers were requested to select learners according to their performances in the Grade 11 mathematics final examinations. One high-achieving learner (more than 75%), one middle-achieving learner (between 40% and 60%), and one low-achieving learner (less than 20%) were selected. If there were no learners who scored more than 75% in the schools chosen, then all three learners were correspondingly chosen on the basis of their examination rankings as compared with other learners in the class.

The first group consisted of six high-achieving learners, four of whom were also registered for the subject Additional Mathematics. The second group consisted of seven middle-achieving learners. The last group consisted of five low-achieving learners. I have been involved in teaching grade twelve mathematics, and was familiar with the organisation and teaching content of the subject. The selection of the learners according to their performance was only for the qualitative part of the study. Lastly, only subjects who were willing to participate in the study were chosen and gender was not relevant.

3.6.1.3 Data analysis of qualitative research

In qualitative research data, analysis begins during the process of data collection. The reasons are as follows:

- The results of early data analysis guide subsequent data collection, which plays an important role in data selection and reduction.
- Early data analysis allows timely theorising about results (Cohen, Manion & Morrison, 2000).

3.6.1.3.1 Steps in data analysis

The analysis of the interview data involved a systematic approach for discovering and categorising the ideas conveyed by the interviewee (Carlson, 1999). The first step in data analysis is the data-coding process. It is almost impossible to interpret data unless one codes them. Codes define categories, pooling a wealth of material into some order and structure. Coding is the process of dividing data into parts by using a classification system.

Different approaches may be followed with regard to data analysis. In this research Tesch's (in De Vos, 1998) approach and Strauss and Corbin's (1998) approach were used. Tesch's approach was adopted to analyse focus group interviews with learners and Strauss and Corbin's approach was used to analyse teacher individual interviews, as exposed subsequently.

3.6.1.3.2 Tesch's approach

Tesch (in De Vos, 1998: 343-344) proposes eight steps to consider in data analysis:

Step 1: The researcher ought to read the entire transcript carefully to obtain a sense of the whole and to jot down some ideas.

Step 2: The researcher selects one case, asks "what is this about?" and thinks about the underlying meaning in the information. The researcher's thoughts can be written in the margin.

Step 3: A list is made of all the themes or topics. Similar themes or topics are clustered together.

Step 4: The researcher applies the list of themes or topics to the data. The themes or topics are abbreviated as codes, which are written next to the appropriate segments of the transcripts. The researcher tries out this preliminary organising scheme to see whether new categories and codes emerge.

Step 5:The researcher finds the most descriptive wording for the themes or topics and categorises them. Lines are drawn between categories to show the relationships.

Step 6: The researcher makes a final decision on the abbreviation for each category and alphabetises the codes.

Step 7: The data material belonging to each category is assembled and a preliminary analysis is performed.

Step 8: The researcher recodes existing material if necessary (De Vos, 1998: 343-344).

3.6.1.3.3 Strauss and Corbin's approach

Strauss and Corbin's approach is the data analysis approach in which the first step is called open coding and the second step of data analysis is axial coding. According to Creswell (1998: 239) the researcher takes the categories of open coding and identifies one as a central phenomenon or idea, and asks the following:

- What caused this phenomenon to occur?
- What strategies are employed in response to it?
- What context (specific) and intervening conditions influenced the strategies?
- What consequences resulted from these strategies?

In this regard, the first phase of the analysis, referred to as open coding, involved a process by which the content of the interview was carefully searched for discrete instances of teachers' expression of concept or idea. Once the main idea/phenomenon was identified, the identified concepts are grouped according to their properties. After performing the Strauss and Corbin (1998) coding procedures a combined axial coding is performed on the collection of axial coding results. Once the categories were identified, they were given a name, to characterise their relationship to the main phenomenon or idea.

The analysis of individual interviews with the teacher was achieved by using Strauss and Corbin's (1998) open and axial coding techniques. For example, during individual interviews with teachers the teachers independently mentioned three items that contribute to their learners' achievement in mathematics. These items were later grouped into a single category by their common characteristics. The coding results provided a comprehensive summary of the contents of the collection of interviews. The following section is the discussion on how coding was conducted.

