CHAPTER 4
RESEARCH METHODS

4.1. Introduction

According to the Collins English Dictionary (2003), phenomenon can be described as the sense of something that can be seen as an occurrence, fact or condition. In this research study the phenomenon referred to is the sense that the condition of academic self-confidence can be linked to learners' ability to learn and do Mathematics. Within this chapter the methods used to do research on this phenomenon will be discussed in full and clear reasons for the choice of these methods will be given.

4.2. Research Methodology

4.2.1. Research paradigm

This research focused on understanding the existence of the research problem at the time, and searched for data and information that was valid and reliable in terms of the existence of this phenomenon. Ivankova *et al.* (2007:265) describe this as a pragmatic point of view. According to Creswell (2009:10), pragmatism comes from circumstances as well as the actions taken to deal with these circumstances and the consequences thereof. The pragmatism belief is that the world is not an absolute entity (Creswell, 2009:11). Ivankova *et al.* (2007:265) and Creswell (2009:11) agree that the reality is what "works at a time". Consequently reality is not an unchanging entity, and therefore the phenomenon was dependent on the individuals who participated in this research study (Nieuwenhuis, 2007a:65). It was decided to make use of a mixed research method by combining quantitative and qualitative research within a pragmatic approach (Mastenbroek & Doorenspleet, 2007:10). During the

course of the research, the views and opinions of learners were studied with regard to how they feel their self-confidence influences their ability to perform in Mathematics. This was done by means of questionnaires and interviews.

4.2.2. Research questions

The central question to this research study is:
What influence does academic self-confidence have on Mathematics achievement?

From this, the following sub-research questions are formulated:

- What is academic self-confidence?
- How does academic self-confidence influence the learning of Mathematics in particular?
- How does academic self-confidence influence the performance in Mathematics?
- What are the mathematical achievements of learners in the GET phase at the school used for the research study?
- Is there a link between the academic self-confidence level of learners at the school used for the research study in the GET phase and their mathematical achievements?

4.2.3. Literature review

In compiling the two literature chapters (Chapters 2 and 3), various sources were used to collect information on the two key components in this research study, namely academic self-confidence and mathematical learning and performance. These sources included the use of scientific books and academic articles as well as search engines on web databases such as EBSCO HOST, SABINET, ERIC and RSAT.

The key words used in the academic search included:

- Mathematics Learning
- Academic self-confidence
- Mathematical self-confidence
- Barriers to mathematical learning
- Mathematics frustration/anxiety

4.2.4. Research design

For purposes of this research study the researcher applied a mixed method approach, and consequently an explanatory design.

4.2.4.1. Mixed method approach

Creswell (in Ivankova *et al.,* 2007:263) defines a mixed method approach as a process for gathering, analysing and "mixing" both qualitative and quantitative information in a single study to better comprehend the research problem and draw clearer links between the variables. This approach was chosen to allow for the collection of numerical data from a number of learners by means of a questionnaire as well as conducting interviews (*cf.* 4.2.8) with some of these learners to enable her to obtain a deeper understanding of how they feel about the phenomenon. This assisted the researcher to compare and 'mix' the findings from the quantitative (numerical data) and the qualitative (interview transcripts) which in turn enabled her to answer the research problem. According to *Creswell* (2009:4), a mixed method approach helps to support and strengthen the findings of the overall study. Ivankova *et al.* (2007:263) affirms that quantitative and qualitative research approaches complement each other when used in a mixed method approach as they allow for a more complete and inclusive research analysis.

