CHAPTER 1: Background to the study

1.1 Introduction

Science education in schools today aims to promote the learners’ understanding and application of basic concepts of evidence. Frequently in school laboratories children are asked to use the thinking skills of scientists. They are expected to classify objects, to control variables, to identify a problem and devise a plan to address this problem, and to develop descriptions, explanations, and models using valid evidence. In spite of teachers’ efforts, however, the more abstract concepts of evidence (e.g. reliability and validity) have proved difficult for many learners to understand and apply. Several studies (Lubben and Millar, 1996; Gott and Duggan, 1996; Millar et al., 1994; MacGuire and Johnstone, 1987; and Bell and Driver, 1994) have indicated that learning science is not a matter of passively absorbing information but of actively constructing for oneself an understanding (of ideas about evidence and observed phenomena in this case). The understanding and application of concepts of evidence plays a central role when setting up a valid experiment.

In the present study an attempt was made to survey learners’ understanding and application of concepts of evidence in experimental design.

1.2 Research outline

The problem investigated in the study, the aims and objectives of the study and the questions investigated are outlined in this section.

1.2.1 The problem investigated in this study

The increasing emphasis on the development of curricula in which children are taught to obtain, analyze and evaluate evidence using experimental and investigative methods led to this investigation. While science education researchers urge the development of curricula in which children pose inquiry questions and plan investigations to answer those questions, some classroom studies of experimental design indicate that many learners had
difficulty with cognitive tasks such as manipulating variables, conceptualizing data as continuous, qualifying data, graphing, and evaluating the validity of data (e.g. Keys, 1998). Many learners seemed to perform experiments with only a rudimentary idea of what they are doing, with virtually no understanding of the purpose of the experiment or the reasons for the choice of procedure, and with little understanding of concepts of evidence needed when setting up an experiment. Much practical work appeared to pupils to be a succession of exercise with apparatus, through which they are led in the hope of solving an ‘unasked’ question.

According to Hodson (1991), practical work is carried out very rapidly, or with unreliable equipment, insufficient attention to care and precision, so that students fail even to produce the phenomenon that they are supposed to observe, let alone be helped to appreciate patterns, trends or explanations. Even when the outcomes are as the teacher intended, conclusions, which seem “obvious” to the teacher can appear less so to the learner. Often the work is humdrum and routine, rather than engaging or inspiring. Hodson (1991) indicates that this sad state of affairs affects the teaching and learning of science.

“As practiced in many schools, it [practical work] is ill-conceived, confused and unproductive. For many children, what goes on in the laboratory contributes little to their learning of science or to their learning about science and its methods. Nor does it engage them in doing science in any meaningful sense”. (Hodson 1991:176)

Thus, there is substantial evidence that children do have difficulty mentally processing the investigation problems put to them by adults, even when they appear to be actively engaged in these investigations. Learners often fail to learn from practical work the things teachers had intended them to learn. As a result, there is a concern that our science teaching as a whole is too narrow, that we should be widening our frontiers beyond ‘science for the enquiring mind’, to encompass ‘science for action (its application in the world) and ‘science for the citizen’ (its implications for society). Thus the current wave of science education research literature emphasizes learning science as inquiry (e.g. Keys, 1998). South Africa has not escaped this move towards inquiry learning in secondary school science.
Operating from the theoretical perspective that the learner’s ‘prior knowledge’ influences his/her understanding of new information, the South African education system is currently undergoing a major transformation process from an education system which encouraged the transmission of information to an education system which supports the ‘constructivist paradigm of thinking’. At the centre of change is Curriculum 2005, which requires more active learner involvement in the learning process. Curriculum 2005 is a national curriculum framework which is based on Outcomes Based Education (OBE). It should be noted that in South Africa, the latest version of the National Curriculum Statement (NCS) for secondary schools now includes some statements about teaching learners to obtain, analyze and evaluate evidence using experimental and investigative methods (Department of Education, 2003). The implication in this purpose is that learners will use these processes of science as a vehicle for improving their knowledge. Notwithstanding this, learners have to draw upon knowledge and understanding of concepts of evidence using experimental and investigative methods in order to carry out these processes. However, there is relatively little classroom research on how learners, who were introduced to the new curriculum system in South Africa, understand, and apply ideas about evidence in assessment activities in the Common Tasks for Assessment. Furthermore, there is still no explicit recognition of a knowledge base and little to guide the teacher as to which activities are more or less appropriate. Consequently, important questions are raised about the extent to which concepts of evidence are understood and applied in secondary school science. How do learners obtain, analyze and evaluate evidence? What teaching methods are most likely to be appropriate to the teaching of skills and concepts of evidence? Can learners’ understanding of scientific evidence be influenced by instruction? Can learners demonstrate or translate their knowledge base about scientific evidence into activities in the classroom? These are the questions towards which this study is directed.

