CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This is a four-year longitudinal study that follows a mixed method approach, in which qualitative methods are being complemented by quantitative ones. The chapter opens with a description of the sample and research design, followed by the instruments and methods of data collection and data analysis, with details of steps taken to ensure validity and reliability, and ethical considerations.

3.2 SAMPLE

Two neighbouring township schools were initially involved in the study. Both schools produced good matriculation results: school A had an average pass rate of 99% while school B had a 88% pass rate over the previous 5 years (2000-2004). These schools were purposively selected for good performance and convenient location for accessibility. All the grade 9 learners, totalling 417, participated in the data collection for the GET phase during 2005. For the FET phase, school A was selected for data collection in order to report on a best case scenario. This school was given an award in 2005, by the Member of the Executive Council responsible for Education in the Gauteng Province, for being the best school from a department of education to have previously served Blacks only under apartheid. In school A, 61 learners chose to continue with Physical Science in grade 10. This group of 61 learners from school A was used for data collection in the FET phase. Attrition further reduced the FET group to 40 learners by the time they reached grade 12.

3.3 RESEARCH DESIGN

According to Mouton (2001), case studies are usually qualitative in nature and aim to provide an in-depth description of a small number of cases. Unlike the experimenter who manipulates variables to determine their causal significance, or the surveyor who asks standardised questions of large representative samples of individuals, the case study researcher typically observes the characteristics of an individual unit, e.g. a class or a school (Cohen & Manion, 1994). A case study cannot rely on a single data collection method but requires multiple sources of evidence (Yin, 2003). As this was a case study of learners in transition from the GET band to the FET band, various instruments, qualitative as well as quantitative, were used. Data sources included curriculum documents, the 2005 grade 9 national examination (CTA), lesson observations, an interest questionnaire, a questionnaire on the Nature of Science, a chemistry diagnostic test, the 2007 grade 11 examination results, and interviews.

The research design is diagrammatically represented in Figure 3.1. It adopted a mixed quantitative and qualitative approach to follow closely the learners' experiences and reflections on their experiences during the critical period of transition. A group of learners were followed from grade 9 into the FET band. Qualitative and quantitative data were collected from the cohort and from eight individual learners. It was intended that the interviews with individual learners would provide the fine-grained detail necessary to describe and interpret the changes associated with transition, while the group data would allow these interpretations to be placed in context.