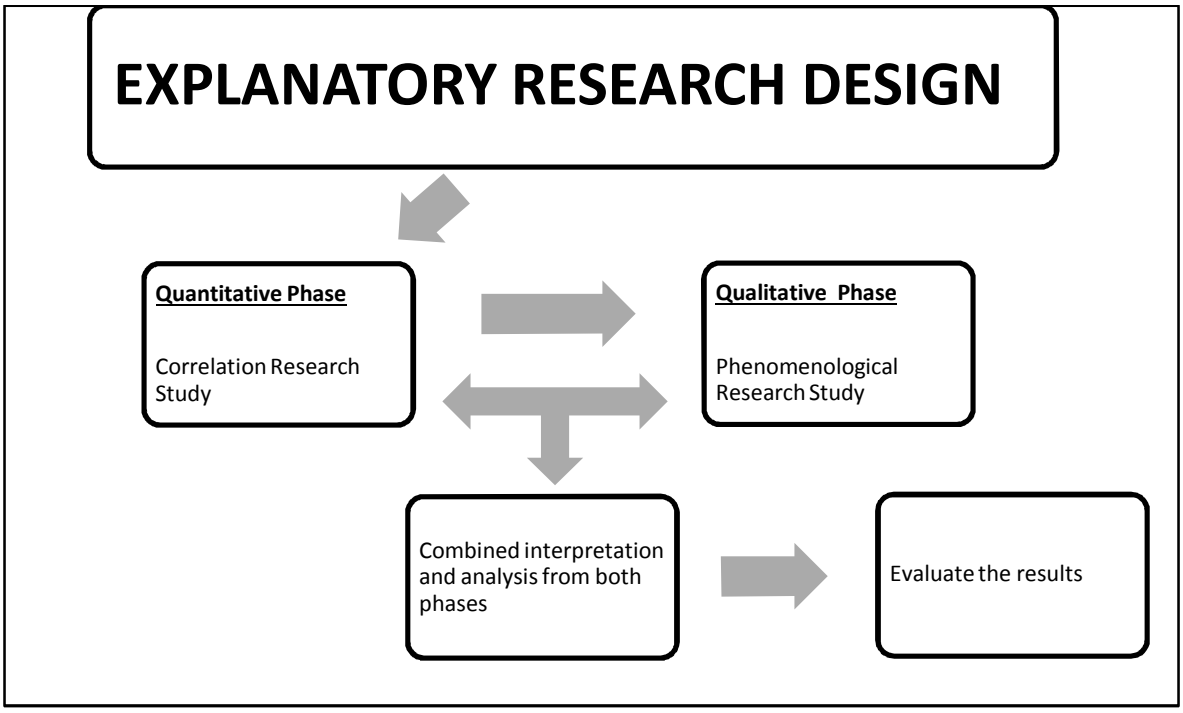
To better understand the concept of the mixed method approach, a closer look into the meaning of qualitative and quantitative research approaches was needed. Leedy and Ormrod (2005:94) define a quantitative research approach as a method used to answer questions about relationships between different variables and factors. In contrast, a qualitative research approach as being used to answer questions about the complex nature of a phenomenon by means of comprehending the phenomena from the perspective of the research participants (learners) themselves (*cf.* 4.2.4.4.1) (Leedy & Ormrod, 2005:94). Maree and van der Westhuizen (2007:39) state that mixed methods reduce the risk of chance associations as it relies on a diverse range of methods. In addition mixed methods can be used to improve the validity and reliability of the research by confirming and generalizing research findings and conclusions (Nieuwenhuis, 2007b:80).

4.2.4.2. Explanatory design

It was decided to collect and analyse quantitative and qualitative data in two consequential stages of the research study. Creswell (2009:209) as well as Ivankova *et al.* (2007:266) describe this process as an explanatory design. According to Ivankova *et al*. (2007:266), in the explanatory design, the qualitative results need to validate and clarify the quantitative results, therefore strengthening the findings. The quantitative results provide an overview of the research problem and the qualitative results need to clearly explain, refine and expand on the general quantitative findings (Ivankova *et al,* 2007:266).

In the following diagram the explanatory research design as employed in this study is depicted.

Diagram 4.1: Explanatory Research Design



4.2.4.3. Quantitative phase

4.2.4.3.1. Correlation research

For purposes of the quantitative research phase a correlation strategy of inquiry was followed. Leedy and Ormrod (2005:108) define a correlation research study as a statistical investigation of the relationship between two variables (*cf.* 5.2.2). The variables in this research study were academic self-confidence and the learners' ability to perform in and learn Mathematics. Correlations were drawn between the 4 themes of the research, namely emotional attitude towards own mathematical abilities, comprehension and application of mathematical concepts, solving mathematical problems and educator involvement (*cf.* 5.2.2.2), as well as between these themes and the learners' academic performances in 2011 (*cf.* 5.2.2.1). Correlation studies only look at the surface relationships and do not explore the reasons causing them. It examines the extent to which these variables are related. A correlation will exist if one variable increases while the

other also increases or decreases in a somewhat “predictable fashion” (Leedy & Ormrod, 2005:180).