3.6.1.3.4 Data coding and categorisation of interviews

In this study I used categorisation to refer to noting the themes and patterns in the interview data. I identified themes from the interview data and from actions that were observed in the case of observation data. As I developed the themes, questions were constantly asked as to whether the information was relevant to the research question or not. For each theme developed, a code was given a label, for example, for sub-research question no. 2, "What in your opinion makes learners succeed in mathematics?", one of the themes the researcher found was "interest and devotion". A code Q2A to represent this theme was used, which indicated that this was an answer to question 2 and that it was the first theme that each of the learners and teachers seem to consider important. For each data set, the researcher labelled the narratives that referred to interest and devotion as Q2A.

In each case I was looking for similarities and differences in the data (Poggenpoel, 1998). The researcher noted only themes that were common in all cases and those that appeared only in some cases but not in others. I considered the information from each learner and teacher vital even if the theme did not appear in each data set. Special care was taken not to lose the richness in the narrative data from the interviews by relating the theme to the context (Poggenpoel, 1998). The researcher used "open coding" where each piece of data was coded into as many themes as it represented. Commonalities and differences were included for all four classrooms, across teachers and across learners to ensure that the "unique context of each case is retained, and the data interpreted within that context" (Poggenpoel, 1998). When coding the data there were more commonalities than differences in each group.

3.6.1.3.5 Processing interview data

Miles and Huberman (1994 in Cohen, Manion & Morison, 2000: 283) suggest the following tactics for generating meaning from transcribed and interview data:

- Counting frequencies of occurrence of themes
- Noting patterns of themes, which may stem from repeated themes
- Seeing plausibility - trying to make good sense of data, using informed intuition to reach conclusions
- Clustering-setting items into categories
- Identifying and noting relations between themes
- Building a logical chain of evidence-noting causality and making inferences
- Making conceptual coherence-moving from constructs to theories to explain phenomena.

For the purpose of this study data gathered from the taped interviews sessions, as well as from the focus group interviews, were analysed according to a combination of the aforementioned processes as follows.

In the case of each of the research questions

- I read the data from each set without writing anything down.
- I read the data a second time and noted the themes and patterns, in the interview data, that struck me as the teacher or learner answers to the research questions. I also noted the themes that emerged as characteristics of the teaching and learning process from the transcribed observation notes.
- I wrote down these themes as categories as they appeared in each data set. These themes were laid out on a chart so that the information from each case was visible. I then developed codes for these themes that were related to the research questions.
- Using the codes for each theme, I went back to the data sets and coded the relevant segments in each theme. I used open coding and consequently some segments had more than one theme.
- I prepared the codes for each theme and excerpts taken from each data set related to that theme. For example in each case of interview data, I included words that each teacher or each learner used in their answers to my questions.
- From the data (and based on the themes), I then wrote an answer to the relevant research question.

The results of this data analysis will be dealt with in Chapter 4. In the following section a discussion concerning the specific technique of questionnaire usage will be discussed.

3.6.2 Quantitative research

As described by McMillan and Schumacher (2001) quantitative research involves the following:

- Explicit description of data collection and analysis procedures.
- Scientific measurement and statistics used.
- Deductive reasoning applied to numerical data.
- Statements of statistical relevance and probability.

Having obtained data from the focus group interviews and classroom observations, it was important for me to confirm the research findings using a quantitative, non-experimental, descriptive method. The advantages of using a quantitative method were:

- Identifying and exploring factors that facilitate achievement in mathematics from traditionally disadvantaged secondary schools.
- Exploring and testing relationships.

In this regard, two questionnaires were designed to gather information regarding factors that facilitate achievement in mathematics. Information related to factors that facilitate achievement in mathematics from traditionally disadvantaged secondary schools was used to validate the results gathered from focus group interviews and classroom observation. Both learners and teachers were required to complete a questionnaire and the results were analysed quantitatively.

I first conducted a basic inquiry of international test users to determine whether a questionnaire measuring factors that facilitate achievement in mathematics in historically disadvantaged schools exists. The internet was also used in this regard. Due to the lack of a standardised South African Grade 12 mathematics questionnaire and direct applicability of the other questionnaires, I designed my own. In each questionnaire individual (or group of) items were analysed.

3.6.2.1 Phase 3

3.6.2.1.1 Questionnaire for learners

In order to investigate trends that were evident in the first phase of the research, the factors that were identified by learners and teachers were used to create the parallel questionnaires (one for learners and one for teachers). The items were selected on the basis of frequency from the initial surveys for phases one and two of the research. The questionnaires were administered to 366 learners. The survey developed for learners in this study consisted of 54 questions. See appendix A.