1.2.2 Aims and objectives

The aim of this study was to examine secondary school learners’ understanding and application of concepts of evidence in experimental data before and after engaging in
some open-ended investigation tasks aimed at teaching of skills and concepts of evidence. This was meant to establish changes in learners’ understandings. Furthermore, the study examined whether learners’ understanding of concepts of evidence might influence their problem-solving strategies. Hence, the study would indicate whether knowledge of concepts of evidence among learners might be traced into activities in the classroom, namely the Common Tasks for Assessment (CTA) investigation tasks. It is assumed that the understanding and application of scientific evidence might develop inquiring minds and critical analytical skills in learners. It is also assumed that this is likely, only if science teachers design teaching methods, to teach the understanding and application of concepts of evidence that engage learners with a sense of the whole task (Gott and Duggan, 1996).

It was realized that the following objectives had to be fulfilled if the aim of the study was to be accomplished:

- The establishment of which concepts of evidence applied by learners to obtain, analyze and evaluate scientific evidence.
- The establishment of whether an understanding of scientific evidence emerged as a result of doing open-ended investigations.

These objectives were likely to be attained through two main sources, namely, a literature survey and empirical investigation. Finally, the study investigated whether learners’ responses to the probes in the diagnostic test could be analyzed using the model of learners’ understanding of validity, which emerged from previous research (Albers, 2004).

1.2.3 Questions investigated

This study sought to answer the following research questions:

1. What understanding do learners entering the Further Education and Training (FET) Physical Science course have of the concept of validity in experimental design?
2. What is the effect of exposure to open investigations on the understanding of learners?
3. How well can learners’ understanding of scientific evidence be demonstrated by the CTA investigation task?

1.3 Significance of the study

The findings and conclusions of this study could be useful for teachers as an aid for considering what their own learners might really be thinking about scientific evidence. Furthermore, since the new curriculum (Curriculum 2005) is in the early stages of implementation in South Africa, the ideas and findings presented here are likely to provide useful information which could be of supportive nature to science teachers in general and Outcomes Based Education in particular. The outcomes of this study might generate interest in teaching methods and learning activities that can foster the achievement of the learning outcomes outlined in the Natural Sciences learning area. The outcomes of this study might also promote inquiry learning, which could lead to meaningful learning and the development of critical thinking skills in learners.

1.4 Demarcation of the study

The study was undertaken in the field of school subject didactics and was confined to the understanding and application of scientific evidence to experimental data in one school of one district of the Gauteng Department of Education. Hence the subjects were secondary school Physical Science learners at the chosen school.

1.5 Organization of the project report

The project report is divided into six chapters.

Chapter 1 introduces the problem. This chapter provides an overview of the problem investigated. The chapter also highlights the significance of the study.
Chapter 2 gives more detail of the theoretical framework of the research. This chapter highlights the theoretical rationale of the study, and reports on other related studies in the same research area.

Chapter 3 dwells on the design of the study by giving the data collection methods employed as well as how data was analyzed. The chapter gives more detail of the theoretical framework of the design, construction and use of the class tasks developed to help learners understand and apply ideas about evidence.

Chapter 4 reports the results of the probes in the diagnostic test. This chapter provides data on the understanding of concepts of evidence.

Chapter 5 presents the results of the CTA investigation task. The chapter provides data on the application of concepts of evidence.

Chapter 6 summarizes and discusses the implications of the results presented in chapters 2 and 5, detailing the extent of the match between understanding and application of concepts of evidence, indicating possible areas for further research.

1.6 Conclusion

This chapter has provided an overview of the problem investigated and the methods used. The chapter set out the problem that was examined and emphasized the essential nature of the problem. The chapter also highlighted the scope and objectives of the study. Finally, the chapter set out the organization of the project report. The following chapter reviews literature relevant to the study.