Science Practical Work: What types of knowledge do secondary science teachers use?

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NWMGIL002

A minor dissertation submitted in *partial fulfillment* of the requirements for the award of the degree of Master in Education

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2014

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature:______________________ Date:_________________________

Abstract

The prominence of practical work in science curricula today infers that these activities offer unique learning experiences for achieving specific goals. Yet, but for a few exceptions, practical work in school science is often neglected and has not been effective in achieving the goals normally associated with it. The rationale behind this study was that an understanding of the bases for decisions made as teachers plan, enact and assess practical work in Grade 8 and 9 natural sciences, may reveal the nature of the knowledge base required for effective practical work. It was thought that such insight might also shed light on some of the reasons for the apparent lack of effective practical work in South African schools. Furthermore it could inform the design of those aspects of pre-service and in-service teacher professional learning programmes aimed at developing the knowledge and skills required for effective practical work.

There is a paucity of research on the knowledge base required for science practical work and no instruments designed to measure, capture or describe such a knowledge base, were found. The aim of this study was firstly to develop a valid and reliable instrument to facilitate the analysis of what teachers say and do with respect to practical work, and secondly to get a feel for using this instrument for the purpose it was intended.

Informed by literature, and using Shulman's notion of pedagogical content knowledge (PCK) as the theoretical lens, the analytical instrument, called the practical work PCK table (PPCK Table), consisting of different categories and sub-categories of knowledge, was developed. A number of strategies were used to improve the validity and reliability of the instrument. These strategies included: i) using the instrument to analyse interviews and lessons of three natural sciences teachers working in three different educational settings, ii) soliciting the input from experts in the field of PCK, and iii) determining the inter-rater agreement in the interpretation of the categories or sub-categories among four raters by calculating the percentage agreement and the Fleiss' kappa statistic. Addressing the shortcomings revealed by these measures culminated in the final version of the instrument, the practical work knowledge table (PracK Table) and its accompanying codebook.

The second aim was addressed by conducting a pilot case study to explore the usefulness of the PracK Table as a heuristic device. A series of eight Grade 9 lessons taught by one teacher were observed. Data sources included lesson observations, teacher and learner interviews, worksheets and samples of learners' work. The PracK Table was used to identify and describe the knowledge the teacher drew on when he engaged his learners in practical work.

This study has shown the construct, ‘PCK for practical work’, to be invalid. It also revealed that a useful, valid and reliable instrument could be developed, if it is informed by authoritative literature, and if its validity and reliability are empirically tested in real contexts. In the case study the strengths and weaknesses in a teacher’s knowledge and practice could readily be identified using PracK Table as the analytical tool. The findings of the case study indicate that a broad knowledge base and access to laboratory resources, although necessary, does not always translate into effective practical work. Furthermore, it suggests that for well-qualified, experienced natural sciences teachers, teaching in fairly well-resourced schools, it is their theories about teaching and learning in general that is the main factor that determines the effectiveness of the practical work they engage in. These findings could have significant implications for the development of teacher professional learning programmes.

Acknowledgements

I wish to express my sincere gratitude and appreciation to the following people:

Pierre, Simon and Nina:- for your love, encouragement and patience throughout the years of this project. Without your support this would not have been possible.

My supervisor, Associate Professor Annemarie Hattingh:- for your invaluable guidance and unwavering support and encouragement.

The four teachers and their learners:- for so willingly allowing me into your classrooms.

My three colleagues:- for your valuable contribution to this project.

Nalini Parsotam:- for giving so generously of your time, proofreading and editing my work.

All my family, friends and colleagues:- for your support and encouragement along the way.

The National Research Foundation for your financial assistance towards this project.

Chapter One

Overview of the Study

1.1 Introduction

This study aims to identify and describe the knowledge teachers draw on when engaging natural sciences learners in science practical work. Although the importance and effectiveness of science practical work at school remains a contested issue, most science curricula today require teachers to engage their learners in some type of practical activity. Most teachers do, or at least feel they should, include practical work in their teaching, but the number of practical tasks and the nature of these tasks vary significantly from one teacher and/or one school to the next. This study is grounded in the belief that science practical work is effective, if not essential, to achieve certain learning objectives normally associated with school science.

The rationale behind this study is that a better understanding of the bases for teachers' decision about whether or not to include a practical task and also about the nature of the task, may shed some light on those aspects of pre-service and in-service teacher programmes and interventions, which are likely to improve the quantity and quality of science practical work.

In order to facilitate the identification of the knowledge types that influence teachers' decisions about practical work, an analytical instrument was developed. This study describes the development and validation of this instrument. It then also investigates its usefulness to identify and describe the knowledge of natural sciences teachers, associated with science practical work.

1.2 Background and Rationale

1.2.1 The purpose of science education

The general purposes of science education stated in many science curricula are to provide learners with the scientific knowledge and skills to:

- actively participate in a democratic society
- to provide learners with the foundations required for further study in science or for professions or vocations requiring more specialised scientific knowledge and skills.

With reference to the second of these general purposes, there now appears to be some consensus that the more specific aims are three-fold:

- to help learners to gain an understanding of part of the established body of scientific knowledge
- to develop learners' understanding of how this body of scientific knowledge has been gained (the nature of science)
- to develop some of the skills required in scientific research.

(Millar, 2004; Department of Basic Education, 2011)

1.2.2 Purposes of practical work in science education

The prominence of practical work in science curricula today infers that these activities offer unique learning experiences, which are important for achieving one or more of the three specific aims stated above.

The purposes of practical work in science education have changed as views of science knowledge and beliefs about teaching and learning have changed. The positivist movement dominated at the start of the 20^{th} century and hands-on 'cook book' type activities were encouraged to *confirm* the science content (Lunetta, Hofstein & Clough, 2004). However, in the latter half of the 20^{th} century the focus shifted towards an *understanding of the way* in which the body of scientific knowledge is established. This shift culminated in science curricula which promoted the development of manipulative and cognitive skills associated with scientific inquiry (Jenkins, 2007) and a greater emphasis on the nature of science (NOS) (Lunetta *et al*., 2004).

The five top ranking reasons secondary teachers gave for doing practical work in a study conducted by Hodson in 2005 (p.61) were:

- to assist concept acquisition and development
- to motivate, by stimulating interest and enjoyment
- to teach laboratory skills
- to give insight into the scientific method and to develop expertise in using it
- to develop certain scientific attitudes, such as curiosity, open-mindedness, objectivity and willingness to suspend judgment.

The links between these reasons and the aims of science education are quite explicit, and they also highlight the knowledge and skills which can purposefully be developed using practical work.

1.2.3 Implementation of practical work

The term practical work in this paper includes all activities in which learners observe or manipulate objects or manipulate, analyse or discuss data obtained from such activities. For the purposes of this study practical work will incorporate the six different types of activities as identified and described by Windschitl (2004) and summarised in Table 2.1 in Section 2.2

Most science curricula today recommend the integration of practical activities with the teaching of the content and in some cases prescribe certain practical activities for summative assessment purposes. Where there are prescribed practical assessment tasks, it is likely that most teachers would at least attempt these tasks, although not necessarily as intended by the curriculum developers. Science practical activities are thus being conducted in many classrooms or laboratories, but these activities may be limited in number and may not achieve the intended outcomes.

As with any activity, the nature of a science practical activity must be closely linked to its intended purpose for it to be effective. For example, an activity designed to illustrate the difference between an endothermic and exothermic reaction (science content knowledge) could be a simple teacher demonstration in which learners are asked to feel the test tube after the reactants are mixed, whereas an activity designed to develop the skill of using a thermometer (procedural skill) may require learners themselves to mix the reagents and then to measure the temperatures.

The kinds of practical work done in South African schools has been described by Rogan and Aldous (2005) and Rogan (2004; 2007), whereas the study by Hattingh, Aldous & Rogan (2007) identifies some of the factors that influence the quality of practical work. The focus of this study however is not on the nature of practical work *per se*, but instead is an attempt to gain a greater understanding of teachers' knowledge associated with practical work and how this influences the decisions they make when engaging learners in practical work.

1.2.4 Teacher knowledge

Effective science teachers know how to help learners understand specific subject matter by drawing on different knowledge types (Magnusson, Krajcik & Borko, 1999). This transformation of knowledge from different domains enabling teachers to present their knowledge of the content to learners in a way that makes this knowledge accessible to them, was first described by Lee Shulman (1986), as pedagogical content knowledge (PCK). The idea of PCK for practical work was initially explored, but on the advice of experts in the field PCK, this notion was re-examined. Given the topic specific nature of PCK (Rollnick, Bennett, Rhemtula, Dharsey & Ndlovu, 2008; Loughran, Milroy, Berry, Gunstone and Mulhall, 2001) and studies that suggest that teachers' beliefs and knowledge types that influence PCK, but that are not considered components of PCK, play an important role in decision making about practical work (Trumbull, Scarano & Bonney, 2006), the idea was discarded.

Initially informed by literature, but later also by empirical findings, input from experts as well as my own experience, the practical work knowledge table, PracK Table, was developed. It is an instrument developed to facilitate the identification and description of teacher knowledge evident in the rhetoric and practice of teachers. Similar to the PCK evidence reporting table developed by Park and Oliver (2008), it identifies not only broad categories of knowledge but also a number of sub-categories for each of the broader categories.

It is believed that the Prack Table not only facilitates the identification and description of teachers' knowledge for practical work, but at the same time reveals the gaps in teachers' knowledge.

1.3 Statement of the Problem

Based on a review of the literature, Hodson (2005) asserts that, but for a few exceptions, science practical work has not been effective in achieving the goals normally associated with it. This view is corroborated by a more recent study in the UK by Abrahams and Millar (2008) that shows that learners seldom learn the ideas that teachers intend them to learn while doing practical work. The situation is no different on the African continent (Kapenda, Kandjeo-Marenga, Kasanda & Lubben, 2002; Abimbola, 1994; Hattingh *et al.,* 2007).

Many reasons have been given for the paucity of effective practical work in schools. A lack of physical resources is one of the main reasons cited by teachers, yet studies have shown that there is no significant relationship between the availability of resources and the level of practical work (Hattingh *et al.*, 2007; Rogan & Aldous, 2005; Abimbola, 1994). Muwanga-Zake (2001) suggests that science is not taught practically in South African schools because teachers lack the practical skills and have deficiencies in their conceptual understanding of science. This is not surprising since in 1998 many South African science teachers did not have a degree in any science discipline and most science teachers had a diploma with the equivalent of only one year of university chemistry or physics (Rollnick *et al.*, 2008). Furthermore, many of these teachers were themselves not exposed to practical work at school (Muwanga-Zake, 2001). He argues that this may be the reason why equipment and chemicals are found untouched in storerooms and why teachers fear doing experiments with learners. However, the provision of resources, the development of practical skills and the acquisition of conceptual knowledge by teachers alone, will not necessarily result in more effective practical work. It appears that factors such as teachers' perceptions of learners and the teaching and learning ethos of the school may also influence not only whether practical work will be conducted, but also the type of practical work they expose their learners to (Hattingh *et al*., 2007).

Teachers need to be able to transform their knowledge of the subject, pedagogy and context for effective practical work and may have to select the most appropriate strategy to use in a particular learning environment. For in-service teacher professional development, it is important to understand teachers' current practices before attempting to change their behaviour. The knowledge framework presented below is a useful tool to do just that. Pre-service teachers programmes informed by an understanding of the knowledge base required for effective practical work may well allow novice teachers to reach a level of proficiency at practical work which traditionally is only achieved after a number of years of experience, in a much shorter period of time.

1.4 Aims and Objectives

Primarily, the focus of this study was to gain an understanding of the bases for decisions made as teachers plan, enact and assess practical work in Grade 8 and 9 natural sciences. It was thought that such an understanding may reveal the nature of the knowledge base required for practical work and also some of the reasons for the perceived lack of effective practical work in South African schools (Hattingh *et al*., 2007). Such insight could also inform the design of those aspects of teacher preparation and professional development programmes aimed at fostering the knowledge and skills required for effective practical work.

Using a theorectical framework of teacher knowledge, adapted from the work of a number of researchers, as the theorectical lens to understand why teachers do what they do, the PracK Table, was developed to identify and describe this knowledge base for practical work.

The aim of this study is therefore to address the following research questions:

1. How may an analytical instrument be developed to identify and describe natural sciences teachers' knowledge associated with practical work?
2. How useful is such an instrument in analyzing a natural sciences teacher's practice in order to identify and describe the knowledge types evident in planning, enacting and reflecting on practical work?

1.5 Relevance of the study

Science practical work in South African schools is limited (Stoffels, 2005) and based on the findings of other international studies (Jenkins, 2007; Millar, Le Maréchal & Tiberghien, 1999), is probably not effective in achieving the intended learning objectives. Well-informed in-service and pre-service teacher development programmes aimed at improving the quantity and quality of practical work are thus necessary.

Teachers' practice, including the choices they make with regard to practical work, is significantly influenced by their knowledge and beliefs. The identification of the different knowledge types and the combination and transformation of these knowledge types as teachers make decisions about practical work may enable us to understand how these factors influence the practice of those teachers who regularly engage in effective practical work. It may also enable us to show a link between gaps in teacher knowledge or failure to transform certain knowledge types and:

- teachers' reluctance to engage in practical activities
- reasons why some of these activities are not as effective as expected.

A search for an instrument to facilitate the identification of the knowledge types influencing practical work proved unsuccessful. The PracK table developed in this study, validated in different educational contexts and its reliability verified by other raters, will therefore add to the body of knowledge on science practical work and facilitate further research in this field.

This study also identifies and describes the knowledge types evident in one teacher's practice as he engages his Grade 9 natural sciences class in practical work in a working class school. And whilst acknowledging that there are a number of contextual factors that may influence teachers' decision-making and that the findings in this one case cannot be extrapolated to include all natural sciences teachers in South Africa, it does provide some useful insights, and suggests that further research using the PracK Table may be valuable. Findings of larger studies in schools in various educational contexts could inform in-service teacher development interventions or programmes in these schools, and also inform pre-service programmes as they prepare teachers to work in these contexts.

1.6 Methodology

A qualitative research design guided by the interpretive paradigm was chosen and the results are presented as a descriptive case study grounded in a social constructivist framework.

Informed by literature and using PCK as the theoretical lens, a PPCK table (see Section 3.4) was developed to facilitate the analysis of the rhetoric and practice of a teacher with respect to practical work. However, based on input from experts in the field of PCK and empirical evidence it became evident that to confine the study to PCK would be both inappropriate and inadequate - inappropriate due to the topic specific nature of PCK and inadequate since other categories of teacher knowledge appeared to have a significant influence on the practical work teachers do or do not do.

Based on the components of PCK as identified by Magnusson *et al.* (1999) and other categories of teacher knowledge identified by Shulman (1986), PracK Table 1 (see Section 4.2.3) was developed. To determine the content validity of this instrument it was used to analyse data in three different educational settings. The reliability of the instrument is dependent on the rater's intepretation of each of the sub-categories of teacher knowledge included in the table. The reliabiltity was determined by having three peers analyse the same data set. Informed by these findings the final version, Prack Table 2 (see Section 4.4), was developed.

Finally a case study, using PracK Table 2 as an analytical instrument is presented. A diagramatic representation of the research design is outlined in Figure 3.1 in Chapter Three.

1.7 Overview of chapters

In Chapter Two, a review of the literature on practical work and teacher knowledge is presented. Secondly it describes the different conceptualisations of teacher knowledge, and how this may influence teachers' practice. It also outlines how the literature has informed the conceptual framework of the study.

The research design and methodology are described in Chapter Three. The description includes the rationale for the research design, the methods of data collection and analysis and a discussion on the reliability, validity and ethical considerations of the study.

Chapter Four describes the different stages of development and validation of the PracK Table. Particular attention is paid to the content validity of the instrument and the degree of inter-rater agreement on the interpretation of the knowledge categories and sub-categories included in the table.

Chapter Five is an analysis of a teacher's practical knowledge manifested as the teacher planned, enacted and assessed practical work.

Chapter Six contains a discussion of the findings presented in Chapters Four and Five. The chapter includes a reflection on the use of the PracK Table in case studies such as this, as well as a discussion of how such insights might inform the design of professional learning programmes. The limitations of the study, recommendations and significance of the study are also included here.

Chapter Two

Literature Review

2.1 Introduction

For more than a century academics, researchers, curriculum developers and teachers have highlighted the importance of engaging learners in practical work in science at school. As learning theories changed, so the purposes of, and approaches to, practical work were re-defined and have evolved into what today is called scientific inquiry. Despite the widespread use of practical work in some countries, its effectiveness in science education is still widely contested since a number of studies have shown that there are very few instances where practical work has effectively been implemented in school laboratories or classrooms (Hodson, 2005; Hatting *et al.*, 2007; Abrahams & Millar, 2008).

Teaching is not an act; it is the complex interaction of beliefs, knowledge, context, behaviour and language of the teacher and the learner. The complexity of these classroom interactions was beginning to be acknowledged when Shulman (1986) put forward the seven categories of knowledge he thought were essential for expert teachers. Before expert science teachers engage their learners in practical work they must have asked themselves the questions: why, what, how, when and with whom? To answer these questions they have to draw on their beliefs and a knowledge base as alluded to by Shulman (*ibid.*).

In this chapter I will show how the literature on the nature and purposes of practical work in school science and on the knowledge base required for effective teaching, informed the conceptual framework of this study.

2.2 Practical work

In the USA just before the turn of the 19th century, the Committee of Ten, tasked with developing a science curriculum, formulated a curriculum which supported practical work and field trips, and also discouraged rote learning (Mintzes & Wandersee, 1998). This curriculum was based on the assumption that learners learn science by verifying and applying ideas in the science laboratory (Lunetta *et al.* 2004). During this time the development of a common scientific method shaped the positivist movement, which views scientific knowledge as the irrefutable truth (Krauss, 2005) and learners followed what is commonly known as the laboratory *recipe* to confirm a scientific truth (Lunetta *et al.*, 2004).

The post-Sputnik era prioritised content knowledge and scientific investigation. At about the same time philosophers questioned the positivist view of science, and developers looked to the works of psychologists Piaget, Bruner and Schwab for a rationale for a science curriculum. These views on science education culminated in a curriculum that in theory promoted the development of "process skills such as observing, measuring, classifying, predicting, hypothezing, controlling variables, and interpreting data", that is, a focus on scientific inquiry (Jenkins, 2007, p.271). In practice it "became a meaningless succession of "hands-on" activities devoid of understanding" (Mintzes & Wandersee, 1998, p. 32) possibly because it assumed that just by doing, science learners would develop an understanding of the scientific concepts and the nature of science (NOS) (Lunetta *et al.*, 2004).

