Chapter 3

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

Since the study aims to conduct a detailed exploration of how teachers transform content knowledge in their classes, a small sample that will allow ample time to study the situation in details is suitable (Fraenkel & Wallen, 1990). Thus a qualitative case study approach that focuses two high school teachers was appropriate to utilize. In this chapter the methodological approach employed to gather evidence to support the study and the associated technical aspects will be discussed. Appropriate measures to ensure validity and reliability will be outlined later in this chapter. I will also indicate how I ensured that I maintained the rigour in this study.

3.2 Research Sample

The title of the study is about township teachers' practice in Gauteng but I became interested in grade 11 science teachers in Katlehong (a township located in south of Johannesburg in Gauteng for the following reasons. Firstly, I am also a teacher in that area and for that reason conducting a study in that place would be advantageous with regard to travelling costs. Secondly teachers in the cluster meetings (a GDE organised structure where teachers meeting regularly in the presence of subject facilitator to monitor work done by teachers belonging to a confined area) teachers expressed their concerns with inadequate learners' performance. Lastly,

there had been a trend for high school learners in that area of performing poorly at grade 12, especially in Physical Science (GDE, 2003).

Since there are few learners who do Physical Science (compared to other high school subjects) up to matric in high schools, there are usually one or two teachers per school for both grade 11 or 12. Preferably, I intended to choose teachers from schools which are in close proximity for easy access and minimising the cost of travelling. But I noted the reluctance of some teachers around the surrounding area to participate in this study. Secondly, some teachers were concerned about the implications of the findings which will be obtained from the study should the GDE request the results of the study. Two teachers from Katlehong volunteered to participate. But I was able to interview and observe only one teacher. Due to the logistical problems I encountered later on with the initial second teacher chosen for the study, a teacher from Tsakane (a Township which is about 45km away and east of Katlehong) was chosen for the study.

Both participants that we used in this study are Physical Science teachers, and have been given pseudonyms Mr Xaba and Ms Simelane. At the time of the study, Mr. Xaba had just obtained a B. Ed degree in one of the local universities in Gauteng. Ms Simelane was then studying for a Science Education degree at the honours level.

3.3 Overall Research Design of the Study

In this investigation the intention was to intensively understand how two in-service teachers with different educational backgrounds transform content knowledge when they are teaching the mole in their classes. Therefore a qualitative approach was the most appropriate procedure for realising the intention of the study (Cohen & Manion, 1980; Fraenkel & Wallen, 1990; Dyer, 1995; Terre Blanche & Durrheim, 2002). Since I intended to investigate two teachers in depth a case study became suitable because case studies are appropriate for intensive investigations of particular individuals (Cohen & Manion, 1980; Fraenkel & Wallen, 1990). The use of case studies for investigation of teachers' practice was employed by van Driel *et* al. (2000) to investigate the development of PCK within well educated teachers. Compared to this study, their study differed from this one in that authors paid attention to pre-service teachers whereas this study focuses mainly on the in-service teachers who are permanently employed by the Gauteng Department of Education (GDE).

After having identified a sample for the study, I arranged an informal interview with the two teachers separately to get their conception of mole and ideas they have when preparing, teaching and assessing the concept under study i.e. the mole. In addition, I needed to find out what materials they use for steps mentioned earlier on, gather those materials and analyse. All of these steps were taken in an effort to help me investigate the extent to which their PCK of the mole has developed.

I then organised a workshop where teachers read a prepared package and sought clarity on issues that were not clear to them.

To ensure that both teachers would present similar lessons of the mole, a common intervention package was organised and made available to teachers. Furthermore both teachers were requested to study the supplied materials with the hope that they will use certain aspects which might be of great assistance when presenting their lessons in future. The workshop and the package were intended to be an additional source of material for the teachers but there will *NOT* be a direct exploration of the intervention per se.

Since the study looks at how teachers act in their attempt to present meaningful lesson(s) on the mole concept, an accurate indication of how they act would probably be obtained by observing them in practice. For two consecutive days, a one hour lesson was observed. Because of time constraints on this study, observations were done one week shortly after teachers were exposed to the learning package since there was no time for teachers to take on board in earnest the ideas from the workshop. There were challenges with regards to issues of validity and reliability.