A Lickert-scale type questionnaire was designed by the researcher herself to measure how confident these learners feel about their own abilities in Mathematics. Learners’ responses were anonymous; to encourage these participants to be more comfortable and truthful when answering questionnaires (Leedy & Ormrod, 2005:185). The content of the questions was directed by the literature review. After careful consideration of the implication, it was decided to use only four options, very confident, confident, less confident, and not confident at all, in order to exclude a neutral option, as the purpose of the study is to determine whether a learner’s confidence influences his ability to perform in Mathematics, and therefore a neutral option would not have enabled the researcher to distinguish between being confident or not (Leedy & Ormrod, 2005:186 and Mertler, 2006:105).

To ensure that the questionnaire could be easily understood and answered, a pilot run was conducted where eight Grade 11 learners and four teachers completed the questionnaire (see Addendum I). The Grade 11 learners were chosen because they have experienced the challenges of Grade 8, 9 and 10 Mathematics already. These learners and teachers did not form part of the study sample. After the teachers had confirmed that the questionnaire was well compiled and understandable and the learners had indicated that they did not experience any problems completing it, the questionnaire was finalised, and data was collected from the sample group.

The following procedures were followed for constructing the questionnaire (see Addendum H) (Leedy & Ormrod, 2005:190-192):

- The questionnaire was kept brief and to the point;
- easy and uncomplicated terminology was used;
- the researcher steered clear from unwanted assumptions;
- no clues were given to obtain a preferred response;
- tasks were kept simple for the learners;
- instructions were kept simple and clear for the learners;
- the purpose of the questionnaire was well explained before the learners completed the questionnaire; and
- the questionnaire was designed to appear professional

By following these procedures it was ensured that the questionnaire was valid. Leedy and Ormrod (2005:28) point out that validity of a questionnaire is determined by the extent to which it collects the data it is intended to collect.

The data gathered from the questionnaire was then compared with the learners in the sample group's mathematical achievement, in the form of their promotion mark for the previous academic year. This enabled the researcher to see whether any link existed between their academic self-confidence and their Mathematic performance.

The results were statistically summarized and presented in the form of tables to assist in interpreting the findings (see chapter 5). According to Pietersen and Maree (2007a:183), descriptive statistics can be used to categorize findings and thereafter summarize the raw data using tables. This enabled the researcher to visualize the findings and determine whether any correlation or relationship could be traced between academic self-confidence and mathematical learning achievement.

4.2.4.3.2. Validity and reliability

To ensure validity and reliability of the questionnaire, a pilot study was done in order to pick up on any unforeseen problems and/or misconceptions. In addition, the study supervisor and a psychologist was asked to verify the analysis of the data (*cf.* 4.2.6)

The quantitative data collected by means of the questionnaire was submitted to a statistician at the North-West University, Vaal Triangle Campus, to ensure accurate, valid and reliable statistical analysis. The statistician analysed the data using a computer software program called, Statistical Package for the Social Sciences (SPSS) version 20. A common factor analysis was done by considering the eigenvalues (Darlington, s.a.). By doing so the statistician and the researcher could determine how many important factors had arisen from the questionnaire. Weisstein (2012) explains that eigenvalues is a set of real numbers relating to vectors that form connections to characteristic values. Thus, in this research, it was determined that six factors had an eigenvalue greater than 1 (Petersen & Maree, 2007b:219 and Dalington, s.a.), indicating that these 6 factors had a significant function within the research. These six factors were then utilized to measure the correlation strength between the various factors as well as the participants' performances of the previous (2011) academic year. This was done by means of obtaining the Pearson Correlation Coefficient between the different factors and the participants' performances.

According to the statistical analyses of the data the reliability for the complete questionnaire was very good, with a case processing summary value of 98.9% validity and the Cronbach's Alpha coefficient of 0.901 (90,1%), showing an extremely high internal consistency.

4.2.4.4. Qualitative phase

4.2.4.4.1. Phenomenological research

Since the correlation phase only looked at the surface relationships between the two variables, academic self-confidence and mathematical learning and performance, a need arose to further explain and explore the relationship between these two variables. It was decided to make use of a phenomenological research study for the purpose of the qualitative research. Welman and Kruger (in Groenewald, 2004:5) believe that a researcher, using a phenomenological approach, is concerned with comprehending the psychological and social experience from the learners' points of view. Qualitative research is very valuable for gaining insight into the participants' experiences and the meaning thereof, as it is centred around these experiences (Leech & Onwuegbuzie, 2007:260). According to Creswell (2009:13) and Lester (1999:1), qualitative phenomenological research is a strategy used for investigating learners' experiences about a certain phenomenon as experienced and explained by the learners themselves.