3.6.2.1.2 Questionnaire for teachers

The teacher questionnaire was constructed from the factors that were identified by teachers in the first phase of the study. The teacher questionnaire was administered to twenty six teachers in selected schools. The survey developed for teachers in this study consisted of 83 questions of which three were open-ended. See Appendix A.

3.6.2.2 Data analysis of quantitative research

Statistical analysis of data involved comparison of learners from high- and low-performing schools, and teachers' item responses. The following statistical tests were used during the analysis of the data:

The Chi-Square test is used to determine the statistical significance of factors that facilitates achievement in mathematics and other variables, using significant levels of 0.05 and 0, 01. For instance, if the probability of uncertainty (p value) was more than 0.05 ($p > 0.05$) the null hypothesis was rejected, while in the case of $p < 0.05$ the null hypothesis was not rejected at the 5% level. Where the p-value was less than 5% the results were accepted as statistically significant and where the p-value was found to be less than 1% ($p > 0.01$), the results were regarded as "highly significant" as advised by Burns and Grove (2001). Observed and expected frequencies are used to describe data. Frequencies are number of subjects or objects in the sample that fall into the various categories of the variables of interest. Frequency distributions are compiled in order to arrange data belonging to the same category. Frequencies, percentages and cumulative percentages are used to describe different variables, and allow for clear presentation of the data. The Phi coefficient test is used with the Chi-Square test to describe the effect sizes[2] (*id est*, magnitude effect of relationships between variables). According to Burns and Grove (2001), Phi-values range from -1 and +1, with the magnitude of the relationship decreasing as the coefficient near zero. In each of the columns on teachers' and learners' questionnaires (Appendix A) there were three possible answers to each question, which were either:

[2] [2] w=0.1: small effect size; w=0.2: medium effect size; w=0.5: large effect size (Ellis & Steyn, 2003).

- Regularly, Always or respondent Disagrees
- Occasionally, Neutral or Sometimes
- Never or Disagree

The weight given to each possible answer was as follows:

Regularly, Always or Disagree	3
Occasionally, Neutral or Sometimes	2
Never or Disagree	1

The data was fed into a statistical database for analysis and will be discussed in detail in Chapter 5.

3.7 TRIANGULATION (QUALITY ASSURANCE)

Neuman (1994) defines triangulation as the use of two or more methods of data collection techniques in order to examine the same variable. Triangulation implies that measurements improve when diverse indicators are used. As the diversity of the indicators increases, confidence in measurement grows, since obtaining indicator measurements from highly diverse methods results in greater validity. Triangulation techniques attempt to map out, or explain more fully the richness and complexity of human behaviour by studying it from more than one angle, thus making use of both qualitative and quantitative data.

According to Cohen and Manion (1997) triangulation is appropriate in the following instances:

- when a more holistic view of educational outcome is sought;
- where a complex phenomenon requires elucidation ;
- when different methods of teaching are to be evaluated;
- where a controversial aspect of education needs to be evaluated more carefully;
- when an established approach yields a limited and frequently distorted picture;
- where a researcher is engaged in a case study.

In this study a multiple triangulation method was followed in which qualitative and quantitative data gathering in the form of:

- six weeks of classroom observations and structured interviews with learners and teachers;
- repeated focus group interview sessions with learners;
- analysis of audiotapes and videotapes of some lessons and focus group interviews;
- questionnaires completed by both teachers and grade twelve learners were used to enhance the validity of the findings and to overcome any biases that might stem from a single method only.

The triangulation approaches that were employed in this study can be categorised into the following types:

(a) Data triangulation

Data triangulation is defined as the collection of data from multiple sources with the intention of obtaining diverse views on the phenomenon under study for the purposes of validation (De Vos, 1998).

Data triangulation was used for this study and data sources for the focus groups comprised Grade 12 learners and teachers. Data interviews were obtained from teachers and learners from well-performing schools and underperforming schools in mathematics. Burns and Grove (1997) assert that responses from such multiple data sources enhance the reliability of the research results.

(b) Methodological triangulation

Methodological triangulation is defined by Kimchi, Polika and Stevenson (1991: 365) *"as the use of two or more research methods in a single study"*.

