Chapter 1

1.1 Introduction

The poor performance of learners who write the grade 12 Physical science examination at the end of each year is of great concern to all those involved in science education. Many studies have shown that learners in science find it difficult to conceptualize basic ideas in chemistry (Novick & Menis, 1976; Stromdahl et al., 1994). But much of this research does not give any assistance in terms of the development of teaching strategies or intervention packages. In fact, it appears from the literature that comparatively less research has been carried out into how teachers teach ideas in those areas of chemistry where misunderstandings arise.

This study will attempt to find out in depth how teachers transform and amalgamate knowledge of content with their knowledge of pedagogy; a term referred to as Pedagogical Content Knowledge, and thus makes the mole concept accessible to learners. For more details, Pedagogical content knowledge will be discussed in chapter two of this study.

1.2 Rationale for the Study

As an educator with a degree in science, and a professional diploma, I considered the textbooks as gospel and most of the time taught the content of chemistry as a collection of facts in a didactic manner. I used to be confused when learners struggled with chemistry content until I became more aware of misconceptions as well as problems students had with

chemistry topics. Hence there is a need to educate other teachers about these issues.

In the township school where I teach, a number of science educators are not well qualified and possibly may not have an idea about issues that learners find difficult. These unqualified science teachers also teach at grade 12 and there has been a trend for learners to perform poorly in science class tests and in their final exam.

Apartheid policies in South Africa before 1994 led to inequality in the education system. Teachers from disadvantaged racial groups were not offered appropriate teacher training programmes and consequently they are not familiar with a number of factors which are currently considered important in enhancing learning. In many Gauteng schools, there are many poorly qualified science teachers who have been teaching for many years (Peloagae, 2001).

To address these problems the Gauteng Education Department spent millions of rands

- establishing intervention programmes and collaborating with private organisations, such as Star School, Learning Channel, German Education Program, etc. to establish programs that would provide extra lessons for learners and to employ "expert teachers" in such programs.
- developing in-service programmes for teachers.

It is disturbing that grade 12 science learners still perform badly on stoichiometric problems. Thus, it may be useful to investigate how teachers approach the mole concepts in their practices.

1.3 Problem Statement

Most learners have difficulties in understanding certain basic chemical concepts. For example Grade 12 physical science learners respond poorly to questions on stoichiometric problems. The examiner's report on grade 12 physical science results points out that matriculants underperforming in questions that are based on volumetric analysis, chemical reactions, chemical equilibrium and redox reactions (Department of Education Grade 12 Final Examination Results Report, 2003). All these topics require mastery of the mole concept.

Poor performance in examinations has been encountered in other studies (Hatkinson *et* al., 1977; Lazonby *et al.*, 1982; Furio *et al.*, 2000; Peloagae, 2001). This is a general problem that is faced by college students (Staver & Lumpe, 1995) and university students (Furio *et al.*, 2000). These authors attributed this poor performance in stoichiometry to misunderstanding of the mole concept by learners. Peloagae (2001) found that high school learners in Gauteng have 'alternative ideas' about the mole concept and they experience difficulties when they are required to solve problems based on mole. This difficulty may be due to educators' difficulties in teaching the topic.

As one of the basic SI units, the mole is important to understand chemistry topics such as acids and bases, oxidation/ reduction reactions, equilibrium constant etc. If learners have understood this content they are able to apply it in different situations. Although learners are taught the mole, through experience I have realised that many still face difficulties in understanding the concept and fail to apply it to solve associated problems (as indicated earlier on). Since this problem is picked up every year by the grade 12 examiner, it seems reasonable to consider how teachers address this topic with particular reference to how they transform content.

Because, the mole is a one of the fundamental concepts for solving stoichiometry problems (Furio et al., 2000), understanding concepts such as chemical equilibrium constant, balancing of chemical equations, acid/base titration etc, it is important that learners have better understanding. It is clear that without an understanding of the mole, comprehension of a number of concepts (including those concepts that were mentioned earlier) in chemistry will be affected negatively. Furthermore, an understanding should be made clear to learner that part of what chemistry researchers do is to interact and work with tiny particles that cannot be counted physically and thus a means is needed describing how much substance we are working with (how much of one substance react with how much of another)

1.4 Aim of the Study

The purpose of the study is to investigate

- How teachers transform content knowledge for teaching with regard to the mole concept
- The influence of a specially targeted approach to teaching the mole on practice of selected teachers.

1.5 Research Questions

1. What resource materials do teachers normally use to teach the mole?
2. What is their personal understanding of the mole?
3. What practices do teachers normally employ when teaching the mole?
4. How is the practice of science teachers affected by exposure to a teaching package on the mole?
5. How can these practices be captured and portrayed?

1.6 Outline of Chapters

1.6.1. Chapter 1: Introduction

The author gives motivation for undertaking the study by alluding to its importance and rationale. The research questions are stated and the aim of the study is explained

1.6.2. Chapter 2: Literature review

Articles on the mole and pedagogical content knowledge (PCK) as a framework is outlined, the implications of PCK for teaching and learning and students misunderstanding of the mole are considered.

1.6.3 Chapter 3: Research design and Methodology

Description of the overall design of the study as well as the rationalization for data collection methods

1.6.4 Chapter 4: Development and presentation of Professional and Pedagogical Representations (PaPe-Rs) and Content Representation (CoRe)

Data that were collected from interviewing two educators and observation of their lessons' presentation of the mole to their learners is presented. PaPeRs and CoRes are presented in details, and give a brief of how PaPeRs were created and details of PaPeRs of two educators.

1.6.5. Chapter five: Presentation of data collected

In this chapter the description and analysis of resource materials that were used by educators to plan and present lesson(s) on the mole will be presented. It will be followed by a detailed explanation of two models that are used to analyse data that was collected through interview and observation. The chapter ends with conclusion and the implication of the findings from the data

1.6.6 Discussion and conclusion

Reflections of the study and research questions are revisited and conceptual difficulties are discusses. Results of both teachers are compared. The limitations and recommendations of the study and the direction for the study are highlighted. The chapter ends with brief recommended further study.