

## CHAPTER ONE

### INTRODUCTION TO THE STUDY

This research report presents findings regarding Basotho<sup>1</sup> high school students' conceptions of earthquakes. The study was conducted with one hundred and thirty students in Forms A, C and D<sup>2</sup>, from one high school in Lesotho. Students' conceptions about earthquakes were elicited using a diagnostic test and interviews. Responses from students were analysed against scientifically acceptable views about earthquakes, established from physical geography and geology textbooks.

#### 1.1 BACKGROUND TO THE STUDY

The construction of a large dam, the Katse Dam, in the Malibamatšo area in the highlands of Lesotho, had an unforeseen effect in the area in terms of the occurrence of earthquakes that were induced by the Katse impoundment. The dam was built as part of the Lesotho Highlands Water Project, the purpose of which is to supply South Africa with water and to generate hydropower to make Lesotho self-sufficient in energy.

In late October 1995, the reservoir behind the Katse dam in Lesotho began to fill. Days later people started feeling earth tremors. One of these tremors, measuring 3.1 on the Richter scale<sup>3</sup> was recorded on January 3, 1996 (International Rivers Network, 1997). The tremors led to the opening of a 1.5 kilometre long crack on the earth's surface. Houses in seven villages beside the reservoir were damaged by tremors, and frightened villagers were moved to a new location (International Rivers Network, 1997). School students, together with other members of the society living in the affected areas, were exposed to the earthquakes caused by the impoundment of the dam. According to International Rivers Network (1997), it was expected that the reservoir-induced seismicity might continue for some time as the reservoir level was raised, and as the water level rose and fell after the initial filling. Reports made by the Department of Water Affairs and Forestry (1996) pointed out that the magnitude of the earthquakes induced by the Katse impoundment were not unusual compared with similar events recorded at almost 200 other reservoirs worldwide.

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<sup>1</sup> Citizens of Lesotho are called Basotho (singular Mosotho).

<sup>2</sup> These classes correspond to grades 8, 10 and 11, respectively, in other countries.

<sup>3</sup> A scale used worldwide for measuring earthquake magnitude (Strahler and Strahler, 1987).

While the natural movement of continental plates is the most common cause of earthquakes, human activities can induce or increase their occurrence in an area. McCully (1996) asserts that reservoirs both increase the frequency of earthquakes in areas of already high seismic activity and can cause the occurrence of earthquakes in areas previously thought to be seismically inactive. According to McCully (1996), as with most aspects of seismology, it is impossible to predict accurately which dams will induce earthquakes, or how strong the tremors are likely to be. Redfern (1991) contends that seismologists have tried every imaginable indicator to predict the occurrence of earthquakes, but none has proved reliable.

The occurrence of earthquakes in the Malibamatšo area in Lesotho has provided a rare and unique opportunity for students in this area to have a lived experience of this phenomenon. This provided students of geography with a first-hand experience of this phenomenon, and possibly provided an opportunity for students to understand it better. Also, the occurrence of the earthquakes in this area possibly served to provide a better forum for teachers to be able to teach the causes and effects of earthquakes, by incorporating students' out of school experience of earthquakes in geography lessons.

## **1.2 STATEMENT OF THE PROBLEM**

Previous research has shown that many students worldwide not only lack detailed knowledge about the causes and effects of earthquakes but also harbour misconceptions about earthquakes and other geological phenomena (Ross and Shuell, 1993; Tsai, 2001). Interviews with 91 students in grades K-6 in the United States, found that some of the students surveyed in the study could not distinguish between an earthquake and a volcano (Ross and Shuell, 1993). From the descriptions of earthquakes given by students in Ross and Shuell's study, misconceptions about earthquakes, weather conditions and other geological phenomena were evident through the use of words and expressions such as "erupt", "like a tornado", and "explosion". In a study of 60 fifth and sixth graders (11-year olds and 12-year olds), Tsai (2001) found that several students in Central Taiwan believed in supernatural forces as the cause of earthquakes, and that students struggled to reconcile their indigenous views with scientific views.

Students in Lesotho live in an area of crustal stability. An earthquake would be an extremely unusual event. Consequently, Basotho students, like other students in areas of crustal stability, could be expected to lack a detailed understanding about earthquakes, owing to the foreignness of this phenomenon to their situation. However, the earthquakes caused by the Katse

impoundment have provided the opportunity to investigate the impact of this lived experience on their understanding of earthquakes.

### 1.3 AIM OF THE STUDY

The aim of this study was to investigate Lesotho high school students' conceptions about earthquakes, at various levels of schooling. The study documents students' conceptions about earthquakes and the causes and effects of earthquakes.