During 1980s and 1990s, constructivism, which emphasized the importance of minds-on and hands-on experiences (Treagust, 2004), gained popularity in Europe and the USA. At the same time NOS was being included in most definitions of scientific literacy, indicating that an understanding of NOS was considered important not only for those wishing to further their studies in science, but for all citizens (Matthews, 1998). At the turn of the 20th century there was once more a call for the role of practical work to be re-assessed in the light of a substantial shift in the thinking about how learners construct their own knowledge. At the same time it appeared that *inquiry*, "which refers to the diverse ways in which *scientists* study the natural world, propose ideas, and explain and justify assertions based upon evidence derived from scientific work" (Hofstein & Lunetta, 2004, p. 30), was the favoured approach in science education.

The term practical work no longer only describes a single session during which learners follow a set list of instructions to arrive at a pre-determined conclusion. Beatty and Woolnough (1982) identified four categories of practical work, starting with the most frequently used, these were:

- standard exercises
- teacher directed discovery experiments
- demonstration
- project work

Today the term practical work could also incorporate interactions involving computer technology and activities that are done over a longer period of time outside of the classroom. For the purposes of this study the term practical work will incorporate the six different types of activities that fall into the category of laboratory work, as identified and described by Windschitl (2004). These are

- demonstrations

- skill building
- discovery learning
- problem solving
- school science inquiry
- authentic forms of inquiry.

His descriptions of each of these activities are summarised in Table 2.1 below.

Activity	Description
Demonstrations	Teacher-guided illustration through the use of materials and procedures
Discovery learning	Students working in structured or semi-structured ways to "discover" or confirm an idea or set of relations
Skill building	Students engaging in manipulative activity following procedures or practising intellectual skills (e.g. tranforming data from table into a graphical representation)
Problem solving	Students use their understanding to solve self-defined or teacher-defined problems
School science inquiry	Hypothesis testing via empirical investigations following the "scientific method"
Authentic form of inquiry	Students work more independently in open ended empirical investigations emulating the work of scientists and it could thus include a variety of types of investigation. The teacher's role is that of mentor and the learner is the apprentice.

Table 2.1 Description of different types of practical activities (adapted from Windschitl, 2004, pp.7-10.)

The central role of practical work in science education implies that laboratory activities offer unique learning experiences, and as such should address more specific goals than those associated with science teaching in general. In the first half of the 20th century practical work was used mainly to improve learners' understanding of scientific concepts and the obsession with '*cookbook*' laboratory work at the time is not surprising. Between 1962 and 1982 the top four aims of practical work, according to teachers were to observe and describe, to stimulate interest in science, to offer opportunities of personal experience with materials and to develop a logical reasoning approach (Hofstein & Lunetta, 2004). In a more recent study conducted by Derek Hodson the five top ranking reasons for including practical work as cited by secondary teachers were:

- assist concept acquisition and development
- to motivate, by stimulating interest and enjoyment
- to teach laboratory skills
- to give insight into scientific method and to develop expertise in using it.

- to develop certain scientific attitudes, such as curiosity, open-mindedness, objectivity and willingness to suspend judgment.

(Hodson, 2005, p. 61)

The importance of practical work in the Revised National Curriculum Statement for Natural Sciences in South African, which was in place at the start of this study, is captured in one of the stated learning outcomes:

> Learning Outcome 1: Scientific Investigations
> The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.
>
> (Department of Education, 2003, p. 10)

This curriculum not only for the first time required the assessment of procedural knowledge in all written tests and examinations, but also demanded that teachers engage learners in a different type of practical activity for summative assessment purposes. Although '*cookbook*' type practical tasks are still useful to achieve certain learning objectives, it was simply not enough. Learners were now also required to design their own investigations and evaluate data. Evidence suggests that several years after the introduction of the above-mentioned curriculum at Grade 8 and 9 level, this commitment to practical work was still not evident in many South African schools (Rogan, 2004).

In 2014 a new Grade 8 and 9 natural sciences curriculum was introduced in South Africa. The curriculum as outlined in the Content and Assessment Policy Statement (CAPS) also places an emphasis on practical work. The first of the three specific aims of this curriculum is 'doing science' (Department of Basic Education, 2011, p.12) and relates to the development of the cognitive and process skills associated with the design and implementation of scientific investigations. CAPS also requires learners to become familiar with the "scientific process" (*ibid.*, p.11).

Four practical tasks covering a range of skills are required for formal school-based assessment purposes for both Grades 8 and 9 (Department of Basic Education, 2011). It has been found that changes in policy do not necessarily result in the expected classroom practice but assessment practices have a profound effect on teachers and what happens in the classroom (Towndrow, Tan, Yung & Cohen, 2010). It can therefore be assumed that teachers will engage learners in more practical work but not necessarily in practical work that can regarded as *effective*. The types of practical activities may also be restricted to only one or two of the types from Table 2.1 above.

It is thus important that pre-service and in-service teachers gain the necessary knowledge and skills in order for them to engage learners in effective practical work, not only for the sake of curricular compliance, but because it is an important element of science education.

2.3 Teacher knowledge

Comparing instruments used to assess teacher competence, Shulman (1986) found that in the 1800's such assessments mainly measured teachers' content knowledge, and that only limited knowledge of teaching theories and methods was required. In the early 1980's the pendulum swung the other way, where assessment of teachers emphasised pedagogical knowledge, with subject matter knowledge considered only of secondary importance. The process-product type research (Van Driel, Beijaard, Verloop, 2001) situated in the teacher effectiveness paradigm was prevalent in this era and focused on de-contextualized teacher behaviour. It was accompanied by top-down curriculum development where the developers specified the knowledge and skills required to implement the curriculum. The teacher was "reduced to the role of technician, whose job was merely to operationalize the plans of others" and to " teach in a way prescribed by others " (Barnett & Hodson, 2001, p. 427). Novice teachers often found that the teaching theories and methods taught in teacher training programmes were in conflict with the knowledge shared by experienced teachers at schools. Educational research and development at the time largely failed to acknowledge the complexity of the relationships amongst the knowledge, behaviour and language that influenced teachers' actions in the classroom.

Clark and Markson (1986) claim that Philip Jackson's portrayal of the true complexity of the act of teaching in 1968 contributed to a greater interest in research in the 1970's, relating teachers' thought processes to their observable actions in the classroom. A report from one of the panels of a 1974 National Conference on Studies in Teaching chaired by Lee Shulman, recognized the role of the unique attributes of teachers on their behaviour in the classroom. It suggested that teachers be viewed as professionals and recommended that educational research study the thought processes of teachers with respect to their perception and definition of their professional responsibilities and situations, in order to understand exactly what teachers do.

Based on this earlier work, Shulman's outline (1986,1987) of a framework for a knowledge base for teaching that began to highlight the intricacies of teaching, thus comes as no surprise. This framework included seven categories of teacher knowledge:

- content knowledge
- general pedagogical knowledge
- pedagogical content knowledge (PCK)
- curricular knowledge
- knowledge of learners
- knowledge of context
- knowledge and beliefs about educational purposes

His coining of the term PCK has had a significant influence on research in science education. He recognised that effective teachers were able to present their knowledge of the content to learners in a way that makes this knowledge accessible to learners. In other words, these teachers were able to successfully combine their content knowledge with their pedagogic knowledge in the classroom. He called this unique type of teacher knowledge, pedagogical content knowledge (PCK). The notion of PCK, which according to Magnusson *et al.* is "a type of knowledge viewed as unique to the profession of teachers" (1999, p. 96), has revolutionised research on teachers. In this category of knowledge Shulman includes "the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word (sic), the ways of representing and formulating the subject that make it comprehensible to others" (1986, p.9).

The concept of PCK has been remodelled, elaborated and reconceptualised by a number of different researchers, based on their understanding of the constituent components of this type of knowledge, and the relationship between PCK and other knowledge types (Gess-Newsome & Carlson, 2013; Park & Chen, 2012; Davidowitz & Rollnick, 2011; Park & Oliver, 2008). Magnusson *et al.* (1999) suggested that PCK itself is constituted from the following components:

- orientations to science teaching
- knowledge and beliefs about of students' understanding
- knowledge and beliefs about curriculum
- knowledge and beliefs about instructional strategies
- knowledge and beliefs about assessment

The insights gained by an understanding of expert teachers' PCK certainly has the potential of enriching teacher development programmes, by exposing other teachers to some of the useful and more effective strategies in teaching a specific topic, based on the experience of others.

A number of studies have suggested ways in which teachers could improve practical work (Baddock & Bucat , 2008; Garlick & Laugksch , 2008; Hodson, 2005; Kanari & Millar, 2003). There are however, only a few examples in the literature of research explicitly focused on the knowledge base for science practical work. One such example is the paper by Mark Windschitl (2004) in which he presents a framework for analysing and describing the knowledge areas teachers draw on when engaging learners in practical work. He distinguishes between PCK, pedagogic knowledge, subject matter knowledge and disciplinary knowledge. In his framework, Windschitl's 'subject matter knowledge' is equivalent to Shulman's substantive content knowledge. Windschitl's 'disciplinary knowledge' is equivalent to Shulman's 'syntactic knowledge', that is, "knowledge of the source and justification of scientific knowledge" (Hanuscin, Lee & Akerson, 2011). In this paper Windschitl (2004) also described the types of knowledge needed for the different types of practical activities he identified.

In cognitive psychology there is a fundamental assumption that one's knowledge and actions mutually affect each other (Meijer, Verloop & Beijaard, 1999). Exploring this relationship, Sanders and McCutcheon (1986, in Ritchie, 1999) suggested that teachers generate practical theories of teaching which are informed by their knowledge and experience. They describe these teacher practical theories as:

> the conceptual structures and visions that provide teachers with reasons for acting as they do, and for choosing the teaching activities and curriculum materials they choose in order to be effective. They are the principle or propositions that undergird and guide teachers' appreciations, decisions and actions. (*ibid.*, p.215)

Ritchie (1999), however emphasises the personal nature of practical theories of teaching and thus refers to it as *personal practical theories.* What teachers do, is influenced by their personal theories of teaching and the opportunities and challenges in the context in which they work. However, their own experiences in classrooms may in turn influence teachers' personal practical theories. Likewise, teachers would have their personal theories about practical work which would relate to their knowledge for practical work and the practical work they engage their learners in, in a similar way.

2.4 Conceptual framework

The conceptual framework used at the start of this study, represented in Figure 2.1 below posits that a teachers' actions with regard to practical work are based on the personal theories they construct about practical work. These theories are informed by the integration of the different knowledge categories and their experiences in the classroom or laboratory.

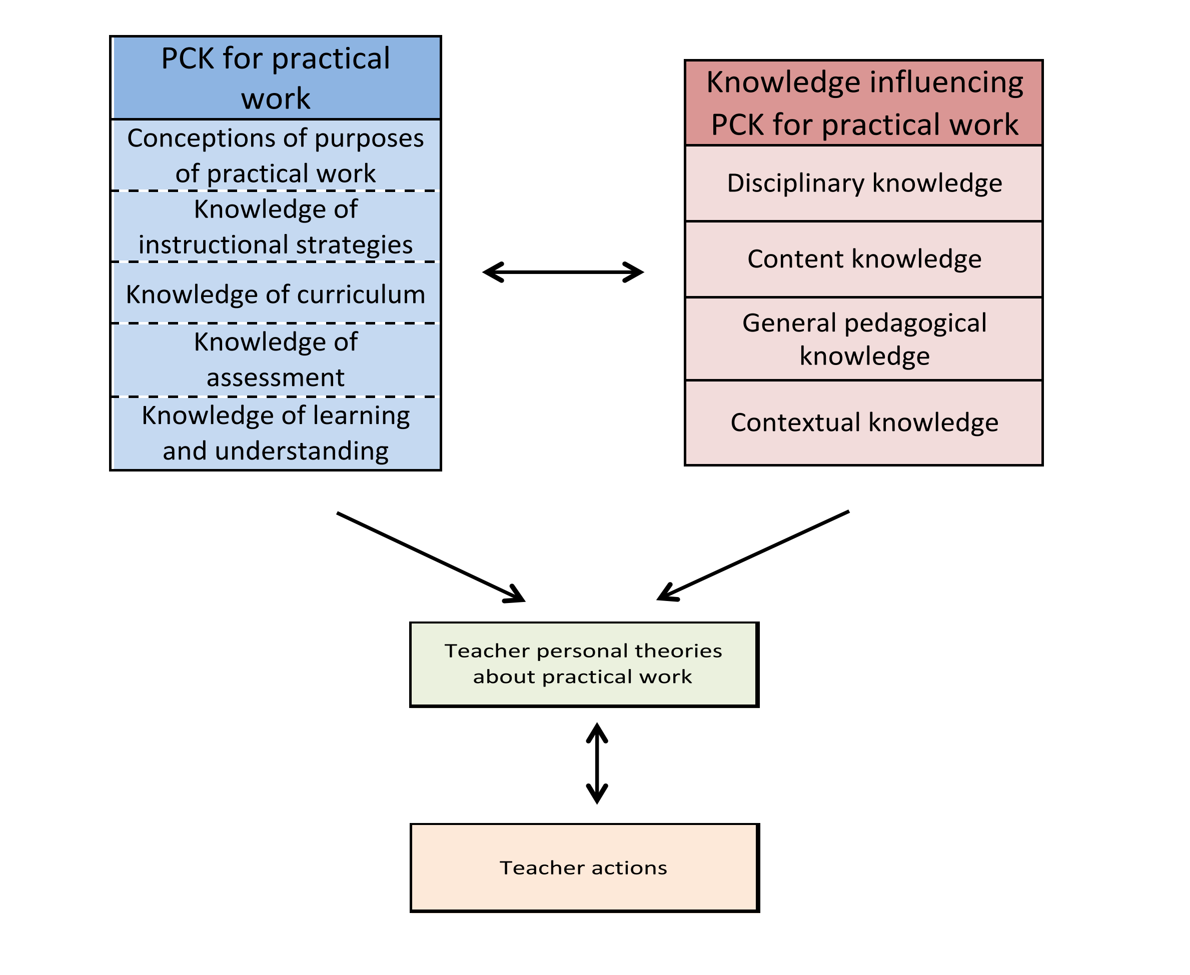

Figure 2.1 Conceptual framework for knowledge for practical work

The knowledge categories included in this framework are drawn from the work of Shulman (1986), Magnusson *et al*. (1999) and Windschitl (2004) outlined earlier. The dotted lines indicate that PCK is a transformation of these knowledge categories.

PCK for practical work is an *transformation* of the following knowledge categories:

- Conceptions of purposes of practical work
- Knowledge of instructional strategies
- Knowledge of curriculum
- Knowledge of assessment
- Knowledge of learning and understanding

The other types of knowledge that *influence the PCK for practical work* are:

- Disciplinary knowledge
- Content knowledge
- General pedagogical knowledge
- Contextual knowledge

To clarify what is meant by each of these in this study, a short description of each the categories of knowledge is given below.

Conceptions of the purpose of practical work

It is the teacher's thinking and beliefs about why it is necessary to do practical work in schools that is being considered, that is, to assist with concept development, stimulating interest, teaching the scientific method, and so forth (Hodson, 2005).

Knowledge of instructional strategies

This is an awareness or understanding of different types of practical activities, as well as the benefits and limitations of each of these and how these strategies could be combined for effective learning (Windschitl, 2004).

Knowledge of curriculum

This refers to the vertical and horizontal curriculum (Shulman, 1986) as well as curricular saliency (Rollnick *et al., 2008*). The vertical curriculum encompasses the formal curriculum of the subject not only at the specific grade level at which they teach, but also at grade levels below and above that at which they teach. Knowledge of how the science topics at a particualr grade level relate and knowledge about the curriculum of other related subjects at the same grade level is referred to as the horizontal curriculum. The teacher's choice of excluding certain sections of a particular topic and/or including others or teaching certain topics in a different order to that prescibed, could demonstrate the teacher's curricular saliency. It is described by Rollnick *et al.*, as " … the teacher's understanding of the place of a topic in the curriculum and the purpose(s) for teaching it." (*ibid*., p. 1367).

Knowledge of assessment

This is the knowledge of different types of formative and summative assessment tasks, ways of eliciting conceptions and skills, ways of recognising the limitations in learners' thinking and flaws in their problem solving approaches (Windschitl, 2004).

Knowledge of learning and understanding

The focus here is on an understanding of how to scaffold the development of ideas and skills and the integration of these ideas and skills in different contexts (Windschitl, 2004).

Disciplinary knowledge

It is the knowledge of the purposes and methods of scientific inquiry, and an understanding of the relationship between scientific models and data and knowledge of how to evaluate the validity and reliability of scientific information (Windschitl, 2004).

Content knowledge

This includes an understanding of scientific concepts, theories, laws, principles, history, classic problems, and explanatory frameworks that organize and connect its major ideas. It also embraces an understanding of the nature of science, the concepts linked to scientific inquiry and the skills to perform such inquiries (Windschitl, 2004).

General pedagogical knowledge

This is the knowledge of techniques of general classroom and laboratory management and how to organize and manage group work, managing materials for learner use and different phases of activity (Windschitl, 2004).

Contextual knowledge

Context here refers to the social and academic background of the learners, the behavioural patterns and academic abilitities within different classes, the way science is perceived and managed at school, and the socio-economic background and expectations of the community the school serves. It also includes an understanding of the relationships between the school's science department with education officials involved in science education at a district, provincial and national level.

As the study progessed this framework evolved and a revised framework is presented in Chapter Six.

2.5 Summary

This chapter shows how the important literature on the nature and purposes of practical work in school science and on teacher knowledge has guided the conceptual framework of this study.

Practical work in science education today has come to include a number of different types of activities. The purposes of practical work as percieved by teachers and as reflected in the South African natural sciences curriculum include the development of skills and knowledge required to engage in the full range of activities and include affective goals, such as motivating learners and stimulating a curiosity in science.

Shulman's knowledge base of seven categories of knowledge required for effective teaching and his concept of PCK have been useful in identifying the types of knowledge required for practical work. What plays out in the classroom or laboratory however, is a manisfestation of teachers' personal theories, which in turn are influenced by the vast knowledge teachers draw on when engaging learners in practical work.

The research design and methods used to develop and test the analytical instrument based on this framework is described in Chapter Three.

Chapter Three
Research Methodology

3.1 Introduction

As has already been indicated, the focus of this study is to identify and describe the knowledge teachers draw on when engaging learners in natural sciences practical work. This study consists of two components. The first is the development and evaluation of an instrument by which to analyse teachers' knowledge for practical work, and the second is a case study in which a teacher's knowledge is analysed using the instrument developed.