For this study a qualitative approach in the form of classroom observation and focus group interviews were used in order to gain insight into the study, and findings of this approach were used to formulate an instrument for the quantitative approach. The main

advantage of using methodological triangulation in the present study was to increase convergent validity of the findings (Burns & Grove 2001). The integration of qualitative and quantitative methods can provide an extended understanding of the scope on factors that facilitate achievement in mathematics in historically disadvantaged communities and increase confidence when results are obtained.

(c) Space triangulation

Space triangulation attempts to overcome the limitations of studies conducted within one culture or subculture, as "not all the behavioural sciences are culture bound, they are subculture bound" according to Cohen and Manion (1997). Space triangulation was not used in this study as the research was conducted in the same country and within the same subculture, namely, Vha-Venda learners and teachers.

3.8 ISSUES TO CONSIDER WHEN USING TRIANGULATION PROCEDURES

Burns and Grove (2001) identify the following important issues when using triangulation procedures. They are:

- divergent results between numerical data and linguistic data can be interpreted;
- overlapping concepts that emerge from the data could be differentiated from one another;
- different method used should be considered equally sensitive and weighted equally;
- the problem of the study limitation.

One argument in support of blending qualitative and quantitative data in a single project is that they are complementary and represent the two fundamental languages of human communication, which are words and numbers (Polit & Hungler 1991).

It is with these thoughts in mind that the current research study has been designed. The methodological triangulation was used in order to offset limitations of using a single data-gathering method. Views from different groups were obtained, including learners and teachers from traditionally disadvantaged secondary schools.

3.9 QUALITY ASSURANCE: RELIABILITY OF THE STUDY

Reliability is the degree of consistency or dependability with which a research instrument measures the attributes it is designed to measure (Bush, 2002). Therefore reliability is concerned with the consistency, stability and repeatability of the informants' accounts as well as the investigators' ability to record information accurately (Brink & Wood 1998: 299). Babbie and Mouton (2001) suggest the following ways in which the reliability of a qualitative study can be compromised. These are:

- the observer' subjectivity;
- asking difficult questions and confusing the respondents;
- asking questions to which respondent has no answers;
- misinterpreting information from participants under observation.

In this regard De Vaus (2001: 31) sees unreliability in quantitative study as resulting from:

- different interviewers get different answers from different people;
- age, gender, class, and ethnicity influence responses;
- answers that are affected by mood and a particular context, and
- poor question wording

In this study reliability was enhanced by means of the following:

- Triangulation was facilitated.
- Teachers were used to select learners based on marks obtained in Grade 11.
- Different subgroups in schools were interviewed [learners (best achievers, average achievers and low achievers), teachers].
- For Phase 3 of this research, pretesting of the data collection instrument was done with six respondents who did not participate in the main study. A suitable time and venue were arranged. No one refused or failed to complete the questionnaire. The statements were discussed after the questionnaire was complete. The learners were most willing to offer comments as to how they each experienced the situation. The questionnaire took roughly 30 minutes to complete. It contains statements and instructions that were clear.

- Audio and a video recording as well as questionnaires were used as data collection methods in phase one.
- Some items from Steyn (2003) and Maree (1997) were used in phase three. Some are unaltered and some altered in the teacher and learner's questionnaires. Steyn (2003) and Maree (1997) found that in calculating reliability coefficients (Cronbach's Alpha) for their instruments were close to 1.
- Reliability was enhanced as learners and teachers, familiar with the topic under discussion, were able to supply answers to the questions that were asked.

3.10 QUALITY ASSURANCE: VALIDITY OF THE STUDY

Validity, as observed by Bush (2002), in research should be concerned with the accuracy and truthfulness of scientific findings. A valid study should demonstrate that which actually exists and a valid instrument should measure what it is supposed to measure (Brink 1991). Torn and McNichol (1998) advised that validity should be evaluated against four measures: the inter-rater validity, content validity, correctional validity and semantic validity.

In this study, the inter-rater validity was enhanced by inviting the statistician from the University of Pretoria's Department of Statistics to assist in the analyses of the research results. Content validity was enhanced by comparing the findings from interviews with literature reviews. Correctional validity was enhanced by comparing the findings from focus group interviews with those from unstructured interviews and questionnaires. These findings were found to be similar. Semantic validity was enhanced by the categories being mutually exclusive and exhaustive, as judged by the researcher and the statistician who was consulted after the unstructured interview schedule had been completed. In order to enhance the validity of this study, the following steps were taken:

- The literature was examined to identify variables to be delineated.
- The questions used for data collection were in line with the conceptual framework of the research and were found to take roughly 30 minutes to complete; contain statements that were easy to understand, and easy to fill in.