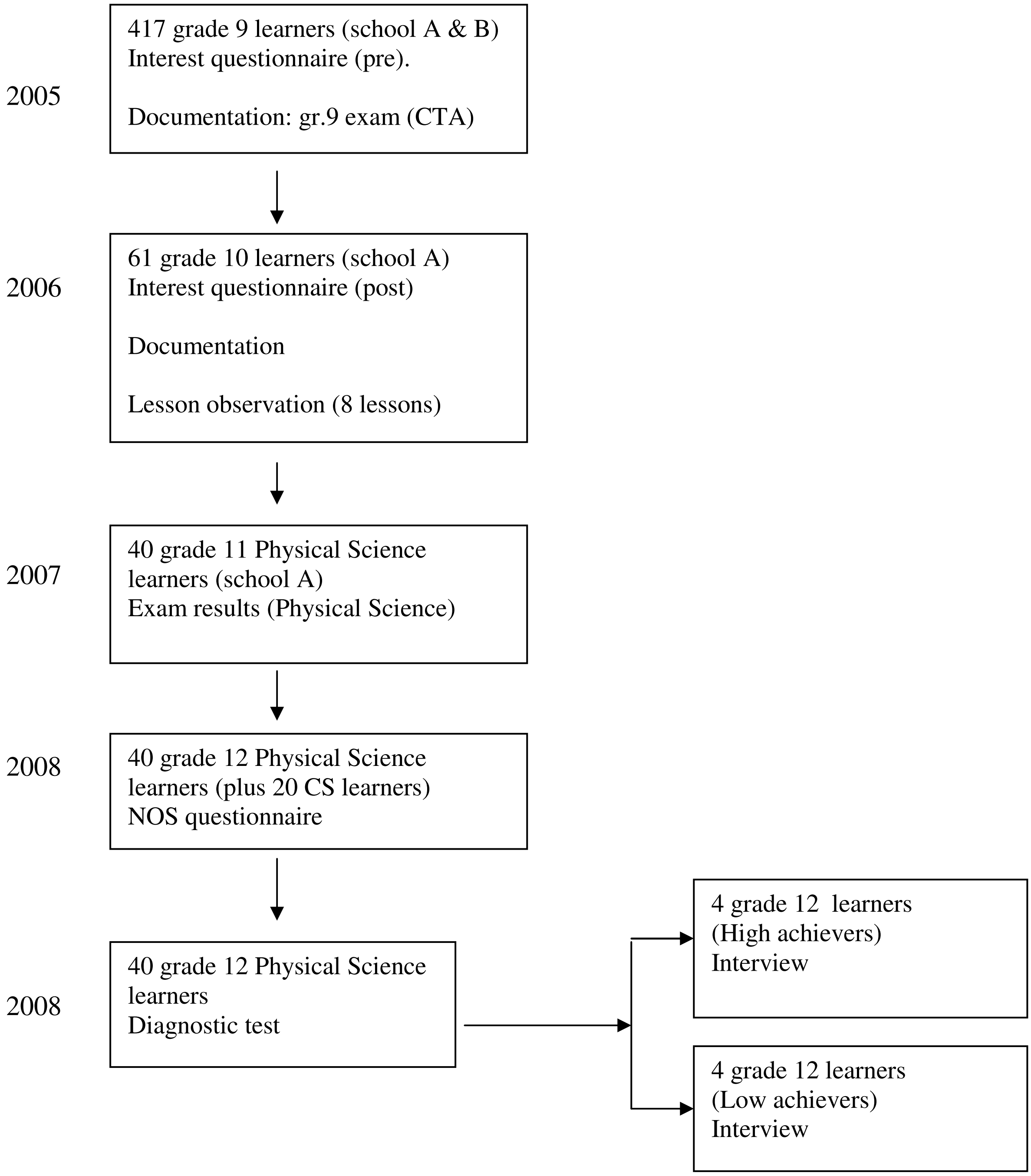

Figure 3.1 A diagrammatic representation of the research design

3.4 INSTRUMENTS AND DATA COLLECTION

The data collection methods used in this study comprised of documentation analysis, an interest survey, classroom observation, a diagnostic test, a questionnaire on the Nature of Science (NOS), interviews and the grade 11 examination results.

3.4.1 Documentation

Document analysis was employed to explore the matching between the GET and FET phases regarding content as well as assessment .This helped to explain how the transition from Natural Science in the GET phase to Physical Science in the FET phase can be characterized in order to answer research question 1.

The Policy Document on the Senior Phase (DoE, 1997), the national GET examination papers of 2005 (DoE, 2005b), and the Revised National Curriculum Statement (DoE, 2002b) were scrutinized to determine whether the learners were exposed to content needed for grade 10 Physical Science. As content was not prescribed by C2005, the grade 9 national examination, called the Common Tasks for Assessment (CTA), was analyzed to assess to what extent concepts required for FET science were examined (DoE, 2002a).

The National Policy on Assessment and Qualifications for schools (DoE, 2006b) shed light on the assessment policy in the senior phase. This enabled me to compare the way assessment was carried out in the GET and FET phases.

According to a study in Western Australia (Chadbourne, 1995), which used documentation as data collection method, the high school curriculum was dominated by university entrance requirements. Learners worked from textbooks and covered the prescribed content of science units that had a long list of very specific objectives explicitly linked to student assessment (Rennie & Parker, 1993). In contrast, the primary syllabus contained four pages of general concepts to be covered during the eight years of pre-primary and primary school and allowed the educator to be flexible as specific content was not prescribed for primary science. I found this to be very similar to the current educational set-up in South Africa and therefore I used official documents to answer research question 1.

3.4.2 Interest survey

Studies worldwide show that positive attitudes towards science decrease throughout the school years, with the most dramatic change occurring during the transition from primary phase to the secondary phase (Schoon, Ross & Martin, 2007; Linn & Hyde, 1989). Therefore I administered an interest questionnaire to explore how learners' interest in Physical Science change during the transition from GET to FET. Changing interest was used as an indicator of learner's experiences of the transition, to shed light on research question 2. Also, a low level of interest in Physical Science during the FET phase could result in career choices avoiding Physical Science (Speeering and Rennie, 1996), which would be a way to manage a difficult transition. Therefore the interest questionnaire could also provide answers to research question 3.