### 1.4 RESEARCH QUESTIONS

The following questions served as the focus of the study:

- What conceptions about earthquakes do the selected high school students in Lesotho have?
- What are the students' conceptions about the *causes* of earthquakes?
- What is their understanding about the *effects* of earthquakes?

### 1.5 SUMMARY OF RESEARCH METHODS AND SAMPLE

A survey was conducted with students in three different grades: Form A students who had not received formal instruction on the topic; Form C students who had been taught about earthquakes at a rather superficial level; and Form D students who had dealt with earthquakes in more detail. It should be noted that the Form A students in the present study had not been taught about earthquakes apart from some exposure at primary school where, according to the curriculum, teachers and pupils are to discuss the effects of some of the environmental disasters in the world. In this section of the curriculum, both earthquakes and volcanoes are simply mentioned as part of the natural disasters. The scope of this curriculum would not give pupils any knowledge about the processes of earthquakes apart from introducing them to the term 'earthquake' and probably giving them a brief definition of an earthquake.

Two research instruments were used in the study.

- A diagnostic test, which served as the main instrument for data collection, was used to investigate students' understanding about earthquakes. Section 3.3.1 in Chapter 3 discusses how the test was developed and administered.
- Semi-structured interviews, which were used to check the test data and to further probe test responses, were conducted with six students selected from the main sample. Section

3.3.2 in Chapter 3 describes how the interviews were developed, and the criteria for selecting interviewees.

Open coding, as suggested by Strauss and Corbin (1990), was used to analyse the responses. Data from the test and interviews were compared and contrasted in order to discover recurring themes and patterns of students' ideas. The emerging categories were arranged in tables, displaying scientifically correct versus scientifically incorrect views about earthquakes. Frequency counts were done to describe the nature and extent of students' ideas about earthquakes.

## 1.6 IMPORTANCE OF THE STUDY

This study can be seen to make four important contributions to science education. **First**, it contributes to the currently limited literature on students' ideas about earthquakes, particularly in southern Africa. **Second**, the study yields valuable insights into the conceptions held by Lesotho students about earthquakes. This will provide an opportunity for comparing the conceptions of students in Lesotho with those in different parts of the world about earthquakes. **Third**, it could be used to alert science teachers in Lesotho about the pre-instructional ideas their students might bring to school, and the alternative conceptions they have even after instruction. Thus teachers will know in advance which alternative conceptions commonly arise about earthquakes, and they could prepare to deal with such issues. Furthermore, the findings from this study could be used by teachers and those involved in in-service and initial teacher education as stimulus material for discussion of teaching aims and intentions, and in particular, as suggested by Mayoh and Knutton (1997), the role of everyday experience within science learning. **Finally**, the study provides insights into the conceptual and cultural difficulties students in Lesotho encounter in the learning of science. These insights will contribute to research conducted in developing countries, which is valuable in understanding the challenges facing children in developing countries in learning science. As Lewin (1993) contends, it is unsafe to assume that insights from research done in Western countries are easily transportable to the environment of developing countries. Therefore the findings of this study are likely to provide relevant information in the context of developing countries, which could be used to inform educational policy and practice in such countries.

## 1.7 AN OVERVIEW OF THE RESEARCH REPORT

**Chapter 2** reviews the literature on some of the theories currently informing the learning of scientific knowledge. The social constructivist theory is set out as the framework on which this research is grounded. Debates on the influence of learners' home culture in the learning of science are also advanced in this chapter. In addition, an overview of the current scientifically acceptable ideas about earthquakes and their causes and effects is provided. This overview is used when analysing students' conceptions in Chapter 4. The chapter concludes by examining the literature on alternative conceptions about earthquakes.

**Chapter 3** presents the research design and methods employed in this research. In addition, a description of the sample for the study is given. The discussion advances the motivation for prioritising the qualitative approach in this study. The research methods used are discussed, focussing on their appropriateness for eliciting students' conceptual understanding. The chapter also sets out how the methods were developed and administered, as well as how rigour was improved.

In **Chapter 4**, the range of conceptions about earthquakes held by the students are presented and analysed. The chapter consists of two sections: First, the results are presented; second, analysis of the results is provided. This structure has been adopted for ease of referring back to the results, rather than having results combined with analysis in one huge section. In this chapter, a comparison is made between ideas of students as they move through the school system. Also, the ideas of students in the present study are compared to those of students in other countries. Suggestions are made to the possible sources of the alternative conceptions emerging from the results.

**Chapter 5** provides a discussion of the main findings of this research, and highlights possible challenges to the validity of these findings. With an awareness of the alternative conceptions held by the students, a way forward is suggested in an effort to ultimately overcome such erroneous ideas. In addition, recommendations are made for future research.