In this chapter the rationale for the research design, the methods of data collection and analysis, will be presented and the reliability, validity and ethical consideration of the study will be discussed.

3.2 Overview of research design

The purpose of qualitative research is to understand, explain and identify behaviour and beliefs and the contexts of people's experiences (Hennink, Hutter & Bailey, 2011). Since the purpose of this study was to gain a deeper understanding of the knowledge bases that underpin teacher decision-making and practice related to practical work in their particular contexts, a qualitative research design, guided by the interpretive paradigm, was chosen.

There are a number of approaches used in a qualitative study. A case study, according to Opie is an "in-depth study of the interactions of a single instance in an enclosed system" (2004, p.74) in which the context surrounding the research is pivotal (Cohen, Manion & Morrison, 2007). The case study approach is well suited to research which will benefit from direct observation and the collection of data in their natural environment (Yin, 2006). A descriptive case study approach (Merriam, 1988) was deemed most appropriate for this study.

Understanding the context specificity of a case study approach, the intention is to gain an in-depth understanding of the knowledge base of a particular teacher, rather than to make general claims about the knowledge teachers draw when doing practical work. This, however, does not exclude the possibility of claiming some transferability of the findings of this study to similar contexts, and in that sense, it has limited generalisibility. (Yin, 2006).

An overview of the research design is represented in Figure 3.1

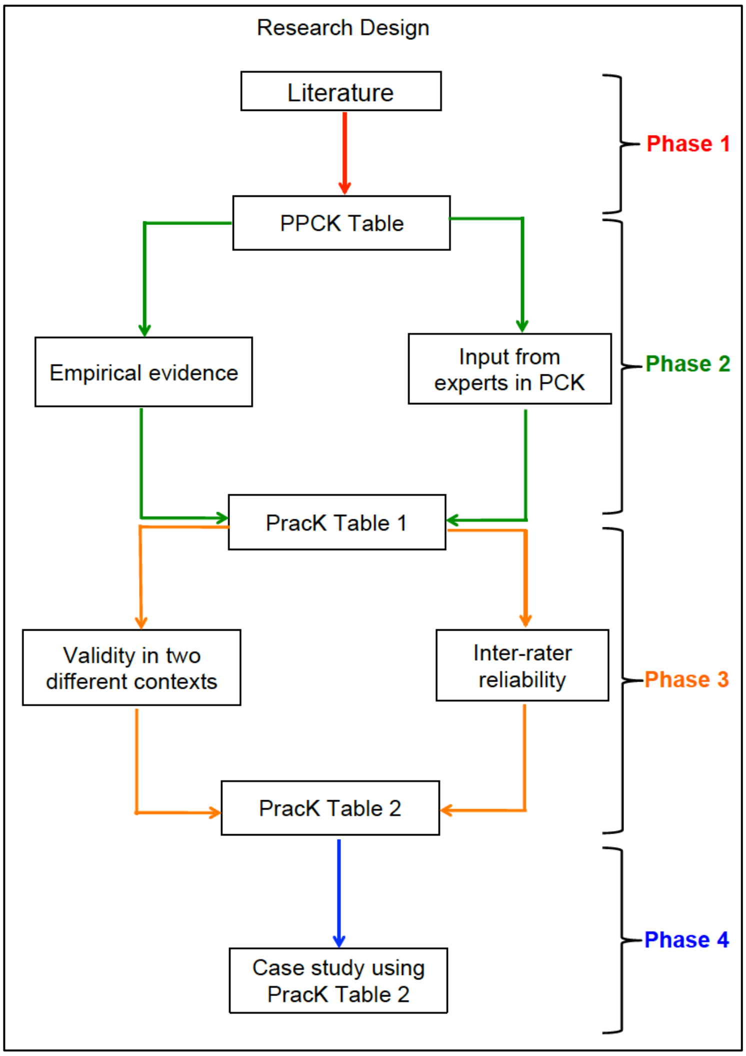

Figure 3.1 An overview of the research design

The design of this study can be divided into four main phases, where each phase is represented by different colour arrows in the diagram above. The first phase, represented by the red arrow, was the development of the first version of the analytical instrument called the practical work PCK Table (PPCK Table) based on authoritative literature on teacher knowledge and practical work. In the second phase, represented by the green arrows, the PPCK Table was piloted and presented to a discussion group which included experts in the field of PCK. Empirical findings from the pilot study and input from the experts informed the second version of the instrument called PracK Table 1. The orange arrows represent the processes by which the content validity and reliabilty of the PracK Table 1 were assesssed, which fed into the third version of the table, PracK Table 2. Finally the blue arrow represents the development of the case study using PracK Table 2 to analyse the data.

3.3 My position as researcher

The assumption in the interpretive paradigm is that there is no single objective truth, and that reality, given its complexity, is open to multiple interpretations (Toerien, 2013). The researcher's subjective views not only influence, but are an integral part of the research process. By explaining the position and roles assumed by me, the researcher, potential biases may be identified and addressed which enhances the credibility of the study (Hennink *et al.,* 2011).

I am a qualified physical sciences teacher with a B.Sc and B.Ed (Hons) degree. I have more than 20 years science teaching experience in a school in Cape Town and I have taught science and chemistry from Keystage 3 up to the Advanced Subsidiary for General Certificate of Education (GCE) level in the UK. For the past five years I have been involved in teacher development. In this role my responsibilities included school-based support for teachers teaching in a variety of teaching contexts, the development and deliviery of university accredited courses for in-service teachers and working as a research assistant in a larger school-based project [1]. In keeping with the interpretive paradigm, I adopt a constructivist view of learning.

In phases two, three and four of the process outlined above, and as will be described in more detail later, I conducted interviews with teachers and observed their lessons. The mere presence of the researcher in the classroom and the types of questions asked by the researcher may influence the teacher's practice and on this basis Cohen *et al*. (2007) would classify the researcher as a participant, especially since the research is taking place in the natural environment of the teacher. Yet they classify the researcher sitting in the back of the classroom taking notes as a non-participant observer. The distinction is not always clear. Since I did not assist in the planning of the lesson or make any suggestions, nor participated directly in any interaction in the classroom, my status is considered that of a non-participant observer during these stages of the process.

I often drew on my knowledge of the science content and teaching, my understanding of different teaching context, my own experience in the classroom and my experience of working with teachers, for the development and validation of Prack Tables 1 and 2 during Phases 2 and 3 of the study. In Phase 3, Part D in particular, I was an active participant.

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[1] Mathematics and Science Education Project (MSEP) is a collaborative project between the Western Cape Education Department and UCT, aimed at developing a model for high-quality mathematics and science learning and teaching.

3.4 Design details

My research is a multi-faceted study, drawing on a number of different data sources in the different phases of the process. The design of the PPCK table, Phase 1, and that of the case study, Phase 4 will be discussed here in detail. Only a brief outline of the design of the other phases will be given here, but detailed information about aspects, such as the participant schools, teachers and the methods of data collection, will be dealt with in Chapter Four preceding the analysis of the data.

3.4.1 Phase 1

Having decided to use teacher knowledge as the framework to gain some insight into what teachers think and do in relation to practical work, I decided to develop an instrument to facilitate the data analysis process. The first version of the analytical instrument, the PPCK Table (Figure 3.2) was developed inductively, informed by relevant literature in the field of teacher knowledge, PCK and science practical work in schools as discussed in Chapter Two.

Similar to the PCK evidence reporting table (PCK ERT) developed by Park and Oliver (2008) (see Appendix A), the PPCK Table, which consists of a number of broader categories and sub-categories of teacher knowledge, was developed. It includes those five knowledge types which Magnusson *et al.* (1999) considered as components of PCK. The literature shows that what teachers say and do in the classroom or the laboratory are also influenced by other knowledge types, and thus these were also included as main catetogories of knowledge.

PPCK Table

KNOWLEDGE INFLUENCING PCK FOR PRACTICAL WORK				PCK FOR PRACTICAL WORK				
Disciplinary Knowledge	**Content knowledge**	**General Pedagogical knowledge**	**Contextual Knowledge**	**Conception of purposes of practical work**	**Knowledge of instructional strategies**	**Knowledge of curriculum**	**Knowledge of Assessment**	**Knowledge of learning and understanding**
evaluation of validity & reliablity of scienctific information	surface level	laboratory management	students	concept acquisition & development	models and modelling	vertical curriculum	formatively assess knowledge and skills	sense making discussions
	theoretical level		classroom		demonstrations			scaffold ideas to related contexts
integration of skills & ideas within larger context	examples and counterexamples			motivation by stimulating interest & enjoyment	discovery learning		summatively assess knowledge and skills	scaffold integration of ideas with other ideas in domain
	how key ideas are related	organise & manage materials	school		skill building	horizontal curriculum		
real science approach to problem solving	historical context of development of idea		district	teach laboratory skills	problem solving		elicit exisitng conceptions	scaffold development of skills
	nature of observation vs inference				school science			
principles of randomised control group experimental design	instrumentation and other technologies	organise & manage group work	community	learn scientific method	authentic science		recognise limitations in learners thinking about concepts, skills	scaffold understanding of appropriate use of skills
	materials needed in problem-solving activities				avoids activities or representions that give rise to alternative conceptions or leads to dead ends	curricular saliency		
viable solutions to problems	distinction between theoretical explanations and empirical/descriptive accounts	organise phases of activity	nation/province	develop scientific attitudes	combines different forms of instruction for effective learning		recognise flaws in problem solving approaches or conceptual thinking	appropriate background reading
					aware of time scale of potential activities or investigations			

Figure 3.2 PPCK Table

Note that all references to a category or sub-category included in the table will henceforth be placed in single inverted commas.

Starting with the knowledge types that influence PCK, I will now describe how the literature informed the sub-categories of each of the broader knowledge categories.

The sub-categories within both of the main categories, 'disciplinary knowledge' and 'content knowledge' were derived from Windschitl's descriptions.

General pedagogical knowledge is a broad term which encompasses knowledge about general teaching and learning processes and practices, regardless of content knowledge. In the context of my study it refers to the general pedagogical knowledge related directly to the organisation and enactment of practical activities, and again, the sub-categories were derived from Windschitl's descriptions. The sub-categories of 'contextual knowledge' are those identified by Park and Oliver (2008).

The five sub-categories of 'conceptions of purposes of practical work' correspond with the main reasons teachers gave for doing practical work in a study conducted by Hodson (2005) as outlined in Chapter Two Section 2.2. The six types of practical activities identified by (Windschitl, 2004) and his descriptions of the teacher knowledge necessary for effectively using some of these strategies, were included under 'knowledge of instructional strategies'. The category 'knowledge of curriculum' was retained as per the *evidence reporting table* (ERT) developed by Park and Oliver (2008) and includes the sub-categories 'vertical curriculum', 'horizontal curriculum' and 'curricular saliency', which were described in Chapter Two Section 2.3. The sub-categories of 'knowledge of assessment' and 'knowledge of student learning' were all drawn from Windschitl's descriptions of teacher knowledge required for practical work.

3.4.2 Phase 2

This phase of the study was an exploration of the appropriateness and relevance of the categories and sub-categories included in the PPCK Table, and to get an initial feel for using the instrument in practice, with the view of refining the Table.

Firstly, a small scale preliminary study was conducted in a school serving mainly learners of a low socio-economic status which was part of MSEP (refered in Chapter Two), the school-based project on which I was working at the time. In keeping with the broader aim which was to examine the knowledge of a natural sciences teacher, the best-qualified natural sciences teacher was asked that I be allowed to observe a practical lesson he intended teaching, and also to conduct a pre-lesson interview and post-lesson interview with him. These data sources were selected because these were going to be the main data sources used in case study. The rationale for using these data sources will be discussed in Section 3.5 below.

In the second part of this phase of the process, the PPCK table was presented for discussion at a forum of novice and expert researchers in the field of PCK. Their input resulted in a significant shift in the conceptual framework of the study. Further methodological details of the preliminary study and the details of the participants in the forum are discussed in Chapter Four, Section 4.2.

The findings of this phase of the study resulted in a number of changes to the PPCK Table, including the name of the table and changes to the main categories and sub-categories of knowledge. The second version of the analytical instrument was called the practical work knowledge table (PracK Table 1). When categorising data using a table such as this, it is essential that there is a common understanding of each of the sub-categories. Each sub-category was therefore assigned a code, and the knowledge intended to be captured by each of the sub-categories, was described in an accompanying codebook.

3.4.3 Phase 3

The usefulness of PracK Table 1 now had to be determined more rigorously. For an instrument to be useful it has to be valid, reliable and easy to use in different educational contexts. Guided by the criteria developed by Barnett and Hodson (2001) to determine the usefulness of their pedagogical context knowledge model, a set of four criteria were developed by which to judge the usefulness of the PracK Table1. These criteria speak to the construct validity of the instrument as well as its reliability in terms of the consistency in the way the codes are interpreted and assigned by multiple raters.

Exploring the relevance and appropriateness of the categories and sub-categories in the PPCK Table in Phase 2 of the process, was in fact the first step in ensuring the construct validity of PracK Table 1. The preliminary study in Phase 2 was, however, conducted in one educational context, whilst in South Africa three main school contexts, based on the socio-economic status of the learners a school serves (discussed in Chapter Four, Section 4.3.1), exist. To ensure construct validity across all these contexts, the preliminary study referred to above, was replicated in two other educational contexts, based on the assumption that the context could influence the nature of the practical activities teachers engage their learners in.

The data from these studies were analysed using PracK Table 1. This analysis was used to determine if the categories and sub-categories reflected, firstly, some aspect of teachers' knowledge for practical work, and secondly if it included all the categories or sub-categories likey to be observed across the educational spectrum.

PracK Table 1 and its codebook would only be reliable if there is consistency in the way the codes are interpreted and assigned, namely that there is a significant degree of inter-rater reliability or agreement. Three raters were asked to code an interview which I had previously analysed. A quantitative analysis of the consistency with which any two raters used a particular code was also done for *each* of the codes assigned in that data source, using a technique described by Carey, Morgan and Oxtoby (1996). A statistical analysis was also done to account for agreement due to chance by calculating the Fleiss kappa statistic (Lombard, 2010) using an online calculator. Full details of the methods used are described in Chapter Four Section 4.3.2.

The findings of Phase 3 of the process resulted in refinements to some of the sub-categories and to the descriptions in the codebook and final version of the instrument, which was now called PracK Table 2.

3.4.4 Phase 4

The overarching focus of my study was to identify and describe teachers' knowledge required for conducting practical work, and as discussed earlier, a case study approach was deemed the most appropriate. PracK Table 2 was specifically developed to analyse data collected for my case study, and Phase 4 is in essence a pilot study using this instrument, thereby addressing the second research question:

> *How useful is such an instrument in analysing a natural sciences teacher's practice in order to identify and describe the knowledge types evident in planning, enacting and reflecting on practical work?*

The decision to include practical activities, and the selection of the practical activity itself, could be probed to gain some insight into the teacher's knowledge. For this reason I decided to focus on Grades 8 and 9 because, unlike in Grades 10,11 and 12, no specific practicals, with strict assessment guidelines, are prescribed for school based assessment. (Western Cape Education Department, 2009).

3.5 Methods of data collection

The complex nature of teacher decision-making and practice, nessecitates the use of multiple data sources in order to make sense of what teachers know, what they believe, what they do, and the reasons for doing what they do (Baxter & Lederman, 1999; Hume & Berry, 2011, Kagan, 1990). The data sources often used in the assessment of teachers' knowledge include semi-structured interviews, classroom observation, lesson plans, video stimulated interviews, reflective journals and researcher's field notes (Park & Oliver, 2008; Rollnick *et al.*, 2008; Hanuscin *et al.*, 2011).

Interviews, whose purpose according to Kvale (1983, p.174) "is to gather descriptions of the life-world of the interviewee with respect to the interpretations of the meaning of the described phenomena", is one the most common and powerful ways used to try to understand human beings (Fontana & Frey, 2000). The focus of my study was not only to identify the knowledge the teacher draws on but also to understand how this knowledge influences the decision he makes with regards to practical work. Just observing the teacher in the classroom could not provide the depth of data required.

There is a wide variety of forms of interviews but the semi-structured interview seemed to be the most appropriate choice for conducting with the teacher and learners. The pre-planned questions ensures that the researcher probes particular areas of interest but at the same time this type of interview allows the interviewer the flexibility of deviating from these questions, potentially providing a greater depth and breadth of data (Fontana & Frey, 2000).

Researcher bias and the effects of social cues are unavoidable in face to face research (Opdenakker, 2006). This critical awareness and peer-coding of transcripts of recorded interviews goes some way in addressing these limitations.

According to Berry, Loughran, Smith and Lindsay, teachers' knowledge of practice is largely tacit in that there are certain features of teaching, for example, " the reasons for approaching teaching in a particular way" and "ways of recognising and responding to student learning difficulties" (2009, p.576) that are not generally found in teacher-talk about teaching and learning. A similar view is expressed by Kagan (1990), referring to teacher cognitions when she says that these are sometimes held unconsciously and that teachers often do not have the language by which to describe them. These features are made explicit to the teacher and researcher only when classroom practice is more closely interrogated. This implies that teacher rhetoric of practical work may not be a true reflection of what happens in practice. Citing Crossley and Vulliamy, Abrahams and Millar (2008) argue that neither questionairebased surveys nor studies based solely on interviews, are likely to accurately capture the essence of practical work as it unfolds in its natural setting, since it is more likely 'to reproduce existent rhetoric"(ibid., p.1950). They recommend the observation of actual practices followed by a post-lesson interview with the teacher based on the belief that teachers' responses are less likely to be rhetorical, knowing that the researcher had observed the lesson.

A description and rationale for using each of the data sources selected for this single case are outlined below.

1. *Pre-lesson teacher interview*

   This interview aimed to explore the learning objectives the teacher hoped to achieve, the difficulties they anticipate and how their knowledge of the learners and context would influence their decisions related to the teaching of the topic. It was be a semi-structured interview (Bogdan & Bilken, 1992) where the guiding questions were informed by the prompts used by Loughran *et al.* (2001) in order to construct the content representations (CoRe) as a way of portraying teachers' PCK. (see interview questions in Appendix B)

2. *Lesson observation*

   As argued above, teacher rhetoric alone is unlikely to reflect the reality of a teacher's practice and since certain components of teacher knowledge are only revealed in their practice, lesson observation is an essential data collection strategy. The main lesson and any other lessons during which instructions directly related to the proposed practical actvity were given, and during which any work started during the main lesson was completed, were observed. A series of eight lessons, of which five involved practical work. were video-recorded.