The qualitative approach consisted of individual semi-structured, open-ended face to face interviews with 15 learners chosen at random from the sample group (*cf.* 4.2.7). The interviews were audio-taped with the researcher's notebook, which enabled her to transcribe each interview. According to Nieuwenhuis (2007b:87), an interview is a two-way conversation during which the researcher asks the learner questions to collect data. This data was then used to learn more about the learners' perceptions and experiences related to the phenomena. Additionally, Nieuwenhuis (2007b:87) states that semi-structured open-ended interviews take place as part of a conversation. During these conversations the researcher's intentions were to jointly explore the learners' views,

ideas, beliefs and attitudes towards their self-confidence levels influencing their ability to learn in Mathematics. The data gathered was then analysed and interpreted together.

The following steps were followed for the phenomenological research study as recommended by Leedy and Ormrod (2005:139-140):

- Data collection

  Leedy and Ormrod (2005:139) affirm that during phenomenological research studies the researcher has to make use of interviews with a carefully selected sample of learners. The aim of these interviews was to confirm or deny the findings from the quantitative research stage. The completion of this research study was in the hands of the researcher and the learners who participated in the interviews. A typical phenomenological interview mostly consists of the learner talking and the researcher listening to the learner's experiences, while recording the learner's responses, expressions and experiences (Leedy & Ormrod, 2005:139). In addition to the interviews, the researcher also observed the behaviour of the learners during the interviews and of the remaining participants in the sample group. Nieuwenhuis (2007b:84) mentions that observations can be used as a qualitative data collection technique. This enabled the researcher to gain a deeper understanding of the research phenomenon.

- Data Analysis

  The core task when analysing the qualitative data is to identify any similarities in the learners' descriptions of their own experiences. After having transcribed the interviews the researcher:

- Identified and categorized statements that related to the topic, therefore separating relevant- and irrelevant data;
- grouped relevant statements into categories that reveal various characteristics of the phenomena;
- searched for different perspectives by considering how different learners experience the phenomena; and
- created a composite by using the identified categories to describe the phenomena as most people typically experience it.

- Report writing

  There is no specific set method for reporting on a phenomenological study. In the report on the questionnaires and interviews the researcher described the data that have been collected, and then reported on all patterns and relationships formed regarding the phenomena. This enabled her to derive a conclusion and make recommendations with respect to what the possible influences of self-confidence on Mathematics could be.

4.2.4.4.2. Case study

Creswell (2009:13) and Nieuwenhuis (2007b:75) defines a case study as an inquiry strategy in which the researcher can do a comprehensive investigation into certain events which could explain the existence of a certain phenomenon. Within this research study the researcher did an in-depth investigation on the influence that academic self-confidence has on learners' ability to perform within Mathematics. The focus within the research was on a particular school in the Johannesburg north district which has a set subject choice that compels learners to take Mathematics in the FET phase. Nieuwenhuis (2007b:75) asserts that by making use of a case study the researcher could understand the dynamics

of the influence academic self-confidence has on these learners' performances within Mathematics better. The strength of this case study lies within the multiple techniques (questionnaires and individual interviews) used to gather data for the research (Nieuwenhuis, 2007b:76).

4.2.4.4.3. Trustworthiness, validity and reliability

Golafshani (2003:600) states that trustworthiness, validity and reliability should not be viewed separately during qualitative research, as truth can be revealed through means of validity and reliability, through which the researcher can have confidence in her findings.

To ensure trustworthiness for the qualitative research study, the following four principles were addressed as proposed by Guba (as quoted by Shenton, 2004:64):

- Credibility: In order to promote credibility, one needs to make the following provisions for the qualitative research study:
  - *To familiarise oneself with the participants before conducting the research*. The researcher is the Mathematics teacher of the research population and sample, and was therefore familiar with the participants and their mathematical abilities and achievement (*cf.* 4.2.5).
  - *To use a mixed method to confirm results*. Before conducting the qualitative part of this research, a quantitative study was also done (*cf.* 4.2.4.3). Thereafter the results from each of these studies were compared in order to establish whether any similarities or differences occurred within the results.
  - *To ensure honesty from participants*. Each of the participants, as well as their parents, was afforded

the opportunity to decline participation. Participants were encouraged to be forthright and honest from the start. The researcher ensured that the participants knew that there are no “right or wrong” answers, but that their views and opinions are important. Moreover the participants were informed of their anonymity. The participants were also informed that they could withdraw from the study at any moment without giving a reason for their decision.