3.4 Validity and Reliability of Data

Reliability refers to the replicability of the results if the data were to be collected a second time, whereas validity refers to the truth of the findings of the study(Lincoln and Guba, 1985). A large body of literature exists to

explain validity and reliability in educational research e.g. Lincoln and Guba (1985) and many more. For purpose of this study Lincoln and Guba's terminology will be used because their terminology is said to be appropriate for qualitative studies.

Firstly, Lincoln & Guba (1985) refer to internal validity as the credibility of the study. By credibility they refer to the extent to which subjects find the researcher interpretations to be believable. Secondly, external validity, commonly known as transferability, is referred to as the extent to which judgement can be made about generalizability of results. Also reliability is termed dependability. By that they refer to the extent of stability of the results, once the unpredictable changes are discounted. Lastly objectivity is termed confirmability which refers to the extent to which data is confirmable.

In order to improve the validity of the research, researchers need to measure what they are suppose to measure, remove their blinkers when interpreting research results and consider alternative explanations for research findings before they come to any conclusions (Sanders, 2004). Advice is given if there is any danger of the threats mentioned above (Lincoln & Guba, 1985; McMillan & Schumacher, 1993; Sanders, 2004). They advise that any act that poses a threat to the study necessitates certain precautionary procedures that are appropriate in science educational research to ensure the trustworthiness of the study.

McMillan & Schumacher (1993) mention that reliability in qualitative research is enhanced by making all aspects of the design explicit. They further suggest that data collection strategies to increase reliability are a combination of the following strategies: verbatim accounts, low inference descriptors, multiple researchers, mechanically recorded data, participant researchers, member checking and participant review.
However, to check the accuracy of the impressions one gained through the observation procedure, interviews were also employed before and after the observed lesson presentations as suggested by Cohen & Manion (1980), Fraenkel & Wallen (1990), McMillan & Schumacher (1993) and Blanche & Durrheim (2002).

In this study data was collected by both interviews and observations and collection of documents for the purpose of triangulation. Studies that were conducted by Chen & Ennis (1995), Marks (1993), van Driel *et al.* (2002) and Furio *et al.* (2000) showed that using a combination technique method known as triangulation results in gathering more reliable data.

All data collection techniques such as interviews and observations were piloted with colleagues (using the concept of electricity at grade 10) in the school where I taught then. The purpose of piloting collection techniques was to enable me to master the skills of collecting data, expose myself to the dynamics associated with using audiotapes, to make sure that the audiotapes are working and to possibly come up with solutions to problems that may be encountered before the actual collection of data.

One of the major threats to case studies is external validity (transferability). The results of this study will not be used to generalise but a deeper understanding of teachers' practice of pedagogical content knowledge will be obtained.

3.5 Interviews

The methods that are used in this study are those that are associated with case studies (Fraenkel & Wallen, 1990; Cohen & Manion, 1980, McMillan & Schumacher, 1993). I used interviews because they are appropriate in finding out what is on peoples' minds. According to Fraenkel & Wallen (1990) and Cohen & Manion (1980) it is advantageous to use interviews as a data collecting technique because the researcher gathers data through a direct verbal interaction with the individual concerned and thus is able, through probing, to get deeper understanding of the interviewee than is the case of other methods.

An interview is an appropriate tool to use if one aims to find out what a person thinks or understand. To get such information from a person is time consuming but this was not a problem in this study as I intended to interview only two teachers. Both interviews and the observation techniques were piloted so that I could learn the skills and to make sure that the technical aspects were working.

An interview schedule was prepared with questions which were face validated by two experts and a colleague to check whether the questions are

seeking what the study aimed to achieve and then they were piloted with the teachers at school where I taught to increase the reliability and validity of the questions before the main study was conducted. I interviewed each of the three teachers at my school spending about or about 20 to 30 minutes in the afternoon or during lunch.

The interview questions sought to find out the knowledge teachers employed when teaching the mole, the intellectual resources they use to plan a lesson on the mole, the explanations they give to learners to define the mole (and why particularly such explanation are considered to be best for learners), what, why and when teaching aids above used, how are those teaching aid were used in the lesson, what kind of learners' activities they created for the mole concept. The interview schedule is included in appendix 1.