According to Gay and Airisian (2003), typical survey studies are concerned with assessing attitudes, opinions, preferences, practices and procedures, and collections of survey data is usually by questionnaires, interviews, telephone or observation. The questionnaire used in this study, given in Appendix A, was modified from the 'Interest Questionnaire for the Natural Science Field of Study (IQNSFS) designed by Swanepoel (1986). In order to validate the instrument, I used the group of 417 grade 9 learners from the two neighboring schools A and B. According to Maree (2003), the size of the sample has to be between five and ten times the number of items in the questionnaire if the researcher wishes to carry out item analysis. The test consisted of 84 items, and a total of 417 learners participated, meeting the requirement sufficiently.

The questionnaire was firstly used to compare learners' interest in Physical Science, Life Science, Mathematics and Computer Science for the original group of 417 learners. These subjects represent one of the learning fields from which learners who graduate from grade 9 have to choose subject combinations for grade 10. The questionnaire consisted of 84 items, 21 questions from each subject. (Refer to Table 3.1). Each item involved an activity related to one of the 4 subjects. Learners had to indicate on a scale of 0 to 3 how much they would like to do each activity.

When the learners reached grade 10, the questionnaire was repeated to explore the trend in interest as they moved from one phase to another. The results of the 61 learners who continued with Physical Science in grade 10 were compared to the results of the same group when they were in grade 9 to ensure that the comparison was valid.

Table 3.1: The distribution of questions in the IQNSFS according to subject.

SUBJECT							
Physical Sciences (PS)		Life Sciences (LS)		Mathematical Sciences (MS)		Computer Sciences (CS)	
Item no.	V no.	Item no.	V no.	Item no.	V no.	Item no.	V no.
1	v3	6	v8	2	v4	3	v5
4	v6	10	v12	7	v9	8	v10
5	v7	11	v13	9	v11	13	v15
14	v16	15	v17	12	v14	16	v18
19	v21	17	v19	18	v20	21	v23
20	v22	22	v24	25	v27	24	v26
23	v25	26	v28	28	v30	27	v29
29	v31	33	v35	31	v33	30	v32
32	v34	38	v40	34	v36	36	v38
35	v37	41	v43	42	v44	39	v41
37	v39	44	v46	47	v49	40	v42
43	v45	45	v47	50	v52	46	v48
48	v50	53	v55	51	v53	49	v51
52	v54	55	v57	56	v58	54	v56
59	v61	62	v64	58	v60	57	v59
63	v65	67	v69	61	v63	60	v62
69	v71	71	v73	66	v68	64	v66
70	v72	74	v76	72	v74	65	v67
77	v79	76	v78	75	v77	68	v70
81	v83	80	v82	78	v80	73	v75
84	v86	83	v85	82	v84	79	v81

3.4.3 Observation

Classroom observations were carried out to explore the teaching practises of the grade 10 teacher and to observe learners' behaviour in class. These observations could help answer all three research questions. Firstly, some answers to question 1 can be found by describing the transition in terms of teaching and learning situation. Answers to questions 2 and 3 can also be found as learners' behaviour would be an indication of how they experience and negotiate the transition.

In observational techniques, the current status of a phenomenon is determined not by asking but by observing (Gay & Airisian, 2003). The advantages of observation as a qualitative data collection type are that the researcher has a first-hand experience with participants, can record information as it is revealed and can notice unusual aspects (Creswell, 2003). Observations can take a number of forms in qualitative research, depending on the involvement of the observer. The observer can be a participant observer, who engages fully in the activities under study but is known to the participants as a researcher. Alternatively, an observer may be a non-participant observer of the activities of the group being studied, that is, one who watches but does not participate (Gay & Airisian, 2003). The advantages of participant observation include the ability to gain insights and develop relationships with the participants. The disadvantages of participant observation are, however, that the researcher may lose objectivity and become emotionally involved with participants, and may also have difficulty participating and taking detailed field notes at the same time. Non-participant observers, on the other hand, are less intrusive and less likely to become emotionally involved with participants (Gay & Airisian, 2003). It is for this reason that I used non-participative observation in the classroom in an attempt to answer the following: What teaching strategy is used? What is the nature of learner engagement in the classroom? How do learners respond to the teacher's directives and questioning style?