- Following the advice of Hall and Hall (1996) the instrument in Phase 3 of this research was taken to superiors in the University. The group consisted of statisticians from the department of Statistics from the University of Pretoria and my supervisors who examined each item of the questionnaire. They suggested a few minor changes and proposed the use of computerised marking facility.
- Due to the nature of the questionnaire, and acting on the advice of my statistician, we decided not to attempt to calculate the a-values.

3.11 BIAS OF THE STUDY

Bias is defined by Goddard and Melville (2001) as a systematic distortion of responses by the researcher, the respondents or by the instrument. In order to decrease bias, attempts were made to address this issue by means of the following:

- A comprehensive literature review
- A representative sample
- Verified statistical findings

3.12 ETHICAL CONSIDERATIONS

Ethical considerations are of the utmost importance when one is conducting research involving human participants (Goddard and Melville, 2001). It is incumbent upon researchers to design a study in which the principles of integrity, a respect for persons and justice are exemplified. The researcher accepts the assertion that research contributes to scientific knowledge and that human and technological advances are based on this knowledge. In particular, it is accepted that educational research should contribute to better the scholarship of teaching and the development of the learner.

According to Cohen, Manion and Morrison (2000) the following are the grounds on which informed consent may be established:

- Participants must be in a position, or old enough, to understand the choice that they are making and children need to have parent or guardian consent to participate.

- Disclosure of purposes of research.
- Disclosure of any risks to participants;
- A provision allowing participants to withdraw at any time.

In view of the above ethical considerations, I took the following steps:

3.12.1 Permission

Permission to conduct research in Vhembe district had been sought from the Regional Director. (Letters requesting permission and their replies can be found in Appendices A and B respectively). Permission for learners to take part in the study was obtained from the school principals, respective mathematics teachers and learners or learners' parents. The aims and objectives of the study were explained verbally to the learners by the researcher prior to their participation.

3.12.2 Appointments

The researcher posted or distributed letters personally to the principals of each selected school, followed by visits and appointments to conduct interviews or submit questionnaires (see Appendix A). Group meetings were held with the teachers and learners to explain the research project and the process. The researcher personally distributed the questionnaires to all schools with the help of the teachers.

3.12.3 Confidentiality

All respondents were assured of confidentiality by means of a written notice. Participants were given a pseudonym to protect their identities and to ensure confidentiality. At all times the learners were informed that they were free to withdraw from the study or not to answer any question if they so wished. Learners were assured of the confidentiality and anonymity of their answers and, in particular, that the information they provided for the research would not be divulged to their school and teachers at any time. Care was taken to ensure total confidentiality.

3.12.4 Consent

Written informed consent was obtained voluntarily without duress and coercion or bribery (Burns and Grove 2001) from the principals, teachers and parents of the learners or learners themselves of the participating schools (See Appendix B). The aims, objectives, methods, and duration of the research were described to the participants.

3.12.5 Data anonymity

The researcher assured all participants that all data collected would be destroyed after the data had been analysed and the research report compiled and finalised. No person, except the researcher, supervisors and the data analyst, would be able to access the raw data. Even the transcript of the raw data contained no names, only the numbers of participants.

3.12.6 Post-research relationships

The research report will be made available to the Special Collection Section of the University of Venda for Science and Technology and to the University of Pretoria where respondents could have access to it.

3.13 SUMMARY

Fouché (in De Vos, 2001) defines research design as a blueprint or detailed plan on how to conduct a research study. Thus a research design ensures that there is a structure for the manner in which data will be collected and analysed as well as the procedure to be followed. In this chapter the research design of the present study was addressed. Firstly the research design and research questions were exposed. Then the particulars of the research approach adopted for the study were given. The specifics of the research design were discussed dealing with ethical considerations, validity, subjects of the study and the data. Thereafter the details of the data collection procedures, the method of data collection procedures, the methods and the instruments as well as the data processing procedure were discussed.

In Chapter 4, I will provide, discuss and contextualise (*id est*., facilitate literature control with regard to) the results of the investigation.