3. *Post-lesson teacher interview*

   During this interview the teacher was asked to reflect on the lesson in general and based on excerpts from the video recording of the lesson, the researcher guided the teacher through a deeper reflection on certain aspects of the lesson. (see interview questions in Appendix C)

4. *General practical work teacher interview*

   This interview explored the teacher's perceptions of practical work, the learning objectives they hoped to achieve, the difficulties they anticipated and how their knowledge of the learners and context would influence their decisions related to practical work in general. (see interview questions in Appendix D)

5. *Learner interview*

   A group of five learners was interviewed two weeks after the eight lesson observations. In this interview learners were asked to reflect on what they learned in the practical lessons included in this series of lessons. (see interview questions in Appendix E)

6. *Other data sources*

   Samples of learner work and learning material used during the lesson were used as evidence of teacher knowledge related to, for example, assessment and purposes for doing practical work.

A number of instruments have been developed to measure teachers' knowledge. For example Mavhunga and Rollnick (2013) developed the pencil and paper content knowledge test and PCK test for chemical equilibrium; Ndlovu (2014) developed the topic specific pedagogical content knowledge (TSPCK) test and Phelps and Schilling (2004) developed survey instruments to measure content knowledge for teaching reading. Loughran *et al.* (2001) used CoRes and PaP-eRs to portray teachers' PCK. Such instruments have not been developed to measure teachers' knowledge for practical work and even if they were, they would not fit the purpose of this study, since the intention is to describe, and not measure, teacher knowledge.

3.6 Data Analysis

Initially, all interviews and video recordings were transcribed verbatim and each exchange in the transcript was numbered to facilitate referencing and cross referencing. These transcripts were divided into units. In an interview a unit is any verbal exchange between the interviewer and interviewee related to a particular question or topic and could be one word, or one or more statements. On the other hand, in the lesson, a unit is a verbal exchange between the teacher and any one or more learners dealing with a particular idea or the actions of the teacher captured in the transcript.

Each unit in the interviews and lesson transcripts, as well as the other data sources, were then coded using the codes assigned to each of the sub-categories included Prack Table 2, to enable an in-depth analysis of the data. Any patterns or regularities needed to be identified by constantly comparing the data from the different data sources for the purposes of data triangulation (Janesick, 1994). This process was facilitated by pulling together all the units assigned a particular code for each of the main categories of knowledge (see example in Appendix F). The analytical process allowed for the effortless location of evidence to support any claims made about a teacher's knowledge.

3.7 Trustworthiness of the overall study

The reliablity of qualitative research refers to the replicability of the study, that is, if it were repeated using a similar sample in a similar context, would the results be similar (Cohen *et al*., 2007)? Validity is based on whether the findings are what they claim to be (Bassey, 1999). In case studies it is often difficult to separate validity and reliability (Lawson & Philpott, 2008) and Bassey (1999), agreeing with Lincoln and Guba (1985), prefers to use the term trustworthiness when referring to these issues.

Unlike quantative research, qualitative research often relies on evidence collected during the study to increase its credibility (Maxwell, 2008). Suggestions of how to reduce validity threats often include prolonged engagement, triangulation, rich data, respondent validation, comparisons and peer debriefing (Bassey, 1999; Maxwell, 2008).

The development of the final version of the analytical instrument included a number of validation processes from the initial PPCK Table to the PracK Table (PracK Table 2). It drew on authoratative literature, empirical findings in different contexts, the critical feedback of experts in the field and on my own experience in education.

As the researcher, working on the MSEP, I established an intensive, long-term engagement with some of the participants during this study. Observation of one or more lessons and at least two interviews with particpants in the first phase of this study, as well as the case study, allowed me to build trust and reduced the risk of making unfounded claims. All interviews were transcribed verbatim and lessons were video recorded to provide a number of different sources of rich data to reduce the effect of bias (Becker, 1970) and these and other data sources including worksheet and learner scripts, allowed for triagulation thus reducing the risk of systematic biases (Maxwell, 2008).

3.8 Ethical considerations

My work in the one school which was part of the MSEP project was done within the ethical constraints of the memorandum of understanding of that project. For the other schools involved, permission to conduct the research was sought from the Western Cape Education Department, the principals and the individual teachers.

The purpose of the study and processes involved were explained to prospective participants. They were invited to participate and were free to withdraw at any time. The confidentiality of the teachers and the school was respected by using pseudonyms and by restricting access to the audio and video recordings to those involved in the research process.

3.9 Summary

Working in the interpretive paradigm, a case study methodology was deemed the most appropriate to address the two research questions. The four-phased research design process, which included the development and validation of the analytical instrument to be used in such a study, and the pilot case study to determine the usefulness of the instrument, were outlined in this chapter.

The findings on the development of the instrument will be presented in Chapter Four and those of the pilot case study in Chapter Five.

Chapter Four

Development and usefulness of the PracK Table

4.1 Introduction

This chapter addresses the first of the two research questions guiding this study:

How may an analytical instrument be developed to identify and describe natural sciences teachers' knowledge associated with practical work?

The PracK Table is an instrument designed to analyse teachers' knowledge for practical work. It consists of a number of categories and sub-categories of knowledge teachers are likely to draw on when making decisions about the practical activities they engage their learners in at school. The categories and sub-categories were derived both deductively and inductively as outlined in the research design process presented in Chapter Three and repeated in Figure 4.1 below.

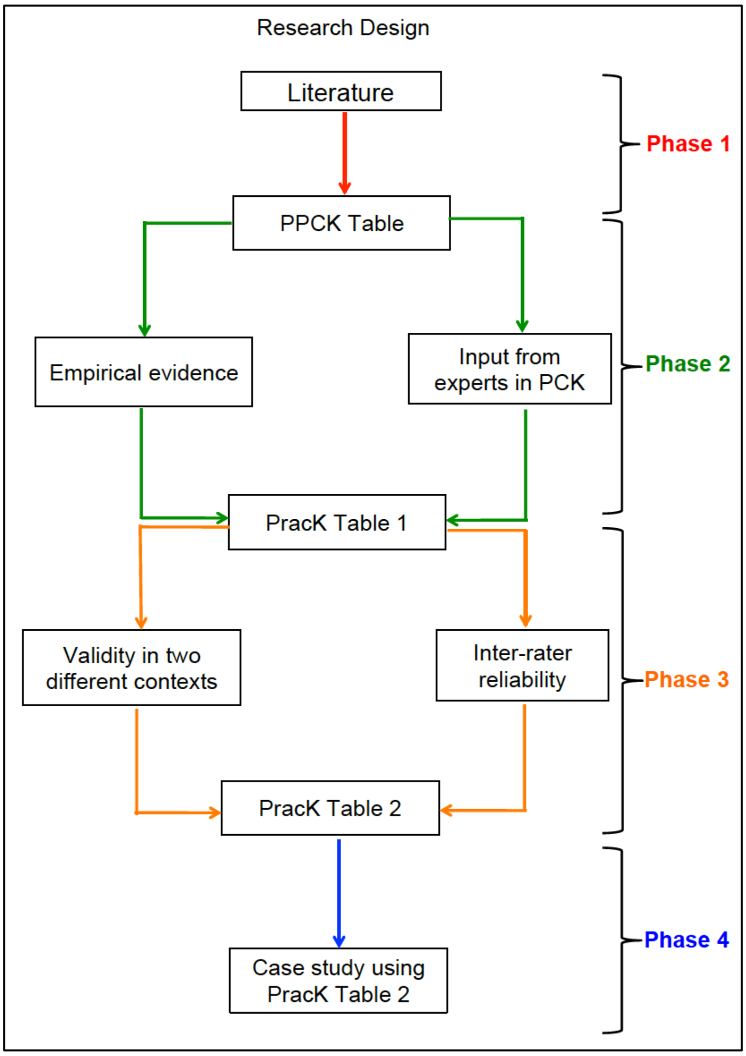

Figure 4.1 An overview of the research design (repeat of Figure 3.1)

The categories and sub-categories of the first iteration of this analytical instrument, the PPCK Table, were derived deductively, and informed by the literature. This process represented by the red arrow in Figure 4.1 above was described in Chapter Three, Section 3.4.1.

Chapter Four first describes the different stages of development of the second iteration of the instrument, PracK Table 1, based on the analysis of one teacher's rhetoric and practice, using the PPCK Table, and input from experts in the field of PCK. This is followed by the presentation of the results of the examination of the usefulness of the PracK Table which includes a focus on the validity and reliability of the instrument. Finally, based on these findings, the recommended refinements to PracK Table 1 are discussed, and the final iteration of the instrument, PracK Table 2 is presented.

4.2 Development of PracK Table 1

After developing the PPCK Table for practical work, the next step was to determine how appropriate and relevant were the categories and sub-categories included in the table and how usable the table was in practice - the process represented by the green arrows in Figure 4.1 above. This was done by first analysing interviews and a practical lesson of a teacher using the PPCK table and presenting the table for discussion to a number of novice researchers and experts in the field of PCK. Certain refinements were also made based on my 20 years of experience as a science teacher, and five years of work in teacher professional development. These insights informed the development of PracK Table 1.

4.2.1 How empirical findings influenced the development

This early stage of the development was an exploration of the appropriateness and relevance of the categories and the overall usability of the table. In this preliminary study two interviews and one lesson of one natural sciences teacher were analysed, with a view of using these findings to refine the table. The specific purpose of this stage of the development was thus to:

- identify the unused categories in order to decide whether they should be removed or redefined.
- identify any statements or incidences which could not be categorised in order to decide if additional categories or sub-categories needed to be included.
- establish if the categories and sub-categories of teacher knowledge were relatively easily recognizable and unambiguous.

A brief description of the school context, the teacher's biographical details and lessons observed will be given. This will be followed by a summary of the categories and sub-categories used and not used and arguments will be presented for the retention or removal of unused categories or sub-categories, and for the addition of categories or sub-categories based on all uncoded statements.

The preliminary study was conducted with one teacher in School A where most of the learners are from areas that are amongst the lowest 20% in terms of socio-economic status in the Western Cape (Davis, 2010). The vast majority of learners attending the school are isiXhosa-speaking. Since I was working in the school as part of a five-year, school-based project it was convenient to conduct my study at this school.

As a participating school in the Dinaledi project[2], a new science laboratory had recently been built and the school had received equipment and consumables to facilitate practical work. This laboratory, however, is used mainly as a teaching venue. There is another laboratory in the older wing of the school that is used exclusively for practical activities. Both laboratories are equipped with an interactive white board, a demonstration desk, laboratory tables and stools and are able to accommodate approximately 40 learners. The school is relatively well-resourced in terms of science practical work. The school does not employ a laboratory assistant and teachers are responsible for acquisitions, maintenance, preparation and clearing of all equipment and other resources required.

Luvo[3] is a B.Sc graduate who majored in chemistry, geography and mathematics, is a qualified science teacher with a B.Ed (Hons) degree and has 13 years science teaching experience. This teacher was selected because he was the best-qualified natural sciences teacher at School A. Before observing and video-recording one of his lessons, a pre-lesson interview (see pre-lesson interview questions, Appendix B) was conducted for the purposes of revealing Luvo's views on different aspects of practical work and ascertaining what types of practical activities he usually included in his teaching. In a post-lesson interview (see post-lesson interview questions, Appendix C) he was asked to reflect on the lesson in general, and to engage in deeper reflection on certain aspects of the lesson in order to reveal the knowledge he drew on when making decisions about practical work.

Learners at the school are engaged in limited practical activities, confined mainly to those tasks which are prescribed by the formal curriculum and which are therefore compulsory. Learners are not exposed to open-ended learner-driven investigations such as those

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[2] A Department of Basic Education project aimed at improving performance and increasing participation in Mathematics, Life Sciences and Physical Sciences in schools serving communities that were disadvantaged by the previous government.

[3] Pseudonyms are used for teachers and raters throughout the study.

required by the national science Expo (http://www.exposcience.co.za/index.php/teacher-information.html).

In the observed lesson Luvo taught 'the particle model of matter' to a Grade 8 class and learners did an investigation recommended in the Grade 8 work schedule (Western Cape Education Department, 2010). He had set up equipment at eight workstations in one of the laboratories. The equipment included a beaker filled with ice and water, an electric heater and a thermometer. Individual learners were given worksheets in which the procedure to be followed was outlined and also included some questions they were expected to answer. Before learners started the investigation, Luvo pointed out what the aim of the investigation was and reminded learners what is meant by a hypothesis. Using the board, he also explained how to read the scale on the thermometer and how to use the thermometer. Learners were required to heat the ice water, record the temperature at regular intervals until it reached boiling point and then to plot their results on a graph. While learners were engaged in the activity he moved from group to group and assisted where necessary. Some groups completed the data collection during the first period. They then drew their graphs and answered the questions in their next period in a classroom four days later.

Verbatim transcripts of the interviews and the video-recordings of the lessons (see Appendices G and H) were divided into units. I have defined a unit in an interview as any verbal exchange between the interviewer and teacher, related to a particular question or topic and could be one word or one or more statements. In the lesson a unit is a verbal exchange between the teacher and any one or more learners dealing with a particular idea or the actions of the teacher captured in the transcript.

In the PPCK Table in Figure 4.2, all the sub-categories of knowledge identified in the data are shaded in green.

PPCK Table - Luvo

ADDITIONAL KNOWLEDGE FOR PRACTICAL WORK				PCK FOR PRACTICAL WORK				
Disciplinary Knowledge	**Content knowledge**	**General Pedagogical knowledge**	**Contextual Knowledge**	**Conception of purposes of practical work**	**Knowledge of instructional strategies**	**Knowledge of curriculum**	**Knowledge of Assessment**	**Knowledge of learning and understanding**
evaluation of validity & reliablity of scienctific information	surface level	laboratory management	students	concept acquisition & development	models and modelling	vertical curriculum	formatively assess knowledge and skills	sense making discussions
	theoretical level		classroom		demonstrations			scaffold ideas to related contexts
integration of skills & ideas within larger context	examples and counterexamples			motivation by stimulating interest & enjoyment	discovery learning		summatively assess knowledge and skills	scaffold integration of ideas with other ideas in domain
	how key ideas are related	organise & manage materials	school		skill building	horizontal curriculum		
real science approach to problem solving	historical context of development of idea		district	teach laboratory skills	problem solving		elicit exisitng conceptions	scaffold development of skills
	nature of observation vs inference				school science			
principles of randomised control group experimental design	instrumentation and other technologies	organise & manage group work	community	learn scientific method	authentic science		recognise limitations in learners thinking about concepts, skills	scaffold understanding of appropriate use of skills
	materials needed in problem-solving activities				avoids activities or representions that give rise to alternative conceptions or leads to dead ends	curricular saliency		
viable solutions to problems	distinction between theoretical explanations and empirical/descriptive accounts	organise phases of activity	nation/province	develop scientific attitudes	combines different forms of instruction for effective learning		recognise flaws in problem solving approaches or conceptual thinking	appropriate background reading
					aware of time scale of potential activities or investigations			

Figure 4.2 PPCK Table showing sub-categories identified in data

The decisions to retain or remove unused categories or sub-categories at this stage of the process were based on authoritative literature, as well as my own knowledge and experience. The bases for these decisions will be discussed in order of increasing number of unused sub-categories in each category.

The categories 'general pedagogical knowledge', 'conceptions of purposes of practical work' and 'knowledge of assessment' had no unused codes and no changes were deemed necessary.

The category 'contextual knowledge' had one unused code i.e. 'nation/ province'. South Africa has a national science curriculum and there are certain national science projects, such the Dinaledi project, which have certain goals and objectives. Provincial education departments however, have a degree of autonomy and have their own objectives. These national and provincial demands placed on teachers and reports in the media on the deficit of scientific skills in South Africa and the country's poor performance in international benchmarking tests such as TIMMS[4] (Martin, Mulls, Foy & Stanco, 2012; Mullins, Martin, Foy & Arora, 2012), may influence what teachers say or do. This sub-category was thus retained.

[4] Trends in International Mathematics and Science Study

In the category 'knowledge of learning and understanding', the one unused sub-category was 'appropriate background reading'. Although Luvo seems to engage his learners mainly in structured, teacher-driven activities, in more open-ended, learner-driven investigations, a teacher may have to be able to guide learners by suggesting readings appropriate to their investigation. This sub-category was thus not removed.

Of the three sub-categories of 'curriculum knowledge' only 'horizontal curriculum' was unused. Horizontal curriculum refers to the teacher's knowledge of the curricular requirements in other disciplines or subjects and of how the science topics at a particular level are related. Although this was not evident in just the two interviews and one lesson observed, such knowledge is important for good teaching. This sub-category was therefore not removed.

There were two unused sub-categories in the category of 'knowledge of instructional strategies', namely, 'problem solving' and 'combines different forms of instruction for effective learning'. Problem solving is central to science and an integral part of science curricula today. Problem solving by means of practical investigations is also encouraged in the new curriculum (Department of Basic Education, 2011) thus some knowledge of problem solving approaches would be required. That sub-category therefore had to be retained. It is sometimes necessary to combine different instructional strategies and teachers should know how to do this effectively. That sub-category was therefore also retained.

In the category 'content knowledge' it was difficult to decide if the teacher understood the content on a surface or theoretical level, and there were three other unused codes, that is, 'knows examples and counter-examples', historical context of development of idea and 'materials needed in problem solving activities'.

Consider the following excerpt from the post-lesson interview in which Luvo was asked what he expected his learners to learn by doing this activity:

> *Ja, I'll say they are to be able to notice that when there is a phase change you know the temperature is not you know increasing or decreasing, it remains constant. … I have not taught them before about latent heat of fusion,… but I just wanted them to start thinking about why this is happening that way, using the knowledge they got when we were discussing the structure of matter… there was something I was showing them the model I was showing them of how particles are arranged and they could see they were moving but very*

> *slowly in solids but in the case of a liquid the movement was faster which means now in the case of a liquid now they have more kinetic energy ….*
>
> [Luvo post-lesson interview, p.1]

It is clear that he knows some of the content related to the particle model of matter, phase changes and the related energy changes, but it is difficult to say whether he understands the concepts at a surface level or a theoretical level based on one statement in the interview. For the purpose of simplification, the first three sub-categories were thus combined to read ‘understands the scientific concepts related to the practical activity’. These distinctions are now made explicit in the description of this new sub-category (as will be seen later).

There are certain topics in science in which the knowledge of the historical development of certain theories is considered important for deepening the understanding of the topic. A classic example would be the development of the atomic model. The sub-category ‘historical context of development of idea’ was thus retained.