- *To apply interactive questioning*. To uncover any intentional lies during the interviews, the researcher explored the participants’ answers by means of interactive questioning. This was done by frequently returning to matters that might have been raised previously by rephrasing the questions.
- *To inspect the research information and reflective feedback*. Opportunities for inspection of the project and results were created on regular bases to ensure feedback from the participants on the progress of the research project. Analysed information was given to the researcher’s study advisor, peers as well as an educational psychologist, from whom feedback was welcomed. This challenged any false assumptions that could have been made. This also gave some new perspective that might have been missed during the analyses.

- Transferability. Detailed theoretical background information on this phenomenon was given in the first three chapters of this research study so that comparisons could be made between the findings and those of the existing information.
- Dependability refers to the extent in which other researchers and/or people can trust that all necessary

measures required for an effective research project have been followed. Therefore an in-depth description of the research methodology is given in this chapter to allow for a repeat of this study.

- Confirmability. To confirm the results of the qualitative study a mixed method approach was used to lessen the effect of any false findings.

4.2.5. Researcher's role

The researcher had the following role, as recommended by Creswell (2009:177):

- Described all steps that the researcher has taken to gain entry to the research site and addressed ethical issues by requesting permission from all parties involved in this research study (*cf.* 4.2.9).
- Described the research site and the participants, by listing all connections between the researcher, the research site and the participants.
    - The researcher is a Mathematics educator within the school (research site) at which the research was done.
    - The researcher is the Mathematics educator for some of, however not all, the learners who participated in the research study.
- Employed strategies to ensure the validity and trustworthiness of the research data.
    - In the consent forms for the learners and parents, the research study was explained in full, and the importance of honesty was emphasised and that there were no right or wrong answers.
    - The researcher was not present when the questionnaires for the quantitative data were handed

out, so as to ensure that learners did not feel obligated to answer in a certain manner.

- A request was made that the educators who handed out the questionnaires was to highlight again that the learners should give their honest opinion.
- The participants were advised not to write their names on the questionnaire, to ensure anonymity. Instead, an identification code was requested so that the researcher could add in their continuous assessment (CASS), Exam and Promotion mark.
- The participants who took part in the interviews for the qualitative data were chosen by means of random sampling (*cf.* 4.2.7)

4.2.6. Psychologist's Role

For ethical reasons, an Educational Psychologist was asked to help assess, validate and confirm the results of the questionnaires and interviews, since an Educational Psychologist is qualified to assess learners' learning abilities and their emotional well-being. In addition, this also ensured that the analysis of the results was valid and reliable.

The role of the Psychologist in this research study is to:

- Ensure that the procedures used to collect the quantitative and qualitative data do not negatively influence the participants.
- Verify the result of the research analysis for both the quantitative and qualitative data.
- Identify any shortcomings in the analysis.

4.2.7. Population and sampling

The population used for this research study was all the learners in the General Education and Training (GET) phase (Grade 8 and 9) of a secondary school in Johannesburg North. The school is situated in Central Johannesburg, Crosby, and forms part of the D10 district in Gauteng. The school requested to stay anonymous. According to Govender (2009:3), this school was established in 1993 for learners from previously disadvantaged communities. Learners come from diverse cultural backgrounds. This school has a set subject choice, and therefore learners are compelled to take pure Mathematics in the Further Education and Training (FET) phase. Govender (2009:3) declares that the Grade 12 Mathematics results in 2009 of this particular school were among the top schools in South Africa.

The sampling method by the researcher for the quantitative data collection was convenience sampling. This sampling method was chosen as a result of the sample being easily and conveniently accessible (Maree & Pietersen, 2007b:177), as she is a Mathematics teacher in the school (*cf.* 4.2.5). The sample used included all willing GET phase learners of the said school, where data was collected by means of a questionnaire (*cf.* 4.2.4.3.1) that determined the learners' self-confidence levels. The sample comprised 215 learners that were asked to participate in the first stage of the research. A total of 190 learners from grades 8 and 9 agreed to participate in the research project, with consent from their parents.