Speering and Rennie (1996) also conducted a longitudinal study that mapped the transition between primary and secondary school in Western Australia from the learners' point of view. They focused on the subject of science and used both quantitative and qualitative methods. They made lesson observations that revealed a wide range of teaching strategies. They noted that in primary science an emphasis was placed on hands-on activities and co-operative learning in small groups. In secondary science students were disappointed at the lack of hands-on activities, too much emphasis on “chalk and talk”, the amount of note-taking and listening to lectures.

Teachers’ actions, assessment and use of resources should all be viewed in terms of how well they enrich the learning experience (Rogan & Grayson, 2003). Learning in class is a dynamic process in which there is interaction of learners, educators and context, with content being the main component of context (Hewson, 1988). It is in this context that I used classroom observation to find out what teaching style is being used by the teacher and what learning strategy is used by learners to overcome the transition problems in the FET class. The classroom observation instrument is adapted from the Integrated Quality Management System (IQMS) instrument from the Education Labour Relations Council (ELRC, 2003) (given in Appendix E).

Appendix F is an exemplar of a grade 10 Physical Science Lesson plan the teacher should have followed, Appendix G is a hand-out for the grade 10 Physical Science according to the NCS and Appendix H and I are both transcripts of Physical Science Lessons that were observed.

3.4.4 The paper and pencil diagnostic test

Learners’ conceptual understanding in the FET phase could help us to understand how they experienced the transition, thereby providing answers to research question 2. Also, strategies and approaches when dealing with questions that require conceptual understanding could indicate how they managed the transition, thus providing answers to research question 3. Therefore, a diagnostic test was administered to assess conceptual understanding and problem solving skills.

In setting a diagnostic test I had to choose between true-false questions and multiple-choice questions by considering their advantages and disadvantages. True-false questions are advantageous because a great number of questions can be answered in a short time, permitting a broad sampling of knowledge. Answers to the questions can be quickly scored, particularly if a key is used. Furthermore, the true-false test is an excellent tool to use for pretesting to determine the status of learners at the beginning of a unit. (Collette & Chiappetta, 1984). The true-false statements were not used, however, because they usually have poor validity and low reliability, and the probability of guessing the right response is 50%, which gives the poor or unprepared student an excellent chance of providing the correct answer. Furthermore, predictions and comparisons are difficult to test because these types of learning outcomes are not easily expressed in statements that are either right or wrong (Collette & Chiappetta, 1984).

Multiple-choice questions are not easy to construct, it being difficult to write plausible distracters, and just as difficult to find four or five closely related options, only one of which is correct. In addition, ambiguity is usually a problem (Collette and Chiappetta, 1984). However, the disadvantages are outweighed by the advantages, particularly when one compares them to true-false statements. I prefer multiple-choice questions to true-false statements because they have a higher reliability than true-false items and are easy to score; the probability of guessing is lower. Furthermore, they are not only useful for testing factual information but are particularly suitable for testing higher levels of understanding, e.g. analysis, evaluation and synthesis (Collette & Chiappetta, 1984). Prepared items are also available from research literature.

The test was administered during the grade 12 year to the remaining 40 learners who chose Physical Science as a subject in gr 10. The test was adapted from Novick and Menis (1976), and is given in Appendix D. For each item, learners had to explain their chosen answer and indicate a level of confidence in their answers. The test consisted of two multiple choice items, one on the mole concept and one on Avogadro's hypothesis. The content areas of the test were based on identified problem areas from my experience as a Physical Science teacher, a chief examination marker, a Physical Science advisor, a co-author of Natural Science textbooks and a grade 12 Physical Science Chemistry examiner for the Gauteng Department of Education.

The data gathered from the diagnostic test were also used together with results from the NOS questionnaire in an attempt to understand if and how learners' scientific epistemological beliefs related to their conceptual understanding and problem solving strategies, which could further illuminate research questions 2 and 3.