The category ‘knowledge of instructional strategies’ captures not only the use of, or an awareness of, the different types of activities but also an understanding of the processes involved in such activities. The sub-category ‘materials needed in problem-solving activities’ under content knowledge was therefore considered superfluous since it would be captured under ‘problem solving’ in the category ‘knowledge of instructional strategies’.

The only main category that was not used was ‘disciplinary knowledge’ and thus demanded closer scrutiny. This category was included in the table based on the work of Mark Windchitl in which he defined it as:

- understanding the purposes of science inquiry
- knowledge of domain –specific methods of investigation
- understanding the nature of relationships between scientific models and data
- knowledge of standards for evidence and argument held in various fields of science
- recognizing reputable sources of information and distinguishing them from pseudo- science, commercial reports, secondary sources etc.

(2004, p. 5)

In his paper he explains that the distinction between knowledge of the discipline and content knowledge was made because an understanding of how scientific knowledge was produced and judged, was important if teachers wanted to move beyond a ‘cook book’ approach to practical work. Whilst this distinction is important, in order to simplify the table without sacrificing its potential to make this distinction in teachers' knowledge, it was decided that some of the categories could be included under content knowledge either unchanged or combined with those which already existed in this main knowledge category.

In the extract of the interview shown above it appears that the teacher understands how the different ideas are integrated, but his response could also be interpreted as an understanding of 'how key ideas are related', which is a sub-category of content knowledge. The difference is quite subtle and it may be difficult to distinguish between the two. The sub-category 'integration of skills & ideas within larger context' was thus removed and the sub-category 'understands how key ideas are related' under 'content knowledge' was changed to 'understands how key ideas *and skills* are related'.

The sub-categories 'principles of randomized control group experimental design', 'viable solutions to problems' and 'real science approach to problem solving' were removed, based on the argument that this would be captured by one of the sub-categories under 'knowledge of instructional strategies'.

With only one sub-category 'evaluation of validity and reliability of scientific information' remaining, it was decided that its inclusion under 'content knowledge' would be more pragmatic and the category 'disciplinary knowledge' was thus removed.

Reflecting on his lessons, Luvo said that one of the advantages of doing this practical was "what they see is able to stick in their minds". During the course of my professional development work I had heard this same idea that practical activities enable learners to remember scientific ideas or concepts, expressed by other teachers. This distinction between understanding concepts and remembering concepts is important as the move away from rote learning is encouraged and the sub-category 'recall of concepts' was thus included under conceptions of the purposes of practical work.

Luvo says the idea for the practical activity "came from the work schedule". The sub-category 'curricular requirements' was included under 'knowledge of curriculum' because none of the other categories captured teachers' knowledge of the content and practical work prescribed or recommended, and the related assessment requirements contained in curriculum documents. This is important in the South African context since the current curriculum is extremely prescriptive and curricular coherence in respect to assessment of practical work is closely monitored in some provinces.

Finally, the name of one category of knowledge was changed. The word ‘ conception’ in the category ‘conception of purposes of practical work’ was thought to be too vague and that the term ‘knowledge and beliefs about education purposes of practical work would make more explicit the facet of teachers’ knowledge intended here.

This stage of the development process was extremely helpful. It required a critical reflection on the literature, realignment with the conceptual framework and an acknowledgement of the importance of empirical findings and experience, in constructing an analytical instrument. It resulted in a number of changes to the PPCK Table.

4.2.2 How input from experts influenced the development

As one of the novice researchers on a larger PCK project, I was afforded the opportunity to present the PPCK table for discussion to fellow novice researchers, as well as experts in the field of PCK, such as Marissa Rollnick (University of the Witwatersrand) and John Loughran (Monash University). Both researchers questioned the construct of PCK for practical work on the basis that PCK is essentially topic specific, a view held by a number of other researchers (e.g. Geddis & Wood, 1997; Park & Chen, 2012) and that practical work was not a ‘topic’ *per se*. An argument either had to be made for either viewing practical work as a ‘topic’, ,, a body of knowledge with its own set of facts, ideas and concepts or the construct had to be abandoned.

Hanuscin *et al*. (2011) argue that although the nature of science (NOS) is not a science topic *per se*, there are certain ideas that have to be explicitly taught in order to improve learners’ understanding of NOS. NOS can, therefore, be viewed as a topic in the domain of science - justifying these authors’ notion of PCK for NOS.

Schuster, Cobern, Applegate, Swartz, Vellom and Undreiu talk about the PCK of inquiry science teaching which they define as “knowledge of topic teaching practices that reflect the inquiry nature of science” (2007, p.1) and later refer to inquiry as an approach to science teaching. Inquiry science teaching is as they say, an *approach* to science teaching rather than a body of knowledge and therefore not topic specific. The construct, PCK of inquiry science teaching, is therefore also questionable.

In retrospect, science practical work is in essence a *strategy* a teacher may employ to facilitate the learning of scientific concepts, to develop the skills of formulating a hypothesis or a conclusion, identifying the different types of variables, data handling, amongst others. Some of these very same concepts and skills could be taught, albeit not as effectively, using paper and pencil exercises. Certain science topics lend themselves to developing certain procedural skills and knowledge, and teachers with a well-developed PCK for that particular topic would thus engage learners in practical activities to do just that. The construct of PCK for practical work was problematic and thus abandoned.

The input from fellow researchers resulted in a significant shift in the conceptual framework of this study. The categories of knowledge identified as components of PCK or influencing PCK, still proved to be useful for identifying and describing the knowledge teachers use to engage their learners in practical work. These categories and sub-categories were essentially retained in the revised version of the PPCK Table, but for the changes informed by the empirical findings as described in Section 4.2.1 above.

4.2.3 PracK Table 1

Based on the discussion above the PPCK table was amended (Figure 4.3.) Since PCK no longer was the central construct in the conceptual framework, the name of the updated table was also changed to the PracK (practical work knowledge) Table.

The main categories included in the table are:

- knowledge and beliefs about educational purposes of practical work (KBEP)
- knowledge of content (KCt)
- knowledge of curriculum (KC)
- general pedagogic knowledge (GPK)
- knowledge of instructional strategies (KIS)
- knowledge of learning and understanding (KLU)
- knowledge of assessment (KA)
- knowledge of context (KCx)

The description of each of these categories is given in the codebook in Appendix I.

PracK Table 1

KBEP	KCt	KC	GPK	KIS	KLU	KA	KCx
concept acquisition & development	scientific concepts related to the practical activity.	curricular requirements	manage laboratory	models & modelling	sense making discussions	formative	learners
recall of concepts	instruments and technology	vertical	organise and manage group work	demonstration	scaffold ideas to related contexts		classroom
	how key ideas and skills are related			discovery learning		summative	
motivation by stimulating interest & enjoyment				skill building	scaffold integration of ideas with ideas in other domains		school
	nature of observation vs inference	horizontal	organise and manage materials	problem solving			
teach laboratory skills	historical context of development of ideas			school science	scaffolds development of skills	elicit existing conceptions and skills	district
learn scientific method				authentic science	scaffold understanding of appropriate use of skills	recognise limitations in thinking and skills	community
	distinction between theoretical explanations and empirical /descriptive accounts	curricular saliency	organise phases of activity	avoids activities or representations that give rise to alternative conceptions			
develop scientific attitudes	evaluation of validity & reliability of scientific information			combines different forms of instruction for effective learning	appropriate background reading	recognise flaws in problem solving approaches and conceptual thinking	province/nation
				aware of time scale of potential activities or investigations			

Figure 4.3 PracK Table 1

4.3 Usefulness of PracK Table 1

Phase 2 of the study was an exploration of the appropriateness and relevance of the categories and sub-categories; and to get an initial feel for using the table in practice, with the view of refining the PPCK Table. The usefulness of the revised table now had to be determined more rigorously, with more attention being paid to the reliability and validity of this analytical instrument. This process is represented by the orange arrows in the diagram of the design process (Figure 4.1)

The approach used to explore the usefulness of the table is fashioned on the work of Barnett and Hodson to determine the usefulness and validity of their pedagogical context knowledge model. They suggested that a model is only useful "if it can provide convincing descriptions of real situations, furnish additional insight, and/or provide a way of interpreting the data arising from interviews and conversations with teachers" (2000, p. 441). In their study main categories, sub-categories and sub-sub-categories of teacher knowledge were identified, and statements in six interviews were assigned three digit codes representing the three different levels of categorization. They developed the following criteria to determine the usefulness and validity of their model:

- most of the codes are necessary in categorizing teachers' statements
- the number of unused codes is low
- most of the teachers' statements can be coded using the model, that is, the number of uncoded statements is low
- there is a reasonable balance among the framework categories utilized; that is, coding does not show the model to be biased toward a particular kind of teacher knowledge (*ibid.,* p. 445)

Turning now to the PracK Table in relation to the criteria stated above, it would be imprudent to expect that any one teacher would display knowledge in each of the sub-categories due to i) limited access to teachers' classrooms ii) the influence of the curriculum and educational context on what teachers say and do and iii) the influence of the types of questions asked by the researcher. It would be equally unreasonable to expect a table such as this to pre-empt every possible aspect of every teacher's knowledge, but at the same time it would be of little value if much of what teachers say or do, does not fall into any of the sub-categories. Finally when considering data sources which are likely to give the greatest insight into teachers' knowledge, such as interviews and lesson observations, as opposed to say, one assessment task, there should be a reasonable balance across the different categories and sub-categories.

The criteria by which the analytical instrument in this study will the deemed useful are thus:

Criterion 1: all the main categories and most sub-categories in each main category are used

Criterion 2: most of teachers' knowledge evident in their rhetoric and practice can be captured by the categories and sub-categories in the table

Criterion 3: there is a reasonable balance among the categories and sub-categories used when analyzing teacher interviews and lesson observations

Criterion 4: the categories and sub-categories are relatively easily recognizable and unambiguous

The first three criteria speak to the construct validity of the instrument while the fourth implies that there would be significant consistency in categorizing data by multiple raters, that is, significant inter-rater reliability.

4.3.1 Validity of PracK Table 1

The validity of a test instrument is said to be the degree to which it measures what it purports to measure. A valid instrument must always be reliable but a reliable instrument is not necessarily valid. The terms often associated with validation of an instrument include construct validity, face validity, content validity and criterion related validity. Construct validity is the overarching construct, demonstrated by all the other types of validity measures (http://www.socialresearchmethods.net/kb/measval.php). This construct validity examines the relationship between the instrument being evaluated and the theory related to the construct being measured and the relationship between the instrument and other variables known to be related to the construct being measured (Kimberlin & Winterstein, 2008).

The PracK Table being evaluated here is not intended to measure teachers' knowledge for practical work; it is merely a heuristic device for describing what teachers know. As such its validity cannot be assessed by the same criteria, as say, the validity of an instrument to measure a teacher's content knowledge. What is important is that on the one hand all the categories and sub-categories included reflect some aspect of the teachers' knowledge that influences their decisions around practical work and on the other, it includes all the categories and sub-categories likely to be observed. These aspects speak to the face and content validity of the PracK table. According to Haynes, Richard & Kubany (1995, p.239) content validity is " the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose." Neither of these measures can be subjected to statistical analyses and rely on the judgment of the researcher in this instance (Kimberlin & Winterstein, 2008).

The categories and sub-categories were derived based on extensive research on teacher knowledge, practical work and the relationship between the two. In addition, the preliminary study using the PPCK Table further informed the PracK Table. I was satisfied with the face validity of the instrument. To verify this judgment, the three participants involved in the determination of the reliability of the table were asked to make a judgment as well. They all agreed that on face value, the table appeared to capture those aspects of teacher knowledge important for practical work.

Assessing the content validity involved a more rigorous process of checking that most of the teacher statements and observations during the lesson could be coded using PracK Table 1, that most codes were used, and also that there was a good spread of codes across the table.

The effects of unequal opportunities in education in South Africa prior to the first democratically elected government persist in the current education system, where schools can be categorized into three broad educational contexts. These are poor performing working class school, a well- resourced, high performing, middle class public school and well-resourced, high performing private school. Working class schools are poorly resourced, do not attract the best qualified teachers and perform poorly in the provincial and national systemic tests (Department of Basic Education, 2013). Schools serving middle class families are generally better off, and those serving upper middle class families, even better off in all three of these aspects of schooling. Clark and Linder (2006) showed how constraining the context of working class schools could be on teaching practice. Assuming that the context would also influence the nature of practical work in schools, the validity of the PracK Table had to be assessed in each of the three main educational contexts in South Africa.

With this in mind, and having already drawn on the evidence in a working class school for the development of the table, it was decided that a well qualified, experienced science teacher in each of the other socio-economic contexts would be interviewed and observed to assess the content validity of the table.

A comparison of the three teachers' qualifications, teaching experience and the schools at which they teach is given in Table 4.1 below.

Teacher	School	Grade observed	Qualifications	Subject specialisation	No. of years teaching	No. of years teaching at current school
Luvo	A – working class	9	B.Sc PGCE B.Ed (Hons)	Chemistry Geography	13	7
Nadjwa	B – middle class	8	B.Sc PGCE	Microbiology Biochemistry	9	7
Michelle	C- upper middle class	9	B.Sc B.Sc(Hons) HDE	Microbiology Biochemistry	13	9

Table 4.1 Teachers' biographical details

Just as described for Luvo in Section 4.1, pre- and post-lesson interviews were conducted with Nadjwa and Michelle and one of each of their practical lessons was observed. The structured questions across the two interviews were the same as in the interview with Luvo, except that the order in which they were asked differed, depending on the availability of the teacher. Again the intention here was not to provide an in-depth description of the other two teachers' knowledge for practical work. Instead, a description of the school, the background of the teacher and the lesson observed, will be presented to sketch the context. This will be followed by a summary of i) the categories and sub-categories used and not used ii) the presentation of evidence of sub-categories not used for Luvo and iii) the presentation of incidences where the teachers' knowledge could not be adequately captured by any of the existing codes.

School B is a well-resourced, high-performing, middle class, public school. The school has two science laboratories which are also used as classrooms and two other rooms which have a demonstration desk at the front. The school employs a full time laboratory technician who prepares practical equipment according to the teacher's instruction. In addition, he does all the printing of worksheets and prepares resources and other material for the teachers in the science department. Learners at the school are engaged in a number practical activities in the junior grades but the number of practical activities decrease as they progress from Grade 6 to Grade 12. Many Grade 12 teachers are of the opinion that, given the demands placed on them to complete the syllabus and to prepare their learners for the high stakes matric examinations, they only have time to complete the prescribed practical activities. An internal science expo is run for the Grade 9's in which they have to reseach a topic of their own choice and present their work to parents, teachers and fellow learners. Although encouraged to do so, very few learners take up the challenge of participating in the Cape Town Science Expo.

Nadjwa was teaching the section on the preparation, tests and properties of oxygen, carbon dioxide and hydrogen at Grade 8 level. She had given the learners notes on the topic and her intention was to demonstrate the preparation and tests for the three gases in the lesson I observed. She also intended comparing the solubility of the three gases.

The lesson was conducted in one of the school laboratories and all the equipment and resources had been prepared by the laboratory technician, and was set up on the demonstration desk at the front of the laboratory. Nadjwa, with the help of three learner volunteers, sucessfully demonstrated the preparation of the three gases, but the tests for the presence of carbon dioxide and hydrogen were unsuccessful. She did not attempt to compare the solubility of the three gases as planned because she was not able to collect enough carbon dioxide and hydrogen required for the investigation. Before the demonstration of each of the gases, Najwa showed a slide on the overhead projector showing the chemicals and the arrangement of the equipment required. Learners were also given a worksheet which they were required to complete as they went along and they had some time after the completion of the demonstration to complete the worksheet.

School C is a well-resourced private school serving an upper middle class community. There are a number of similarities between Schools B and C with regard to availability of resources and the types of practical activities learners in the schools are engaged in. School C has two dedicated science laboratories and two other rooms, referred to as mini-labs, which have a demonstration desk at the front and workstations along the three walls of the room. The school employs a full time laboratory technician who prepares practical equipment according to the teachers' instructions. The technician, however, who was straight out of high school, had no experience of working in a laboratory, is still being trained by the teachers.

The number of practical activities in School C also decreases from Grade 8 to 12 as the time pressure takes it toll. As with School B, only the prescribed activities are done in matric. The school also used to run an internal science expo and some learners were encouraged to participate in the provincial competition. At the start of the Grade 8 year learners are made aware of the laboratory rules and are familiarised with the basic laboratory equipment. At Grade 8 and 9 level an attempt is made to include a practical activity for every topic taught.

Michelle was teaching the respiratory and circulatory system to Grade 9's. In the double period lesson observed, learners were asked to investigate the effect of exercise on heart rate. According to the teacher, the main objective of the lesson was for learners to learn the scientific method.

The lesson was conducted in a mini-lab in which 28 learners were seated in rows. At the start of the lesson the teacher stated the aim of the investigation and asked for possible ways to conduct this investigation. She then explained how to measure pulse rate and allowed them to practice doing this once. Learners were then asked to conduct their investigation in groups. They were encouraged to leave the classroom to reduce the noise level and were asked to report back to the classroom in 30 minutes. All the groups went outside- some running up and down the stairs, some running across the playground, and others doing star jumps in the quad. After half an hour, all the groups had returned to class. As learners returned they were given the worksheet and asked to complete the task on their own, but they were allowed to reference any book or notes they chose. This was done in almost complete silence. A few learners raised their hands and asked questions mainly to clarify what it was they had to do. At the end of the lesson all learners handed in their work. The teacher later reported that not all learners completed the task in the allotted time and they were then given the opportunity to complete it in the next period.

In Section 4.2.1 all the codes assigned for Luvo were shaded in Figure 4.2 above. These codes were transposed onto PracK Table 1 and all the codes evident for the three teachers were shaded in Figure 4.4 below, thus clearly showing the used and unused codes.