For the qualitative data collection a sample was chosen using a purposive sampling method. This method enables the researcher to purposefully choose 15 interview participants with different performance abilities and achievement in Mathematics (Creswell, 2009:178).

Purposive sampling was done by compiling three lists using the whole GET phase of the school's learners' Mathematics promotion marks at the end of 2011, namely:

1. Poor Mathematics Achievements: All learners with marks below 50%
2. Average Mathematics Achievements: All learners with marks between 50% and 75%
3. Good Mathematics Achievements: All learners with marks above 75%

These three lists were then arranged in ascending order of the learners' Mathematics promotion marks. According to Leedy and Ormrod (2005:139), a typical sample size for a phenomenological research study is between 5 and 25 learners. Consequently a random sample of 15 learners, five learners from each list, was taken to ensure that learners with different mathematical abilities were included in the study, where after individual interviews were conducted with these learners (*cf.* 4.2.4.4.1).

After having compiled the three lists the following procedures were followed to choose five learners from each list (See Addendum J).

1. Poor Mathematics Achievements: A total of 23 learners were represented in this list: $23 \div 5 = 4{,}6$. Therefore the researcher used every 5th learner on the list. These participants were numbered 001; 006; 011; 016 and 022. However, 016 and 022 did not give consent to the interview and therefore the immediate next learner (namely 017 and then 023) was used for the interviews.
2. Average Mathematics Achievements: A total of 137 learners made were represented in this list: $137 \div 5 = 27{,}4$. Therefore the researcher used every 28th learner on the list; these participants were numbered 001; 029; 057; 085

and 113. However, 029 and 085 did not give consent to the interview; therefore the immediate next learner (namely 030 and then 086) was used for the interviews.

3. Good Mathematics Achievements: A total of 32 learners were represented in this list: $32 \div 5 = 6{,}4$. Therefore the researcher used every 7^{th} learner on the list. These participants were numbered 001; 008; 015; 022 and 029. All five of these chosen learners gave consent to the interview.

4.2.8. Data collection procedure

Before any data collection was done, permission was requested from all relevant parties to conduct the research (*cf.* 4.2.9). It was also made clear that participation was voluntary and anonymous. A literature review was conducted to gather existing information on the two key components (*cf.* 4.2.3). During the data collection the researcher decided to make use of a mixed method approach using an explanatory design. Consequently quantitative data was firstly collected from all willing learners (*cf.* 4.2.7) who were asked to participate in the research study by completing a Lickert-scale questionnaire designed by the researcher. The second stage took place where interviews were conducted with randomly selected participants (*cf.* 4.2.7) in order to collect qualitative data. During these interviews the learners' feelings were discussed regarding their academic self-confidence concerning Mathematics and their performances therein (*cf.* 4.2.4.4.1). The interviews were then transcribed and manually coded by the researcher. Copies of the coded transcribed interviews can be found in Addendum K.