The interviews were audio-recorded. One pre interview session was scheduled for each teacher which made a total of two pre interviews for the study. During the pre-interview session with a teacher I asked the questions that were prepared and gathered resources such as textbooks, booklets, tests, past exam papers that were used to prepare a lesson in order to check on the explanations (or misconceptions if any), analogies examples given and problems used for learners. I also probed the respondent where the responses were not clear to me.

After this short interview I scheduled a workshop with each teacher on an intervention package that has been previously used to teach the mole. The

workshop was scheduled for an hour in one of the afternoon (See section 3.8). However the workshop lasted for 3 hours.

3.6 Observation

Following interviews I observed lesson presentations by the teachers. The study used observations so that I was able to directly gain impression in presentation of lessons as occur and make appropriate notes about its most noticeable features (Cohen & Manion, 1990). The advantage of using observations is that the researcher can decide which kinds of behaviour are important for the study. However the disadvantage of observations lies in obtaining observations that are objective, unbiased and accurate in the sense that the observer has avoided influencing the behaviour of the subjects. The issue of bias can be overcome by declaring this bias, so that the reader can judge the observations with this in mind.

During observations, field notes were taken rather than using observation schedules. Observation schedules were not used because of the nature of the study. In this study, the idea is, given the situation teachers face in their natural environment (situation), what strategies do they employ which indicate teachers' use of PCK in their classrooms without me making judgements in a more global sense. A sample of field notes is given in appendix 3.

Before the main observation I spent a day with the teacher in a class not participating but as a spectator so that learners could get used to my

presence. During the main observations I assumed a non-participant observer status (Cohen & Manion (1980), McMillan & Schumacher (1993) and Fraenkel & Wallen (1990)). I assumed this position because teachers are very sensitive to anyone who seeks to observe them in their classroom while teaching. Furthermore, for ethical reasons, and not wanting to introduce an element of threat to teachers, I explained to teachers through a letter and verbally that I will not be there to judge or criticize them, but to observe what is happening (See Appendix 1). Through this procedure, I wanted to ensure that I did not lose data that is important for the study during observation because any inappropriate action on my part might cause one withdrawal of teachers from the study.

When I was piloting the observation skills in one of my female colleague's class, she was not comfortable with my participation. Because she knew the purpose of my presence in her class, she gave response without giving them a chance to talk. This enabled me to obtain her in-depth knowledge but it disadvantaged learners from responding and coming with their ideas. Hence, I decided to assume non- participatory observer role so that the teachers are not influenced by the purpose of my study.

I also noted that I will be making judgements based on the data collected, so if I became part of the group to be studied the validity of inferences made from the observations may be questioned. Lastly, as I was concentrating on capturing almost every thing which happened during the lessons it will probably be difficult to participate and capture every detail of events.

After the observations there was a short post-interview session to seek clarification on certain issues that the teacher presented during the lesson, so that I do not write only what I think is important for the study but to capture the situation as it unfolded.

3.7 Recording of Observations and Interviews

As the lessons went on, detailed field notes were taken in the classroom and as I interviewed the respondent. Since my concentration was on capturing almost everything (even the body language about the teacher) that is happening in the classroom, there was a possibility that I may miss information which may be of value to the study; audiotape was used to help capture the voices of the teacher and the learners (Fraenkel & Wallen, 1990).

Inside and outside noise from the classroom of interest can be difficult to control and often seriously interfered with the understanding of content (Fraenkel & Wallen, 1990). On the previous day I noted that there was a possibility of disturbing noise from the surrounding classrooms because a number of teachers were attending training elsewhere, three recorders were placed at strategic positions in a classroom. One was next to the teacher in front and the other two were placed in the middle and at the back of the classroom.

3.8 Workshop

A one day workshop was scheduled with the two teachers. On the day of the workshop I had photocopied a tutorial sheet on the mole that is used at the

College of Science at the University of Witwatersrand (2004) and chapter fifteen of Dilley (1990) (See appendices 4 and 5). These copies were supplied to each of the two teachers before the session started. During the workshop the teachers and the researcher studied and discussed the package together. Both my copies were highlighted especially in areas that I intended to stress because I thought that if they are well captured that will help the teachers to develop their own strategy of transforming that information.