Responses to the diagnostic test were further explored during interviews with eight individuals.

3.4.5 The NOS questionnaire

Understanding the Nature of Science (NOS) has been regarded as one of the basic requirements for scientific literacy (Lin & Chiu, 2004). It was found that student views of science were significantly related to their knowledge integration and learning orientation methods (Tsai, 1998).
This implies that learners' scientific epistemological beliefs may be related to their coping with science. Therefore, I administered a questionnaire to explore learners' understanding of the Nature of Science, as results could provide answers to research question 3. I hoped to relate learners' epistemological inclinations to their strategies and approaches for negotiating the transition.

The Nature of Science is a fundamental issue for philosophers of science (Klee, 1997). Studies by philosophers, scientists and educationists attempting to investigate the philosophical underpinnings of science in relation to teaching often observe poor understanding of the NOS amongst educators and learners (Linneman, Lynch, Kurup, Webb and Bantwini, 2003). Philosophers have made spirited attempts to provide recommendations in the form of national guidelines (McComas & Olson, 1998).

The questionnaire, consisting of 48 items on a five-point Likert scale, is given in Appendix C. The items of the NOS questionnaire were derived from the Nature of Scientific Knowledge Scale (NSKS) (Rubba & Anderson, 1978). The subscales are amoral, creative, developmental, parsimonious, testable and unified. These subscales are described in Table 3.2. Each subscale was composed of eight items, four positive and four negative as indicated in Table 3.3.

One problem with questionnaires is that if a question is incorrectly understood or the answer is incomplete, nothing can be done about it, unlike an interview where any misunderstanding could be cleared. Emotions and sentiments are difficult to express in writing. Furthermore, many subjects fail to answer questions completely honestly, instead giving the researcher the answer they think he or she wants to hear (du Toit, 1992). However, according to du Toit (1992), questionnaires are probably the most commonly used means of collecting data. It is an economical way of collecting information for both researcher and subject, since it saves time, input and costs. Furthermore, if carefully and correctly compiled, the researcher can ask anyone to administer questionnaires on his/her behalf, and it can help subjects by focusing their attention on significant items. Greater uniformity is more likely to be achieved in the answers given if they are in writing and accompanied by clear instructions (du Toit, 1992).

Table 3.2 Model of Scientific Knowledge (Rubba & Anderson, 1978)

NSKS subscale	Description
Amoral	Scientific knowledge provides man with many capabilities, but does not instruct him on how to use them. Moral judgements can be passed only on man's application of scientific knowledge, not on the knowledge itself.
Creative	Scientific knowledge is a product of the human intellect. Its invention requires as much creative imagination as does the work of an artist, a poet, or a composer. Scientific knowledge embodies the creative essence of the scientific inquiry process.
Developmental	Scientific knowledge is never "proven" in an absolute and final sense. It changes over time. The justification process limits scientific knowledge as probable. Beliefs which appear to be good ones at one time may be appraised differently when more evidence is at hand. Previously accepted beliefs should be judged in their historical context.
Parsimonious	Scientific knowledge tends toward simplicity, but not to the disdain of complexity. It is comprehensive as opposed to specific. There is a continuous effort in science to develop a minimum number of concepts to explain the greatest possible number of observations.
Testable	Scientific knowledge is capable of public empirical test. Its validity is established through repeated testing against accepted observations. Consistency amongst test results is a necessary, but not a sufficient condition for the validity of scientific knowledge.
United	Scientific knowledge is born out of an effort to understand the unity of nature. The knowledge produced by the various specialised sciences contribute to a network of laws, theories and concepts. This systemized body gives science its explanatory and predictive power.

Speering and Rennie (1996) used a questionnaire in their study of learners' perceptions about science, so as to select case study learners. It consisted mostly of open-ended questions about the learners' experiences of primary science, its perceived relevance, the educators' relationships with learners, gender issues, achievement and their expectations of secondary science.