PracK Table 1 - Luvo, Najwa & Michelle

<table>
<tr><th>KBEP</th><th>KCt</th><th>KC</th><th>GPK</th><th>KIS</th><th>KLU</th><th>KA</th><th>KCx</th></tr>
<tr><td>concept acquisition & development</td><td>scientific concepts related to the practical activity.</td><td>curricular requirements</td><td>manage laboratory</td><td>models & modelling</td><td>sense making discussions</td><td rowspan="2">formative</td><td>learners</td></tr>
<tr><td rowspan="2">recall of concepts</td><td>instruments and technology</td><td rowspan="3">vertical</td><td rowspan="3">organise and manage group work</td><td>demonstration</td><td rowspan="2">scaffold ideas to related contexts</td><td rowspan="2">classroom</td></tr>
<tr><td rowspan="2">how key ideas and skills are related</td><td>discovery learning</td><td rowspan="3">summative</td></tr>
<tr><td rowspan="2">motivation by stimulating interest & enjoyment</td><td>skill building</td><td rowspan="2">scaffold integration of ideas with ideas in other domains</td><td rowspan="2">school</td></tr>
<tr><td>nature of observation vs inference</td><td rowspan="3">horizontal</td><td rowspan="3">organise and manage materials</td><td>problem solving</td></tr>
<tr><td>teach laboratory skills</td><td rowspan="2">historical context of development of ideas</td><td>school science</td><td>scaffolds development of skills</td><td>elicit existing conceptions and skills</td><td>district</td></tr>
<tr><td rowspan="2">learn scientific method</td><td>authentic science</td><td rowspan="2">scaffold understanding of appropriate use of skills</td><td rowspan="2">recognise limitations in thinking and skills</td><td rowspan="2">community</td></tr>
<tr><td>distinction between theoretical explanations and empirical /descriptive accounts</td><td rowspan="3">curricular saliency</td><td rowspan="3">organise phases of activity</td><td>avoids activities or representations that give rise to alternative conceptions</td></tr>
<tr><td rowspan="2">develop scientific attitudes</td><td rowspan="2">evaluation of validity & reliability of scientific information</td><td>combines different forms of instruction for effective learning</td><td rowspan="2">appropriate background reading</td><td rowspan="2">recognise flaws in problem solving approaches and conceptual thinking</td><td rowspan="2">province/nation</td></tr>
<tr><td>aware of time scale of potential activities or investigations</td></tr>
</table>

Figure 4.4 PracK Table 1 showing codes evident for the three teachers

Forty six of the 48 codes i.e. 95,8 % of sub-categories were used and there was a good spread across all the main categories thus meeting criteria 1 and 3 (Section 4.3) - this suggested strong content validity. A few explicit examples of evidence of each of the sub-categories which were unused for Luvo, but were apparent for Nadjwa or Michelle are presented below.

Michelle's curricular saliency is clearly evident when she speaks about some of the other practicals she has done.

> *As I said for most topics we actually do a prac – so we also will do another one – where we will dissect the heart and the lung. So this specific prac lended itself to the learners practicing the scientific method which we find them very weak in. The dissection we find that if we assess that, that they actually do better at it come Grade 11. So that they do it later anyway so we rather not assess that now and there you are more assessing dissecting skills and drawing skills. We did that previously we did an onion cell prac. In that one we sort of assessed their drawing skills.* [Michelle post-lesson interview, p.4]

The practicals are not done merely as a matter of curricular compliance but are informed by her knowledge of the curriculum, knowledge of her school context and specific assessment purposes she has in mind.

As Nadjwa spoke about the other activities she intended doing after the demonstration of the preparation and tests of the gases, it became clear that she combines a number of different strategies in her teaching.

> *Ok – so – we try and have a test after each module so there is going to be a gases test on this module. But before that we are doing a little presentation activity. So we have 10 topics – you have things like …. of gases , respiration, baking, carbon dioxide – baking cakes kind of thing and they have to relate one of the three gases to their topics . So they should know that baking cake relates to carbon dioxide. And so we put them in groups of three and we allow them to do some research on it so they come back and each person in the group must present something about baking cake and how it relates to their topic. And then one of the criteria is to make a mind map of the topic and then presentable and copy down so that the rest of the kids to make the rest of them interested – cause what we found was that they would chat and not be interested so they need to copy down the mind map so the rest of them just listening they have to copy down the mind map as well. … And then they write their test soon after that. We always tell them they don't really have to study the mind map but they just read through it and we ask them one question in the exams so why did the Hindenburg explode kind of thing or what is … so we don't force them study the extra information but general information about the topic.*
> [Nadjwa pre-lesson interview, p.6]

Besides these activities Nadjwa also generally engages her learners in problem solving activities.

> *we give them two investigations – so we tell them you have to look at the effects of rainbows . Then you have to create your own rainbow. … So we don't tell them anything. So they have to figure out how some do it in a dark room, others do it with water, other do it with the glass you know so they need to*

> *figure out, research, carry it out and then come up with their reports. … How you carry that out – that is entirely up to you. So its amazing – so you get some kids come up with the same, some come up with ingenious things …*
> [Nadjwa post-lesson interview, p.8]

Here it is also significant to note that an understanding of the hazards associated with laboratory chemicals, procedures and equipment and the ways of avoiding or minimising these hazards is not only essential for teachers and laboratory assistants, but should also be explicitly taught. Evidence of such knowledge was not equally evident in all teaching contexts.

In Michelle's school the learners entering the school laboratory for the first time are made aware of some of these hazards and it was reinforced when necessary.

> *but also when it is a specific prac when a specific rule is important like when you smell something you don't actually smell it, you waft it and this prac is very important that you have your safety goggles because this is very corrosive or whatever …* [Michelle post-lesson interview, p.8]

In Nadjwa's lesson, when one of the learners offered to assist the teacher, he immediately took off his school tie and put on his safety goggles. When other learners volunteered to assist, their classmates reminded them to wear safety goggles. This suggested that her learners also had this awareness of potential hazards and laboratory safety rules.

This awareness also influenced the choice of instructional strategies of both these teachers. Michelle says *"Sometimes if its something we feel is too dangerous like with the reactions of the group one metals we obviously demonstrate that one"* [post-lesson interview]. One of the reasons Nadjwa gave for doing the activity as a teacher demonstration rather than a hands-on activity is also safety.

> *It's going to be a teacher demonstration ya… Basically because it includes hydrochloric acid and it also goes a bit quicker also. As I've said they had hands on experience already so, we choose the safer stuff. I think they did one on filtering – chalk and salt …..* [Nadjwa pre-lesson interview, p.6]

Knowledge about health and safety in the laboratory and associated with particular activities, procedures and equipment is not adequately captured in PracK Table 1 since it was not foregrounded in the preliminary study with Luvo. However, further investigation highlighted its importance and this has thus been included as a sub-category of 'content knowledge'.

All other units across all data sources in this study could be coded using PracK Table 1 and thus satisfies criterion 2. The content validity is thus adequate as it captures the knowledge it intends.

4.3.2 Reliability of PracK Table 1

The subjectivity of qualitative analysis is a major consideration for researchers since replicable analysis is important for the scientific credibility of a study. One way of guarding against such bias, especially in large-scale studies involving multiple raters, is by taking explicit steps to ensure inter-rater reliability or inter-rater agreement (Carey *et al.*, 1996). In this study the purpose of determining the inter-rater agreement was different. The purpose was two-fold: i) to identify and address any discrepancies in the interpretation of the code book and ii) to enhance the credibility of the PracK Table as a heuristic and analytical device if it could be shown that there is significant consistency in coding by multiple raters.

There are a total of 48 codes on the Prack Table and the inter-rater agreement was determined amongst three raters and myself. Three colleagues were asked to code an extract from one teacher interview which the researcher had previously analysed. Wendy and Mark have some experience in educational research in the field of teacher knowledge, and are familiar with the work of many of the theorists that informed this study. Both were also members of the discussion group which gave input on the PPCK Table earlier in the process. The third rater was a teacher, Colleen, with some experience in educational research, but not in the field of teacher knowledge. All raters are qualified science teachers, have experience in high school teaching and have some experience in educational research, albeit in different fields (see Table 4.2)

Name	Rater no.	Current position	Qualification	Research focus	No. years teaching experience
Wendy	2	PhD student	B.Sc HDE B.Ed(Hons) M.Ed	Teacher knowledge	7 years
Colleen	3	Science teacher	B.Sc HDE B.Ed(Hons) M.Ed	Science assessment	16 years
Mark	4	Educational specialist	B.Sc HDE B.Ed(Hons)	Teacher knowledge	12 years

Table 4.2 Raters' biographical details

In a joint session, the background of the study and the purpose of the coding exercise was explained to Wendy and Colleen, and together, we coded a few teacher comments. Due to circumstance rather than by design, a separate session was held with Mark using the same presentation and together coding the same comments. In round one, all raters were given a transcript of one interview, divided into 14 text units (Appendix J). This was done to avoid disagreements caused by differences in the segmentation of the text. Each rater was given a copy of PracK Table 1, on which each of the sub-categories was assigned a code (Appendix K), as well as the codebook. They were asked to code the transcript independently, one unit at a time, noting their reasoning as they proceeded. A specific code could only be assigned once per unit. In an audio-recorded discussion each rater motivated his/her coding and all disagreements were discussed to see if consensus could be reached. This second round of coding allowed for the identification and correction of problems in the codebook.

Two methods to determine the level of agreement are possible. The first is to examine the agreement in how the raters interpret and assign each of the different codes .The second is to examine the agreement in the set of codes each rater assigned to each of the text units. The codes assigned by each rater for each of the 14 units for both rounds of coding are summarized in Figures 4.5 and 4.6 below.

ROUND 1																									
Unit No.	Codes																								Rater
1				KBEP4	KBEP5	KCt1	KCt3								KIS6					KA3	KCx1				1
	KBEP1				KBEP5	KCt1					KC4									KA3	KCx1				2
		KBEP2		KBEP4																KA3					3
						KCt1		KC1	KC2					KIS4	KIS6						KCx1				4
2	KBEP1					KCt1	KCt3	KC1				KIS1									KCx1				1
	KBEP1					KCt1					KC4	KIS1													2
			KBEP3																				KCX3		3
						KCt1		KC1		KC3															4
3	KBEP1					KCt1	KCt3																		1
	KBEP1					KCt1																			2
										KC3															3
						KCt1		KC1																	4
4						KCt1	KCt3		KC2																1
						KCt1																			2
						KCt1		KC1	KC2	KC3	KC4														3
									KC2																4
5	KBEP1											KIS1													1
																									2
	KBEP1																								3
												KIS1													4
6												KIS1									KCx1		KCX3		1
												KIS1									KCx1		KCX3		2
												KIS1													3
						KCt1						KIS1									KCx1				4
7																								KCX4	1
																							KCX3		2
																							KCX3	KCX4	3
																					KCx1		KCX3		4
8																		KA1			KCx1	KCX2			1
																		KA1			KCx1	KCX2			2
		KBEP2														KLU2						KCX2			3
								KC1													KCx1				4
9					KBEP5										KIS6					KA3					1
					KBEP5																				2
					KBEP5								KIS3		KIS6										3
						KCt1									KIS6										4
10																		KA1							1
																		KA1							2
																		KA1							3
		KBEP2																							4
11							KCt3												KA2	KA3					1
							KCt3												KA2	KA3					2
								KC1										KA1							3
		KBEP2																							4
12									KC2							KLU2									1
											KC4														2
									KC2																3
								KC1	KC2																4
13				KBEP4	KBEP5										KIS6		KLU4								1
					KBEP5						KC4														2
			KBEP3		KBEP5															KA3					3
														KIS4	KIS6										4
14								KC1	KC2		KC4								KA2					KCX4	1
								KC1			KC4												KCX3	KCX4	2
																							KCX3		3
								KC1	KC2																4

Figure 4.5 Codes assigned in round 1

ROUND 2

Unit No.	Codes																								Rater
1	KBEP1			KBEP4	KBEP5	KCt1	KCt3								KIS6					KA3	KCx1				1
	KBEP1			KBEP4	KBEP5	KCt1	KCt3								KIS6					KA3	KCx1				2
	KBEP1			KBEP4	KBEP5	KCt1	KCt3								KIS6					KA3	KCx1				3
					KBEP5	KCt1	KCt3	KC1						KIS4	KIS6						KCx1				4
2	KBEP1					KCt1	KCt3	KC1				KIS1									KCx1				1
	KBEP1					KCt1	KCt3	KC1			KC4	KIS1									KCx1				2
	KBEP1					KCt1	KCt3	KC1				KIS1									KCx1				3
	KBEP1					KCt1		KC1				KIS1									KCx1				4
3	KBEP1					KCt1	KCt3																		1
	KBEP1					KCt1	KCt3																		2
	KBEP1					KCt1	KCt3			KC3															3
	KBEP1					KCt1		KC1																	4
4						KCt1			KC2																1
						KCt1			KC2																2
						KCt1		KC1	KC2	KC3															3
						KCt1			KC2																4
5	KBEP1											KIS1													1
	KBEP1											KIS1													2
	KBEP1											KIS1													3
	KBEP1											KIS1													4
6						KCt1						KIS1									KCx1		KCX3		1
						KCt1						KIS1									KCx1		KCX3		2
												KIS1									KCx1		KCX3		3
						KCt1						KIS1									KCx1		KCX3		4
7																							KCX3	KCX4	1
																							KCX3	KCX4	2
																							KCX3	KCX4	3
																					KCx1		KCX3		4
8																		KA1			KCx1	KCX2			1
																		KA1			KCx1	KCX2			2
																		KA1			KCx1	KCX2			3
								KC1										KA1			KCx1				4
9					KBEP5	KCt1									KIS6					KA3					1
					KBEP5	KCt1									KIS6					KA3					2
					KBEP5	KCt1									KIS6					KA3					3
					KBEP5	KCt1									KIS6					KA3					4
10																		KA1							1
																		KA1							2
																		KA1							3
																				KA3					4
11							KCt3												KA2	KA3					1
							KCt3												KA2	KA3					2
								KC1																	3
																		KA1		KA3					4
12									KC2							KLU2									1
									KC2							KLU2									2
									KC2							KLU2									3
									KC2							KLU2									4
13				KBEP4	KBEP5									KIS4	KIS6		KLU4								1
				KBEP4	KBEP5						KC4				KIS6		KLU4								2
				KBEP4	KBEP5										KIS6		KLU4								3
				KBEP4	KBEP5									KIS4	KIS6		KLU4								4
14								KC1	KC2		KC4								KA2				KCX3	KCX4	1
								KC1	KC2		KC4								KA2				KCX3	KCX4	2
								KC1	KC2		KC4								KA2				KCX3	KCX4	3
								KC1	KC2		KC4								KA2				KCX3	KCX4	4

Figure 4.6 Codes assigned in round 2

The vertical columns indicate the agreement in interpreting and assigning codes, whereas the comparison of the horizontal rows for each text unit shows the agreement in coding a particular unit of text. Since the purpose here is to determine if different raters interpret each of the categories and sub-categories in the same way, only the vertical columns will be analysed.

By comparing the vertical columns of these tables, the value of establishing a certain level of consistency in the way raters use particular codes at the beginning of the analytical process in an open-ended study, becomes apparent. The initial independent coding showed very low consistency, but after discussion and clarification of some of the codes, the consistency improved significantly.

In order to quantify the consistency with which any two raters used a particular code a 2 x 2 table contingency was constructed to calculate the proportion of agreement (Carey *et al.*, 1996) as outlined in the Figure 4.7 below.

No. of units in which both raters used the code	No. of units in which rater 1 used the code and rater 2 did not
No. of units in which rater 2 used the code and rater 1 did not	No. of units in which neither rater used the code
proportion of coding in agreement (sum of diagonal divided by total number of units)	

Figure 4.7 The contingency table

Such a table was constructed for each of the 24 codes which were used at least once by any of the four raters in the first or second round of coding, and for each pair of raters (i.e. 1 & 2; 1 & 3; 1 & 4; 2 & 3; 2 & 4; 3 & 4) based on the codes assigned in rounds one and two.

By way of an example, the contingency tables comparing raters 2 and 4 are shown in Figure 4.8 below. (see Appendix L for the rest of the contingency tables)

Comparing coding of Rater 2 and Rater 4

	ROUND 1		ROUND 2	
KBEP1				
	0	3	3	1
	0	11	0	10
	0,786		0,929	
KBEP2				
	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP3				
	0	0	0	0
	0	14	0	14
	1,000		1,000	
KBEP4				
	0	0	1	1
	0	14	0	12
	1,000		0,929	
KBEP5				
	0	3	3	0
	0	11	0	11
	0,786		1,000	
KCt1				
	3	1	6	0
	2	8	0	8
	0,786		1,000	
KCt3				
	0	1	1	3
	0	13	0	10
	0,929		0,786	
KC1				
	1	0	2	0
	5	8	3	9
	0,643		0,786	
KC2				
	0	0	3	0
	4	10	0	11
	0,714		1,000	
KC3				
	0	0	0	0
	1	13	0	14
	0,929		1,000	
KC4				
	0	5	1	2
	0	9	0	11
	0,643		0,857	
KIS1				
	1	1	3	0
	1	11	0	11
	0,857		1,000	
KIS3				
	0	0	0	0
	0	14	0	14
	1,000		1,000	
KIS4				
	0	0	0	0
	2	12	2	12
	0,857		0,857	
KIS6				
	0	0	3	0
	3	11	0	11
	0,786		1,000	
KLU2				
	0	0	1	0
	0	14	0	13
	1,000		1,000	
KLU4				
	0	0	1	0
	0	14	0	13
	1,000		1,000	
KA1				
	0	2	1	1
	0	12	1	11
	0,857		0,857	
KA2				
	0	1	1	1
	0	13	0	12
	0,929		0,929	
KA3				
	0	2	2	0
	0	12	1	11
	0,857		0,929	
KCx1				
	3	0	4	0
	0	11	1	9
	1,000		0,929	
KCx2				
	0	1	0	1
	0	13	0	13
	0,929		0,929	
KCx3				
	1	1	2	0
	0	12	0	12
	0,929		1,000	
KCx4				
	1	1	1	1
	0	12	0	12
	0,929		0,929	
Average	0,873		0,938	

Figure 4.8 Contingency table for raters 2 and 4

During the second round of coding the four main points of discussion were:

1. the distinction between KCt3 (‘understands how key ideas and skills are related’) and KBEP1 (‘concept acquisition & development’)
2. the understanding of the code KC4 (‘curricular saliency’)
3. the distinction between (KC1) ‘knowledge of curriculum requirements’ and the teacher’s ‘knowledge of content’
4. the categorisation of teachers’ knowledge of practical procedures.