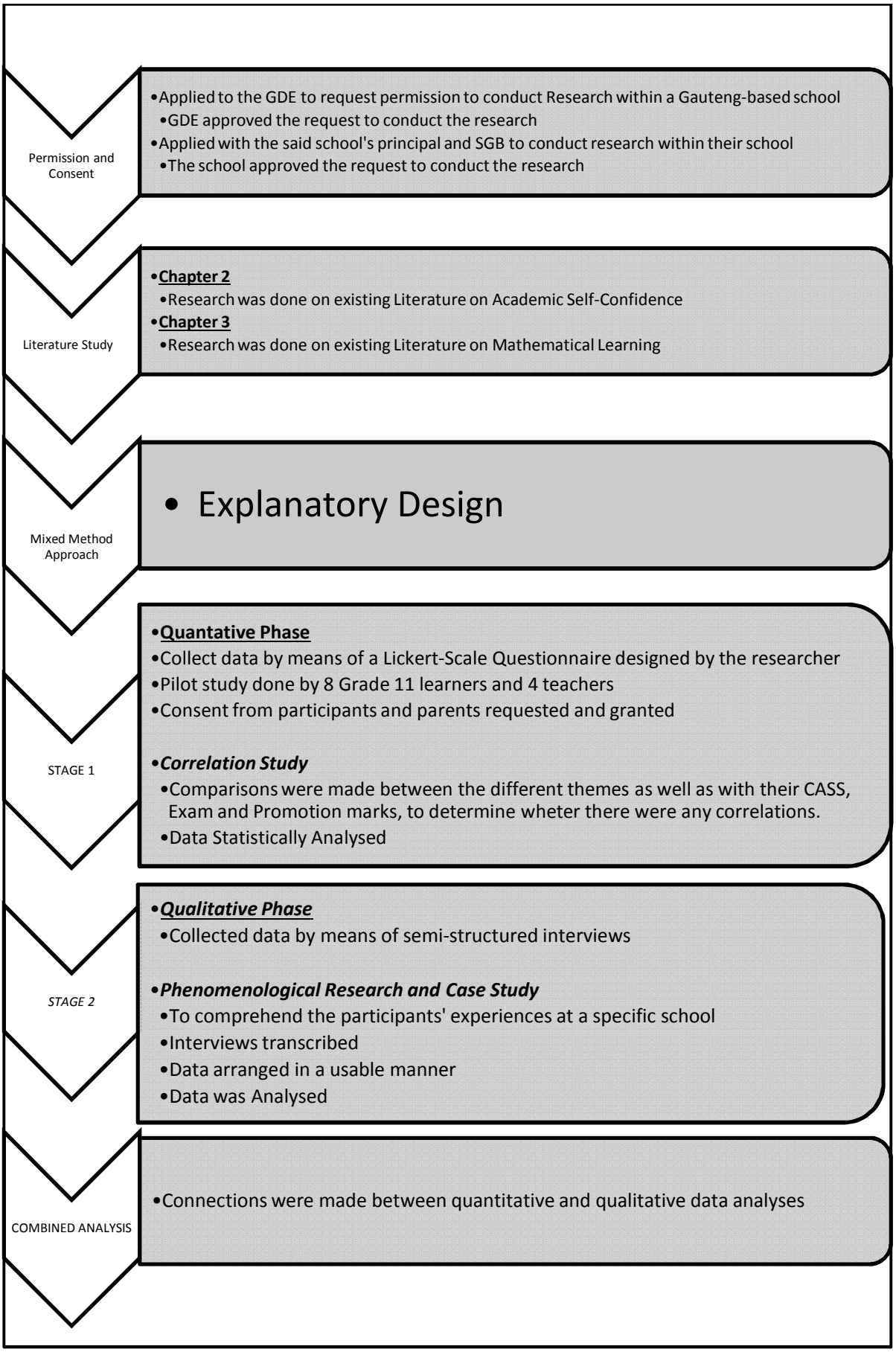
The following interviewing schedule was used during the interviews of the learners:

- How do you feel about Mathematics?
- How do you feel about your ability to do Mathematics?
- Do you believe that you can do Mathematics? Why?
- Do you think confidence influences your ability to do Mathematics? Why?
- How do you feel about your performance in Mathematics last year (2011)?
- How are you managing with Mathematics this year (2012)?
- When you are faced with a difficult problem, how does it make you feel? How do you cope with this?
- How does it feel when you solve difficult Mathematical problems?
- What do you do when you are struggling with Mathematics?
- Can you explain Mathematical concepts to your peers with confidence?

After these two stages had taken place the data collected was analysed and combined to formulate a sensible interpretation thereof.

The following diagram illustrates the research procedure followed before; during and after data collection was done:

Diagram 4.2: Research Procedure



4.2.9. Ethics

According to Creswell (2009:87), one needs to foresee ethical issues that may arise during the research study. During this research study data was collected regarding the learners' academic confidence levels and their experiences with regard to their ability to learn Mathematics (*cf.* 4.2.8). The researcher promoted the integrity of the research project by ensuring that all instructions for the data collection were clear and understood. She also constantly encouraged honesty.

Permission was obtained from all stakeholders in this research study (see Addendum D-G):

- The Gauteng Department of Education (GDE)
- The principal of the school
- The School Governing Body (SGB) of the school
- The parents of learners in the General Education Training (GET) phase, i.e. Grades 8 and 9.
- The learners in the GET phase

Participation in this research project was completely anonymous and voluntary. No learner was forced to participate unwillingly. All data collected was dealt with confidentially. An ethical application was submitted to the Ethics Committee of the North-West University and approved (see Addendum C).

4.3. Conclusion

In this chapter the methodology and reasoning behind the research methods and design were discussed. In the following chapter the quantitative and qualitative data will be analysed and interpreted, and a report will be given on the findings.