The NOS questionnaire was administered to the 40 Physical Science learners who progressed to the grade 12 year. I also administered the test to 20 Commercial Science learners who were not taking Physical Science. I intended to establish whether the learners taking science had a different understanding of the Nature of Science, as students' views of science are significantly related to their knowledge integration and learning orientation methods (Songer & Linn, 1991; Tsai, 1998). Therefore, the science learners' performance on the NOS questionnaire would be related to their knowledge integration which might illuminate research questions 2 and 3 on experiences and coping with the transition.

3.4.6 The Grade 11 Physical Science examinations

The grade 11 Physical Science examinations were not set by me or by the teacher. They were common national examinations set by the Department of Education. The examination was therefore regarded as a litmus test of learners' progression or lack thereof through the FET phase.
Performance as measured by this examination was used as an indicator of learners' experiences of the transition. Furthermore, performance in Physical Science during the FET phase was also regarded as an indication of coping with the transition. Therefore, the examination results could shed light on research questions 2 and 3.

The examination results were also used in conjunction with the results of the Interest Questionnaire and the results of the NOS questionnaire to explore whether interest in Physical Science and epistemological inclination were related to performance. This could be useful to triangulate results.

3.4.7 Interviews

Recognizing the limitations of paper and pencil tests and questionnaires, interviews were used to collect rich data on the transition from a few individuals. Pope and Gilbert (1983) asserted that successful understanding between people "depends not so much on the commonality of the construct systems but on the extent to which people can understand the construct system of the other" (p. 197). This provides ample motivation for the interview to be used as a supplement to the questionnaire and the diagnostic test in helping to understand the thinking of the student to provide answers to research questions 2 and 3.

The interviews were conducted just after the diagnostic test that had been written. Some of the interview questions were based on the diagnostic test in order to clarify learners' answers. The interviews also probed other aspects relating to transition. The aim was to get a balanced mix of reactions to questions on:

- Attitude towards science during transition
- Career choice
- Favourite subject
- Teacher-student relationships over the period of transition
- Expectations of teaching strategies ahead of transition
- Description of transition in their own words

Interviewers try to make sense of the cognitive processes that accompany learners' responses. Confrey (1990) argues that if one wants to know more about knowledge, one should ask the people who claim to know and the student who comes to know. Research interviews are usually divided into two broad categories, namely structured and unstructured. In a structured interview (Behr, 1983) the interviewer usually takes the lead. Definite guidelines are followed here because the interviewer requires specific information. This implies predetermined procedures. The interviewer draws up an interview schedule in which the following are described:

- the course of the interview
- the way in which instructions and questions are to be worded
- the way in which answers will be processed

In an unstructured interview, the interviewer usually does not take the lead, though according to a predetermined protocol it need not be a random or unfocussed process. According to Traxler and North (1966), the art of unstructured interviewing is that the questions should appear to arise spontaneously from the conversation. According to Jacobs and Vrey (1982), the unstructured interviewer must endeavour to listen perceptively to what the subject is saying. This means hearing what the subject is saying, not just what the interviewer wishes to hear. If the interviewer hears what s/he wishes to hear, s/he is working in terms of a personal internal frame of reference. If the interviewer listens in terms of the external frame of reference, s/he will be in a position to listen not only to the spoken words, but also to what is left unsaid. The interviewer should furthermore note the tone of voice and intonation. According to Mackay (1973), open questions should be asked in an unstructured interview. Questions should neither imply an answer, subtly reveal the attitude of the interviewer nor pass judgement.

In this study the interviews were mainly semi-structured, in which follow-up questions flowed from the response of the subject, thus combining the most useful aspects of both structured and semi-structured interviews (McMillan & Schumacher, 2006). The interviews were conducted with eight learners who were taking Physical Science. The learners were purposively selected for performance: the four highest scoring learners and the four lowest scoring learners were selected.

Semi-structured interviews were the main qualitative data source in the study of students' perceptions about science conducted by Speering and Rennie (1996). Speering and Rennie (1996), reported on a longitudinal study that mapped, from the students' point of view, the transition between primary and secondary school in Western Australia. In their interviews with the subjects, they asked them questions based on: school change, attitude to science, teaching strategies, teacher-student relationship, favourite subject, career choice. The interview questions in the current study were also categorised in the same manner. Furthermore, the subjects were asked to review their answers to the conceptual problem-solving diagnostic test. In addition, key terms such as GET and FET were explained to the subjects before the interview.