The first discrepancy was the overlap of KCt3 (‘understands how key ideas and skills are related’) and KBEP1 (‘concept acquisition & development’). In three of the units there was disagreement on whether the text showed the teacher’s understanding of the ideas or whether it showed his beliefs about the purposes of doing the practical activity. After discussion there was agreement that the texts revealed the teacher’s beliefs that practical work facilitates the understanding of concepts about the purposes of practical work, as well as his content knowledge as seen in the unit below:

> *I: OK, that is fine. Why do you think it is important for learners to learn about breaking of bonds, making of bonds that you spoke about?*
>
> *B: It is important because as it is the whole idea of chemical change really. In a chemical change they need to know that some bonds get broken and some get formed and also the properties. They need to know that how you form a gas from a solid and a liquid and all those type of things.*

Here the teacher had used models to illustrate the making and breaking of bonds for the purpose of developing learner's understanding of the concepts involved but at the same shows that he understands how some of the key concepts are related. However these two codes are not always linked. The two excerpts below illustrate the teacher's beliefs about the educational purposes of using models and his content knowledge respectively:

> *Excerpt 1*
>
> *B: The problem is that you cannot see the atom. That is one of the biggest problems. There is a lot of imagination involved. So that is why we end trying the models as it gives them an idea. It is not exactly perfect, but it gives them idea of what happens.*
>
> *Excerpt 2*
>
> *I: Why do you think balancing of equations is important?*
>
> *B: It is important because if you look at the law of conservation of mass, it is actually based on that the equation must be balanced.*

This did not however justify any changes to the description of the code but needs to be noted by anyone using the PracK table.

The second issue was the understanding of the code 'curricular saliency'.

> *B: The other one I was saying is for them to be able to check the product on whether it is acidic. They have done acids and bases in grade 8. It is good for them to apply what they know in another scenario. I think that this will be nice for them to do.*

Wendy assigned the code 'curricular saliency' whereas the researcher coded this text as 'vertical curriculum'. Wendy explained that "curricular saliency encompasses all of the above (curricular knowledge, vertical curriculum and horizontal curriculum) for me, in my own definition of it." However, given the descriptions in the codebook, she agreed that 'vertical curriculum' would be a more appropriate code. Again no changes to the codebook were deemed necessary.

The third point of discussion revolved around ‘knowledge of curriculum requirements’ and the teacher’s of knowledge of content. In discussions with teachers with regard to science content, their input is generally framed by the formal curriculum - so unless probed directly about the scientific content of the practical it is very difficult to make this distinction and to ascertain if they know examples or counterexamples of the concepts, when applicable. Consider unit 3 and 4:

Unit 3

I: OK, that is fine. Why do you think it is important for learners to learn about breaking of bonds, making of bonds that you spoke about?

B: It is important because as it is the whole idea of chemical change really. In a chemical change they need to know that some bonds get broken and some get formed and also the properties. They need to know that now you form a gas from a solid and a liquid and all those type of things.

Unit 4

I: What else do you know about chemical change that you don’t intend your learners to know?

B: There is the idea of exothermic and endothermic and spontaneous and non-spontaneous, which in reality at this stage I think it will be hard for them. Maybe later on they will get to learn about that.

Based on these extracts it was agreed that it is difficult to distinguish between the two categories. Based on my knowledge of the teacher’s qualifications and experience teaching higher grades for many years I judged this to indicate his knowledge of the scientific concepts rather than his knowledge of the curriculum. Mark and Colleen were not prepared to change the codes assigned. It was decided that unless explicit reference is made to any curriculum documents or textbooks it would be assumed to reflect teacher knowledge and that this should be clarified in the training sessions with raters and noted in the codebook. It also highlighted one of the limitations of analyzing interviews in isolation since additional background knowledge of the interviewee may influence the coding of data.

The fourth point, raised by Wendy, was that there was no category to capture the teacher’s knowledge of specific practical procedures. As an example – does the teacher know how to do a titration?; how to dilute an acid?; how to do a serial dilution? The best way of including this aspect of teacher knowledge was to change the first sub-category under content knowledge to ‘understands the targeted scientific concepts and /or procedures.

After the second round of coding, an average percentage agreement of greater than 90% for each pair of raters, across all the codes, was achieved. The only sub-categories that had a level of agreement of less than 85% were 'curricular requirements' (KC1) and 'understands how key ideas are related' (KCt3). A summary of all the contingency tables for round 2 is presented in Figure 4.9 below:

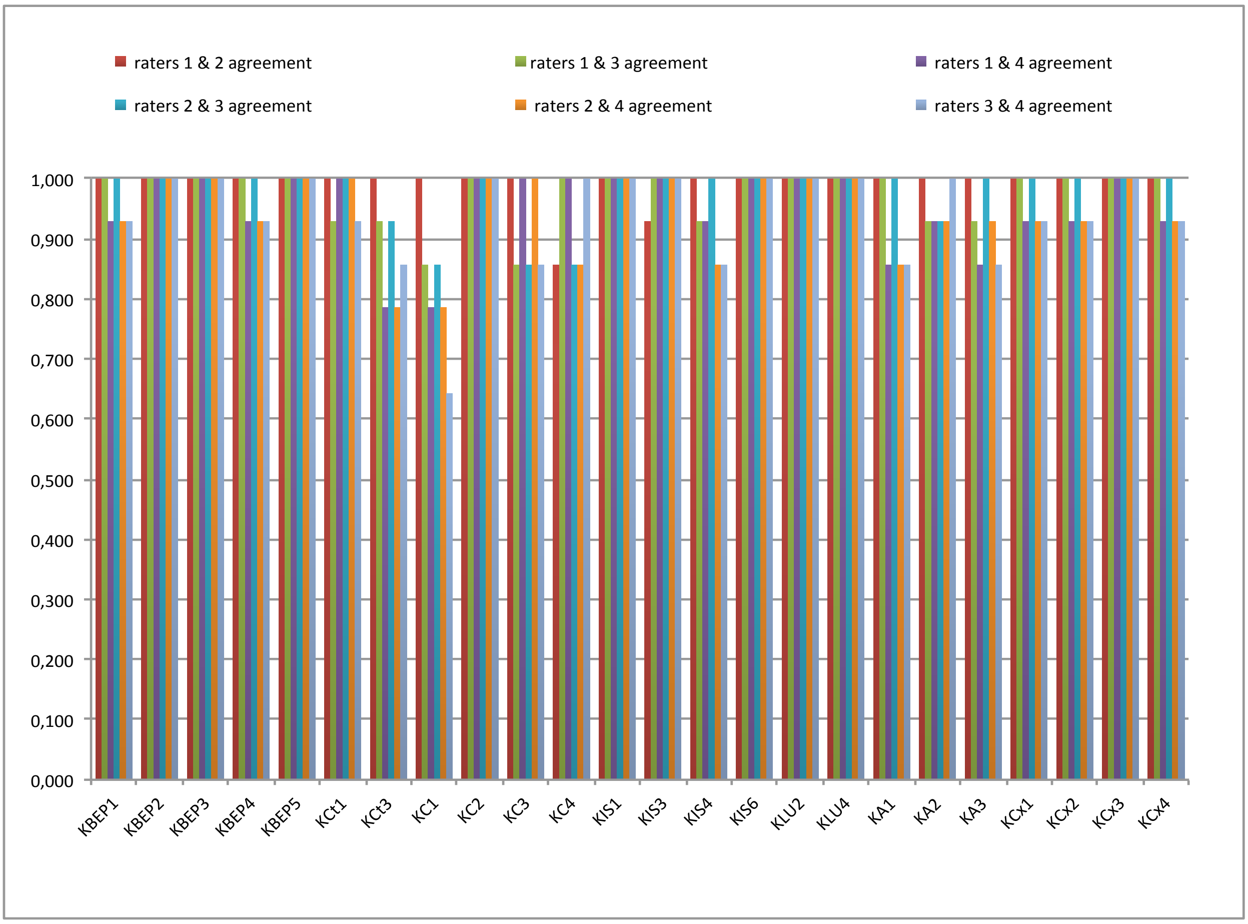


Figure 4.9 Graph showing the proportion of agreements across all codes

Whilst the percentage agreement calculated in this way may be simple and widely-used, it could be misleading, since it does not account for agreement that could occur due to chance (Lombard, 2010 and Carey *et al.,* 1996). There are measures that do take this into account, for example, Fleiss' kappa, Krippendorf alpha and Cohen's kappa (Lombard, 2010). Fleiss' kappa was chosen because it can be used for more than two raters assigning more than two distinctive codes. Fleiss' interpretation of the coefficient, the one used in this study has three value ranges as outlined in Figure 4.10.

Kappa statistic	**Strength of agreement**
< 0.40	poor
0.40 to 0.75	intermediate to good
> 0.75	Excellent

Figure 4.10 Fleiss' kappa benchmark scale
(adapted from Lombard, 2010, p. 125)

Fleiss' kappa statistic and average percentage agreement for the second round of coding was calculated for each of the 24 codes using the online calculator ReCal3 accessed on the http://dfreelon.org/utils/recalfront/recal3 May 18, 2014. The results are represented in Figure 4.11.

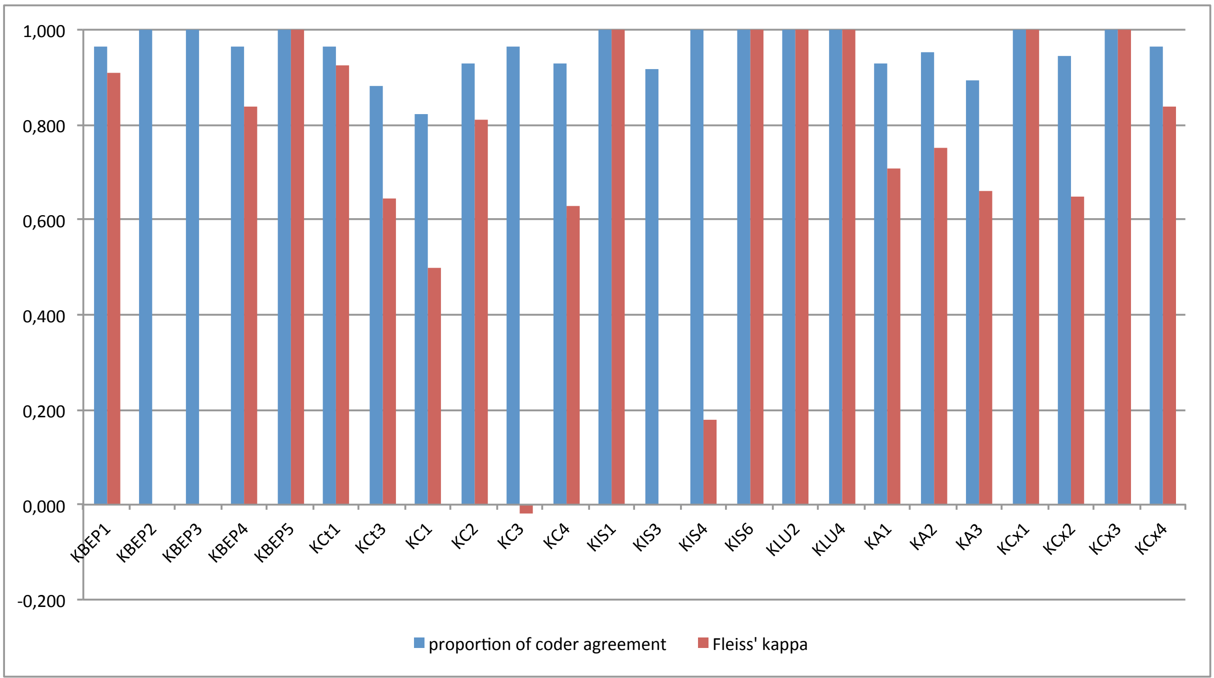


Figure 4.11 Graph showing Fleiss kappa and average proportion of agreement after second round of coding

The Fleiss kappa coefficients for KBEP2, KBEP3 and KIS3 are not indicated because it produced an undefined result for each of these codes due to the fact that none of the raters used these codes in round 2. In addition to the categories, KC1 and KCt3, identified as problematic based on the percentage agreement, the poor level of agreement based on kappa statistics for 'horizontal curriculum' (KC3), 'curricular saliency' (KC4) 'skill building' (KIS4), 'elicit existing conceptions and skills' (KA3) and 'classroom' (KCx2) indicated that potential problems existed there as well.

The code KC3 was only assigned by rater 3 in units 3 and 4. These discrepancies are partly linked to the difficulty in distinguishing between 'knowledge of the curriculum' and teachers' content knowledge as discussed above. These discrepancies may also have been due to a different interpretation of the code by rater 3, who was not familiar with the framework of teacher knowledge used in this study. None of the other raters who were more familiar with these knowledge categories, coded either of these extracts as 'horizontal curriculum'. The description in the codebook is quite clear and no changes were made but these disagreements suggest that this code needs to be discussed in detail when training raters using the PracK Table. The issue of 'curricular saliency' (KC4) was already discussed earlier.

Mark was the only one who assigned the code KA3 (‘elicit existing conceptions and skills’) to unit 10 and in a follow-up discussion it became apparent that the description of the code was inadequate. It needed to indicate that this was the eliciting of knowledge and skills before the topic or skills are taught to inform the teachers’ practice rather than a way of checking whether learners understand that which had already been taught. He was the only rater that assigned the code KIS4 (‘skill building’) to unit 1.However, after re-examination of the unit, and further discussions with the other raters, it was agreed that the teacher intended developing certain skills and that the code had been correctly assigned by Mark. He was also the only rater that did not assign the code KCx2 (‘knowledge of classroom’) to a unit 8. This was not picked up during the initial discussion but he later agreed that the text indeed indicated the teacher’s knowledge of the classroom.

In the studies by Park and Oliver (2007) and by Carey *et al.* (1996) which involved open-ended interviews and /or observations, inter-rater agreement was determined between just two coders, using a set of 52 and 152 codes respectively. Jordan and Miller (2007) used three coders to determine agreement in their study and they point out that as the number of raters increases it becomes harder to obtain consistently high levels of agreement. In this study coding of **four** raters were compared across 24 codes using both percent agreement and Fleiss’ kappa. The average Fleiss’ kappa across all the codes was 0,763 and given the adjustments made to the codebook and the fact that it compared four raters, the overall level of agreement is considered to be excellent.

Not all the codes were evident in the one interview analysed by each of the raters. Checking the inter-rater agreement of each, or even most, of the codes would have required the coding of many different data sources, demanding an unreasonable amount of time from participants for the purposes of this small study. However, given an average Fleiss’ kappa 0,759 achieved for the codes included above, a reasonable strength of agreement would be expected for the remaining codes.

4.4 Refinements to PracK Table 1

In Section 4.3.1 the content validity of PracK Table 1 was examined and it was found that all the main categories and most of the sub-categories of teacher knowledge were evident across the three different educational contexts. It was also found that with the addition of one sub-category under ‘knowledge of content’ that covers the teacher’s knowledge of health and safety aspects of practical activities and the inclusion of knowledge of practical procedures in the sub-category ‘ understands the scientific concepts related to the practical activity’, that the categories and sub-categories would adequately capture teachers' knowledge for practical work. The revised table now called PracK Table 2 is shown in Figure 4.12 below.

PracK Table 2

<table>
<tr><th>KBEP</th><th>KCt</th><th>KC</th><th>GPK</th><th>KIS</th><th>KLU</th><th>KA</th><th>KCx</th></tr>
<tr><td>concept acquisition & development</td><td>targeted scientific concepts and / or procedures</td><td>curricular requirements</td><td>manage laboratory</td><td>models & modelling</td><td>sense making discussions</td><td rowspan="2">formative</td><td>learners</td></tr>
<tr><td rowspan="2">recall of concepts</td><td>instruments and technology</td><td rowspan="3">vertical</td><td rowspan="3">organise and manage group work</td><td>demonstration</td><td rowspan="2">scaffold ideas to related contexts</td><td rowspan="2">classroom</td></tr>
<tr><td>hazards associated with the practical activity</td><td>discovery learning</td><td rowspan="3">summative</td></tr>
<tr><td rowspan="2">motivation by stimulating interest & enjoyment</td><td>how key ideas and skills are related</td><td>skill building</td><td rowspan="2">scaffold integration of ideas with ideas in other domains</td><td rowspan="2">school</td></tr>
<tr><td>nature of observation vs inference</td><td rowspan="3">horizontal</td><td rowspan="3">organise and manage materials</td><td>problem solving</td></tr>
<tr><td>teach laboratory skills</td><td rowspan="2">historical context of development of ideas</td><td>school science</td><td>scaffolds development of skills</td><td>elicit existing conceptions and skills</td><td>district</td></tr>
<tr><td rowspan="2">learn scientific method</td><td>authentic science</td><td rowspan="2">scaffold understanding of appropriate use of skills</td><td rowspan="2">recognise limitations in thinking and skills</td><td rowspan="2">community</td></tr>
<tr><td>distinction between theoretical explanations and empirical /descriptive accounts</td><td rowspan="3">curricular saliency</td><td rowspan="3">organise phases of activity</td><td>avoids activities or representations that give rise to alternative conceptions</td></tr>
<tr><td rowspan="2">develop scientific attitudes</td><td rowspan="2">evaluation of validity & reliability of scientific information</td><td>combines different forms of instruction for effective learning</td><td rowspan="2">appropriate background reading</td><td rowspan="2">recognise flaws in problem solving approaches and conceptual thinking</td><td rowspan="2">province/nation</td></tr>
<tr><td>aware of time scale of potential activities or investigations</td></tr>
</table>

Figure 4.12 PracK Table 2

The level of agreement on the interpretation and assignment of each of the sub-categories by different raters as discussed in Section 4.3.2 addressed the reliability of the instrument to capture teacher knowledge. It emerged that a few changes to the descriptions of the sub-categories were necessary to enhance the reliability of the instrument. The original and revised descriptions are indicated in the Figure 4.13 below. (for the full revised codebook see Appendix M)

Sub-category	Code	Original description	Revised description
understands the targeted scientific concepts and / or procedures	KCt1	Understands the concepts under discussion or being addressed (at a surface or theoretical level) in a lesson	Understands the concepts and procedures under discussion or being addressed (at a surface or theoretical level) in a lesson
curricular requirements	KC1	the content and practical work prescribed or recommended in curriculum documents and the related assessment requirements	**Explicit reference made to** the content and practical work prescribed or recommended in curriculum documents and the related assessment requirements
elicit existing conceptions and skills	KA3	Techniques used to ascertain learners current understanding of scientific concepts and their proficiency in particular skills	Techniques used to ascertain learners understanding of scientific concepts and their proficiency in particular skills **before being taught these concepts or skills**

Figure 4.13 Revised codebook descriptions

4.5 Summary

This chapter described all the steps taken to develop a valid and useful analytical instrument to identify and describe the knowledge teachers draw on when engaging their learners in practical work. The three phases of this process contributed to the final version of the instrument, PracK Table 2, which is thought to be useful for analyzing what teachers say and do with regard to practical work.

The findings in this chapter will be discussed in more detail in Chapter Six.