In Dilley's chapter 15 the highlighted areas that we (participants and I) dealt with included "what is a mole" and "why do we need to use it in chemistry", the connection between the mole and mass, chemistry and kitchen demonstration of the mole, working out how many atoms there are in the pile.

The two teachers and I engaged one another on this document for about 45 minutes because teachers showed interest. I started by giving teachers a scenario that supposed a teacher was standing outside his yard and a next door neighbour's child came and related to him/ her that they were taught about the mole in their Physical Science class on that day but could not understand a thing because he did not capture the definition of the mole well and so asked him/ her to explain what is a mole.

The teachers were asked how or what would they say in helping these learners. They reflected that they were avoiding teaching this part of the chemistry syllabus because firstly it is not asked in the final grade 12 examination. Secondly, the reason that came out was that they also did not

understand the mole concept well and thus were not confident to teach it. The third reason was that the concept is avoided since it is taught at Grade 11 in South Africa and it is therefore easy to avoid the mole conceptual understanding questions because they are the ones who compile and mark tests and examination at grade 12.

The next part of one intervention package was the tutorial sheet on the mole concept from the College of Science at the University of Witwatersrand. The sheet comprises the three main aims of the tutorials and four main tasks. The aims of the tutorials are for the learners to; (1) discover the comprehension of the mole; (2) bring to an understanding of the mole as a number and (3) let learners perform calculations involving the mole. (For this package see appendix 5).

Most time was spent discussing task number 2 and 3. This portion of the tutorials deals with ideas on the mole which reveals some of the misconceptions that students may have about the mole. These ideas included the moles of different substances that occupy the same volume, the mole of different substances that have the same masses. After the workshop, teachers were requested to use the materials for presenting the mole in their classes and to allow the researcher to come and observe them whilst they were teaching the mole. A, schedule was made for me to come to the teachers' schools one week after the workshop to observe lessons for a week in order to investigate their use in the class of the package.

3.9 Ethical Considerations

Permission to collect data from the schools was sought from the Regional Department of Education in Ekhurhuleni west. Letters were written to the schools' principals, head of department of Physical Science and volunteering teachers explaining the purpose of the research and requesting permission to use their resources and school and participation. Data were collected only from the participants who volunteered to participate in the study. Findings of the study were communicated to all participants and they were allowed to reflect on the analysis of the data. GDE's permission was sought to use the public schools for this study. The ethics committee at the University of Witwatersrand was not supplied because at the time of conducting this study it was not applicable then.

3.10 Data Analysis

The interview questions were piloted and the responses from the pilot interview were used to prepare codes that made themes to answer the research questions. Researchers, who were conducting a study similar to this, checked the correctness of data transcription. They were asked to critique the interpretation of transcripts. In addition, respondents were given opportunity to check whether their responses were captured correctly or not.

Field notes were enriched using recorded tapes and teachers' reflections. (See appendix 3). The next process was to analyse this information. All data was portrayed and analysed using Content Representations (CoRe) and the

Professional and Pedagogical experience Repertoire (PaP-eR). CoRes and PaPeR are models developed by Loughran et al. (2004).

According to Loughran et al. (2004) a CoRe is a ways of representing the teachers' understanding of PCK whereby the different knowledge aspects that teachers consider when preparing and presenting a particular topic in their field of teaching. A PaP-eR on the other hand is like a window into a teaching /learning situation wherein the content is contextualised with an understanding of illustrating certain aspects of PCK (Loughran et al., 2004).

In conjunction with Loughran et al.'s method, a model called "categories of description of the mole conception" was used to analysed the teachers' use of content (Strömdahl et al., 1994: Tulberg et al., 1994) and the way teachers' conception of the mole. Details of the Strömdahl et al. (1994) and Tulberg et al. (1994) will be discussed in chapter 5 and Loughran et al.'s model will be discussed in the next chapter.

3.11 Concluding remarks

In this chapter the methodological approach for the study was discussed. Furthermore, appropriate issues that were taken care of when conducting this study were outlined. The chapter concluded by focusing on the intervention strategy that was employed to engage and enhance teachers' subject matter knowledge on the focused knowledge area.