The interviews were audio-tape recorded and transcribed verbatim, given in Appendix J. According to Behr (1983), a tape-recorder is a convenient method of keeping a detailed and accurate record of an unstructured interview. The advantage here is that nuances such as tone of voice, hesitations and emotional responses are not lost. The interviewer should put the interviewee at ease by explaining the purpose of the recording and how the information will be dealt with.

3.5 DATA ANALYSIS

Once data had been collected, the analysis took place. Documents, classroom observations, questionnaires (both the IQNSFS and the NOS survey), the diagnostic test and interviews were analysed. The results of the grade 11 examination were primarily used as an external measure of learner achievement, to be correlated with interest and epistemological inclination.

3.5.1 Document analysis

Analysis of the curriculum documents was made for scope and depth of coverage of content. The topics tested in the CTA for the grade 9 Natural Science were matched with those prescribed for the NCS.

3.5.2 Classroom observation

Non-participative observation of a natural setting was carried out to find out about the nature of learner engagement in the classroom. A total of eight grade 10 lessons, consisting of four sets of twin lessons taught to two classes, were observed and coded numerically in the chronological order in which they were observed. This was done for easy reference. Rennie (1990) and Kelly (1995) observed science lessons without using observation schedules, instead creating their own categories from the field notes that they had taken. These were then used to focus their descriptions of the observed lessons. The categories used in this study for focus on the description of the lessons are adapted from Manyatsi (1996), as general features of the lessons, questioning style of the teacher, directives and/or statements made by the teacher and the nature of learner engagement.

3.5.3 Questionnaires and interviews

The IQNSFS questionnaire

According to the NCS, learners who graduate from grade 9 have to choose subject combinations from some of the eight learning fields in grade 10. One such learning field is the Physical, Mathematical, Life and Computer sciences. The Interest Questionnaire (IQNSFS) consists of 84 questions from the Physical, Mathematical, Life and Computer sciences, with 21 questions from each subject. (Appendix A).

Arithmetic means, standard deviations and median of the distribution of scores formed the basis of item analysis to determine the level of interest in the different subjects. Firstly, the reliability of the questionnaire was determined. For each subject, items were left out one by one while calculating the correlation of the scores of the remaining items to assess whether specific items fitted with the rest.

When the learners were in grade 9, the test was used to compare interests in the four subjects, and also to compare boys and girls. The questionnaire was repeated in grade 10, with the 61 learners who continued Physical Science. The performance of the grade 10 group was compared to the performance of the same group of 61 learners when they were in grade 9. In this way, changes of interest in science at the articulation of the transition could be determined to assess learners' experiences of the transition.

Scores on the interest questionnaire were also correlated to the grade 11 examination scores to probe a possible link between interest and achievement during the transition.

The NOS questionnaire

Table 3.3 shows how the questionnaire was scored. Positive Item V-numbers were scored from 1 to 5, i.e. "strongly disagree" to "strongly agree", whereas the Negative Item V-numbers were scored in reverse. Table 3.4 indicates which numbers had to be scored in reverse.

Table 3.3 NSKS Item Point Value Assignments

Response	Positive Item Value	Negative Item Value
Strongly Agree	5	1
Agree	4	2
Neutral	3	3
Disagree	2	4
Strongly Disagree	1	5

In scoring the NSKS, the point value assignments shown in Table 3.3 were made. Subscale scores were calculated by adding the appropriate four positive and four negative items (refer to Table 3.4). By summing up these subscale scores, an NSKS score is calculated. A maximum score of 40 points for each subscale and 240 points for the entire NSKS score is possible. Table 3.4 also classifies the items according to the subscales in Table 3.2.

The learners were also categorized as post-positivist-oriented or empiricist-aligned, based on their score on the NOS survey. The responses of the two belief groups (post-positivist and empiricist) to the diagnostic test and their marks in the examinations were then compared to establish which group coped better with the challenges of transition.

Table 3.4 NSKS Item-to-subscale key

NSKS Subscale	Positive Item **V**-numbers	Negative Item **V**-numbers
Amoral	6, 7, 10, 50	9, 20, 23, 38
Creative	19, 22, 30, 34	3, 25, 36, 43
Developmental	18, 28, 39, 44	27, 29, 33, 45
Parsimonious	4, 8, 31, 48	16, 17, 41, 42
Testable	14, 24, 40, 47	11, 13, 15, 35
Unified	5, 32, 37, 49	12, 21, 26, 46

Interviews

To understand their strategies of coping with the transition, eight of the Physical Science learners in grade 12 were selected to participate in follow-up semi-structured interviews. They were labelled as high academic achievers or low academic achievers based on their grade 11 Physical Science examination results. The 4 highest achievers and 4 lowest achievers were selected for interviews.

3.6 VALIDITY AND RELIABILITY

Researchers use several strategies to check on and enhance a study's validity. According to Cohen and Manion (1994), inferences about validity are made too often on the basis of face validity, that is, whether the questions appear to measure what they claim to measure. Reliability, on the other hand, is the extent to which findings can be replicated or reproduced by another inquirer, while objectivity is the extent to which findings are free from bias (Denzin & Lincoln, 1994). Reliability is not prized for its own sake, but as a pre-condition for validity, as an unreliable measure cannot be valid (Lincoln & Guba, 1985). I used a combination of the following strategies in order to reduce researcher bias and improve the reliability and validity of the data collected:

- Used a range of instruments to allow triangulation.
- Included a similar neighbouring school to validate the interest questionnaire with a sufficiently large sample of grade 9 learners.
- Used verbatim accounts of interviews or observations by collecting and recording data with tape-recordings or detailed field notes, including quotes.
- Agreed with the participants not to make prior appointment for a particular lesson but instead show up unannounced. This was to avoid having lessons specially prepared for the classroom observation. If participants were absent on any particular day, particularly the teacher, another visit would be arranged.
- Recorded my own reflections, concerns and uncertainties during the study and referred to them when examining the data collected.
- Chose options with higher reliability, e.g. multiple choice rather than true false when it came to pen-and-paper tests.
- Determined the Cronbach reliability coefficient where applicable.

3.7 TRIANGULATION

In triangulation, researchers make use of multiple and different methods to provide corroborating evidence (Miles & Huberman, 1994; Erlandson, Harris, Skipper & Allen,1993; Glesne & Peshkin, 1992; Ely, Anzul, Friedman, Garner & Steinmetz, 1991; Patton, 1990, 1980; Merriam, 1988; Lincoln & Guba, 1985). The multi-pronged approach of this study, whereby questionnaires and the diagnostic test were supplemented with documentation, classroom observation and interviews, ensured that I stayed clear of a narrow and one-dimensional account of the learners' experiences of transition from GET science to Physical Science in the FET band. The interviews were intended to relate responses from the interest questionnaire to the diagnostic test, the examination and classroom observation. Classroom observation in turn was meant to relate classroom practices to official documentation. Responses from the NOS questionnaire were used to determine epistemological beliefs which in turn determined the extent to which one could integrate knowledge and thus cope with transition. The belief groups were compared with regard to their marks in the examination and also to the responses to the diagnostic test which required conceptual understanding. The triangulation design is used because the strength of each method can be applied to provide not only a more complete result but also one that is more valid (McMillan & Schumacher, 2006).

3.8 ETHICAL CONSIDERATIONS

Once the participants were selected, I obtained their formal, informed consent for participating in the study. Informed consent benefits both the participants and the researcher and ensures that both know their reciprocal rights and expectations (Airasian & Gray, 2003). The participants knew what they were expected to do and they understood any risks involved. They also knew the conditions under which they might withdraw from the study. They were assured that their identities would be protected and that their supervisors would not have access to their individual data.

I am fully aware that trust is earned, not given and that it must be maintained throughout the study: "Trust and rapport in fieldwork are not simply a matter of niceness; a non-coercive, mutually rewarding relationship with key informants is essential if the researcher is to gain valid insights into the informant's point of view" (Erickson, 1990, p. 141).

3.9 CHAPTER SUMMARY

In this four-year longitudinal study a group of learners was followed from grade 9 into the FET band. I used a combination of qualitative and quantitative data collection strategies in order to reduce researcher bias and improve the reliability and validity of the data collected.