Chapter Five

Case study using PracK Table 2 as the analytical instrument

5.1 Introduction

After developing what has been shown earlier to be a valid and useful analytical instrument, it was important to get a feel for using PracK Table 2 for the purpose it was intended, that is, to analyse a number of different data sources in a case study designed to identify and describe a teacher's knowledge for practical work.

This chapter, therefore, addresses the second of the two research questions guiding this study:

How useful is such an instrument in analyzing a natural sciences teacher's practice in order to identify and describe the knowledge types evident in planning, enacting and reflecting on practical work?

A pilot study was conducted in School A (the same school described in Chapter 4) based on a series of five Grade 9 lessons taught by one teacher. The data sources used in this pilot study were:

- pre-, post and general interviews with the teacher
- 5 lesson observations
- worksheets used in the lesson
- samples of learners' work
- an interview with learners

The purpose of the case study was thus to determine if the PracK Table and its complementary codebook provided a useful framework for i) identifying the teacher's knowledge for practical work, or lack thereof, and ii) describing this knowledge in rich detail, which in turn, could facilitate the structuring of a professional learning programme tailor-made for the particular teacher.

This chapter is divided into four main sections:

- a description of the background of the teacher and the school context
- a description of the lessons observed.
- an analysis and discussion of the knowledge types the teacher draws on as he discusses, plans and enacts practical work in a Grade 9 natural sciences class

- a discussion of the role of the teacher's beliefs and knowledge on teaching and learning when engaged in practical activities

5.2 Teacher background and school context

Context is central to any case study and as teachers' formal education, previous teaching experience and the educational context in which they are teaching, could influence their thinking and practice, it is foregrounded here.

5.2.1 Teacher Background

Batandwa, who is fluent in English and Xhosa, obtained a degree LIC (Licenciado) in Education, which is the equivalent of a BSc (Ed), in Cuba in 1996 (majoring in Physics and Chemistry). It is a five year degree which includes lesson observations in the fourth year, while the fifth year is dedicated to teaching practice and research in the schools. His area of research was the use of computers as a teaching aid, and he specialised in the teaching of Chemistry.

At the time of this study he had taught physical science or natural science for a total of 14 years. He started his teaching career in South Africa at a poorly resourced school where he taught for seven years. Thereafter he taught at a well-resourced school for three years before he joined his current school. He has taught natural sciences at Grade 8 and 9 levels, physical sciences from Grade 10 to 12, as well as mathematics at Grade 8 and 10. This was his third year of teaching chemistry at Grade 9 level.

5.2.2 School context

This part of the study was conducted in the same school in which the preliminary study for the development of the PracK Table was done (School A – see Section 4.2.1). In essence it is a working class school where most of the learners are isiXhosa speaking. It is has two science laboratories which are fairly well-resourced and does not have a laboratory assistant. One of the practical lessons observed, was taught in the normal classroom while the other was taught in one of the laboratories.

5.3 The lessons

As part of my engagement in the school-based project at the school at the time, I had arranged to observe a series of lessons on the reactions of metals with water, and also with oxygen, in Grade 9. Unlike the lessons described in Chapter Four, in which I specifically asked to observe a practical lesson, Batandwa was not aware that my interest was in practical work. Nonetheless, five of the eight lessons observed included practical activities or work directly related to these practical activities, and only these will be discussed.

The first lesson was conducted in a normal classroom in a pre-fabricated building. Equipment and chemicals were on the teacher's table at the front of the room at the start of the lesson. Batandwa started the lesson by showing the structure of lithium and water using pieces from a molecular model kit, which he attached to the board using 'prestik'[5], and then handed out a worksheet (Appendix N). This worksheet required learners to re-phrase the heading on the sheet into an aim, list the apparatus used, write word and chemical equations, and note their observations.

The teacher demonstrated the reaction of lithium with water by placing a small piece of lithium in a soft drink bottle half-filled with water. He did this at the front of the room and showed the bottle to the learners near the front of the room. He pointed out that a gas was being given off as had been predicted by one learner before the reaction took place. Some learners at the back of the room were unable to see what was happening in the bottle. He then successfully performed the test for hydrogen, much to the delight of the learners.

After working through the chemical equation on the board, he then completed the representation of the chemical equation on the board using the molecular models. The solution in the bottle was then tested with litmus paper. Later in the lesson, with some coaxing, a learner volunteered to perform the next part of the demonstration. The learner was warned not to touch the metal. The teacher removed a small piece of sodium from a container and asked the learner to cut a smaller piece, and to put it into the half-filled glass bottle. The learner was not wearing safety glasses and there was no safety screen.

The third reaction, which was potassium with water, was done by the teacher. After the first test for hydrogen in this reaction did not produce the expected popping sound, the teacher placed another piece of potassium in the bottle and still no sound was heard. A few minutes later the teacher placed litmus paper in the 'potassium bottle' and as he tried to lift the bottle, the top half of the bottle came off, much to his surprise, and to the amusement of the learners. He did not try to explain what had happened.

After the third reaction, he asked learners to write down their observations. He also asked learners to consider the rates of the reactions, and to write a conclusion with respect to rate. Only a few learners made any notes during the lesson.

---

[5] a rubber-like temporary adhesive

At the start of the second lesson, learners were asked to write the equations for the three reactions performed in the previous lesson on the board. The teacher then asked learners to write a scientific report based on the reactions they observed. He wrote the headings he expected in the report on the board and explained what each of the headings meant, summarizing it as shown in the screen shot in Figure 5.1. below

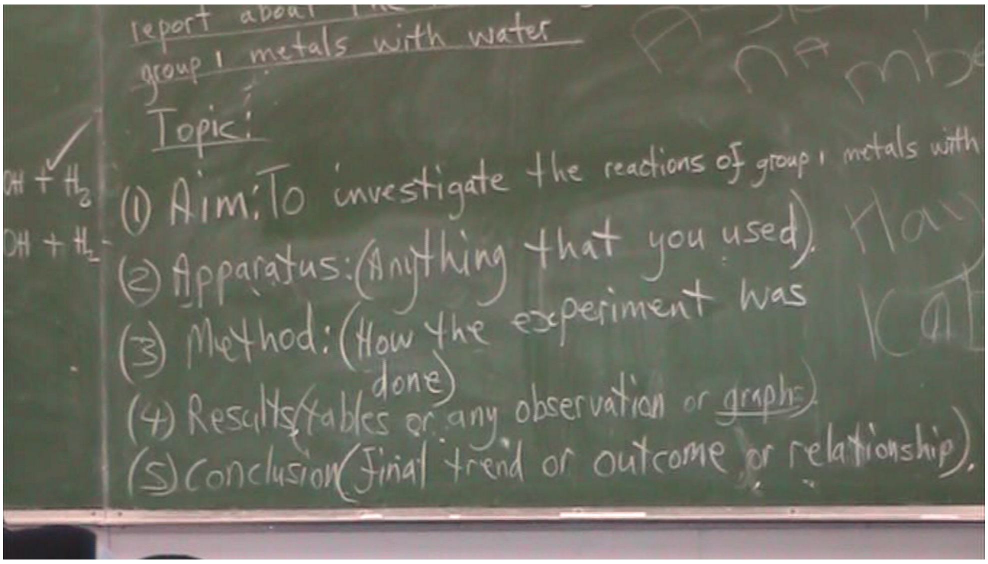


Figure 5.1 Screen shot of board in lesson 2.

The third, fourth and fifth lessons were spent completing and marking a worksheet on balancing of equations. In the sixth lesson Batandwa handed out the instruction sheet to each learner for an experiment on the combustion of magnesium (Appendix O) which they were to perform in groups the following day. He explained in detail what they had to do. His attempt to show them what happens when magnesium is ignited was unsuccessful.

The following day the combustion of magnesium practical was conducted in the laboratory. Only those learners who handed in their scientific reports based on the previous practical, were asked to report to the laboratory, and were divided into groups of four or five learners. The teacher had set up the equipment at five workstations, and at four of these there were full rolls of magnesium ribbon.

He started the lesson by doing a PowerPoint presentation on what he expected in the scientific report, based on the activities in the first lesson. This was followed by a demonstration of how to perform the next experiment. He demonstrated exactly what needed to be done, spending some time showing the learners how to use the electronic balance – something they had never used before. Some learners immediately started burning the magnesium without following the instructions, while others started immediately according to the instructions given. The teacher assisted learners with the weighing of the materials for most of the lesson. Most learners seemed to work in a haphazard way and it was difficult to assess whether they had gathered all the data expected of them. The teacher warned learners not to look directly at the blinding white light produced. Towards the end of the lesson one of the burners caught alight, and whilst panic set in amongst some learners, the teacher calmly took control of the situation. Discipline in the class deteriorated completely at this point, and some learners started packing up their equipment and left the room before the end of the lesson.

In the final lesson the teacher gave learners a printed copy of the PowerPoint presentation (Appendix P) he had given in the previous lesson, and asked them to complete another worksheet on the reactions of metals with oxygen (Appendix Q).

5.4 Teacher Knowledge

PracK Table 2 was used to identify evidence for each of the knowledge categories in a series of interviews, lesson observations and copies of learners' completed worksheets that accompanied the lessons observed. Batandwa displayed evidence of all of the main categories of knowledge, but a number of sub-categories were not evident (unshaded) as seen in Figure 5.2.

<table>
<tr><th>KBEP</th><th>KCt</th><th>KC</th><th>GPK</th><th>KIS</th><th>KLU</th><th>KA</th><th>KCx</th></tr>
<tr><td>concept acquisition & development</td><td>targeted scientific concepts and / or procedures</td><td>curricular requirements</td><td>manage laboratory</td><td>models & modelling</td><td>sense making discussions</td><td rowspan="2">formative</td><td>learners</td></tr>
<tr><td rowspan="2">recall of concepts</td><td>instruments and technology</td><td rowspan="3">vertical</td><td rowspan="3">organise and manage group work</td><td>demonstration</td><td rowspan="2">scaffold ideas to related contexts</td><td rowspan="2">classroom</td></tr>
<tr><td>hazards associated with the practical activity</td><td>discovery learning</td><td rowspan="3">summative</td></tr>
<tr><td rowspan="2">motivation by stimulating interest & enjoyment</td><td>how key ideas and skills are related</td><td>skill building</td><td rowspan="2">scaffold integration of ideas with ideas in other domains</td><td rowspan="2">school</td></tr>
<tr><td>nature of observation vs inference</td><td rowspan="3">horizontal</td><td rowspan="3">organise and manage materials</td><td>problem solving</td></tr>
<tr><td>teach laboratory skills</td><td rowspan="2">historical context of development of ideas</td><td>school science</td><td>scaffolds development of skills</td><td>elicit existing conceptions and skills</td><td>district</td></tr>
<tr><td rowspan="2">learn scientific method</td><td>authentic science</td><td rowspan="2">scaffold understanding of appropriate use of skills</td><td rowspan="2">recognise limitations in thinking and skills</td><td rowspan="2">community</td></tr>
<tr><td>distinction between theoretical explanations and empirical /descriptive accounts</td><td rowspan="3">curricular saliency</td><td rowspan="3">organise phases of activity</td><td>avoids activities or representations that give rise to alternative conceptions</td></tr>
<tr><td rowspan="2">develop scientific attitudes</td><td rowspan="2">evaluation of validity & reliability of scientific information</td><td>combines different forms of instruction for effective learning</td><td rowspan="2">appropriate background reading</td><td rowspan="2">recognise flaws in problem solving approaches and conceptual thinking</td><td rowspan="2">province/nation</td></tr>
<tr><td>aware of time scale of potential activities or investigations</td></tr>
</table>

Figure 5.2 Overview of Batandwa's practical work knowledge

Evidence of each of the sub-categories of knowledge in his planning, enactment, assessment and his discourse about practical work, will now be presented and discussed. The codebook presented in Chapter 4 can be consulted for descriptions of each of the sub-categories.

5.4.1 Knowledge and beliefs about educational purposes of practical work

Evidence of each of the sub-categories in this category of knowledge was found, but it appears that developing learners' understanding of the science content, and learning to write a scientific report, were his main objectives.

His focus on the development of conceptual understanding is reflected in what he said and did. When asked to elaborate on why he thought practical work was important he said:

> *… to make sense, much more sense of what they will be doing. Because at times, when you explain to someone, OK, a car moves this way, and all that, but when they actually see the car being moved, and all that, it's, it's far much better than explaining it, you know.* [practical work interview, p. 1]
>
> *OK, the other thing in the demonstration they could see that, when you start something solid there and you end up with something completely different. The properties of the reactants being totally different from the properties of the products, you know … that is what, that was one other thing. Because we could also prove the properties the product. They could see the gas coming out … they could also see a litmus paper, I mean, becoming acidic and all those things, ja.* [practical work interview, p. 6]

In the lesson he used a molecular modeling kit to show the microscopic changes that occur during the reaction because he believes it helps with the understanding of scientific ideas, since it is difficult to conceptualise particles of such a small size.

> *The problem is that you cannot see the atom. That is one of the biggest problems. There is a lot of imagination involved. So that is why we end trying the models as it gives them an idea. It is not exactly perfect, but it gives them idea of what happens….* [pre-lesson interview, p. 2]

Reflecting on the first lesson he also stated that one of the main learning objectives of the demonstration was to:

> *… first of all, it was the, to, for them to understand how the chemical reaction is taking place. I think I did also the model in there … to say that, OK, during chemical reaction actually there is a breaking of bonds and formation of new bonds.* [practical work interview, p. 6]

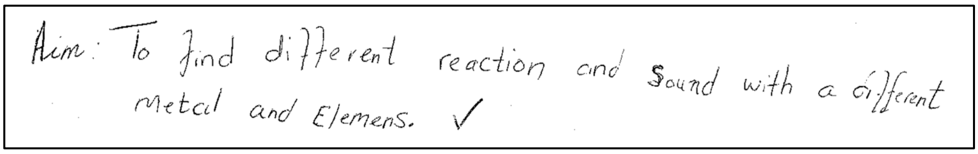
Batandwa's other main intended learning outcome in teaching this topic was that learners would be able to write a scientific report. In seven of the total of eight lessons observed, the teacher either mentioned or spent up to 20 minutes of the lesson on scientific report writing. The amount of time allocated to this during lessons, and the inclusion of a formative assessment task in order to improve their skills of writing such a report, reflected the importance he placed on this.

The headings he expected to be included in the 'scientific report' are associated with a standard scientific investigation following the general scientific method, and he said to the learners:

> *So, a scientific report is what scientists use whenever they are doing a [indistinct] or any experiment, they must come up these days it's a bit standardised way of reporting to someone else who may not have been there when the experiment was taking place neh? So whether you're going to be a very eh big scientist, like in the future, like working in a research centre or wherever, whatever the outcomes of the particular research you do, you must present them in the form of a scientific report.* [lesson 2, p. 7]

It thus appears that Batandwa believes one of the purposes of practical work is to teach the scientific method. He attempted to do this by setting learners the task of writing a scientific report based on the teacher demonstration, to familiarize them with the scientific method that they would have to engage in later in the year. The feedback given to learners (or the lack thereof) seemed to indicate that he places greater importance on the written product rather than the development of the procedural knowledge and skills required when engaged in a scientific investigation. The aim extracted from one of the learner's reports (Figure 5.3), for example, was marked correct by the teacher, and no further comments were made.

a)



b)

Aim: To find different reaction and sound with a different
metal and Elemens. ✓

Figure 5.3 a) Extract from a learner's scientific report b) extract retyped for clarity

He later provided learners with the "ideal" scientific report which he read through without any input or questions from learners.

During the first lesson he called a learner up to the front of the class to "show the rest of them how to do things" and explained how the learner should handle the metals, before allowing him to proceed with the demonstration. In the combustion practical he wanted to give learners the opportunity to 'measure the mass'. It seemed that he also wanted to develop some laboratory skills.

Batandwa also hoped to instill in learners the curiosity to experiment on their own by showing them that experiments do not have to be done at school.

> *The other thing that I was trying to show them is that it is not always in a laboratory type of set up where you can have the formal laboratory equipment, that you can do the experiment. You can use anything. For example I was using the coke bottles and all that. That also is alright. Because you can do other experiments without having to be in the laboratory, you can do it at home.*
> [post-lesson interview 1, p. 1]

Learners were most attentive during the practical demonstration and their excitement expressed in their clapping and cheering. The smile on the teacher's face after the successful demonstration showed the great pleasure he derived from the activity as well.

A distinction has to be made between understanding and remembering. When a practical activity is done, learners may well remember what they observed, but they may not understand or even remember the scientific concept that it illustrated. For example, some learners were able to remember that a popping sound was heard when doing the test for hydrogen but they did not remember that this meant that a new product, hydrogen gas, was produced. The cautionary note he added when reflecting on the lesson suggested that Batandwa was anticipating this problem highlighted by Abrahams and Millar (2008).

> *The idea of an experiment - some of them get fascinated with that you know, though at times, even if we do experiments, they get fascinated by the action that is there and then they lose the content that is in the lesson. That is the only problem. They like the sound. They laugh and then they clap hands and all that.*
> [post-lesson interview 1, p. 1]

On a number of occasions Batandwa referred to how practical work aids recall. He did so in the extract above and again when he said:

> *Ja, rather than me telling them every time, you know. So, at times, when they see, they better, …, they tend to remember it better, you know.*
> [practical work interview, p.1]

In summary then, the evidence suggested that Batandwa believes that the main purposes of doing practical work is to facilitate the conceptual understanding and to teach the scientific method. He also believes it assists with the recall of scientific concepts or ideas, the development of laboratory skills and scientific attitudes. His beliefs about the purposes of practical work are not any different to those of many other teachers, even abroad (Hodson, 2005). However, as cautioned, teachers do not always achieve the desired learning objectives (Millar *et al*., 1999).

5.4.2 Knowledge of content

Batandwa has a good understanding of the science content and how the key ideas are related in the topic of reactions of metals with water and oxygen. This was evident not only in the interviews, but also in his teaching.

When asked to identify and elaborate on the main ideas in this section of work, he responded:

> *OK. One of the things is to reinforce the idea of the chemical reaction, … Also the other issue is the balancing of the equations will be reinforced in that topic as well. The other thing is we look at the products and then we check whether it is basic or acidic. The use of the litmus paper and all that, so that is what we are going to do. It must dissolve that in water and see how it is like. Those are the main ideas. …*
>
> *The properties of the reactions they will be different from the properties of the products. That they must get clear there. Also that during the chemical reaction, chemical bonds get broken and new bonds get formed. … So that is the main idea about the chemical reaction. The other thing is about the balancing, …*
>
> *It is important because as it is the whole idea of chemical change really. In a chemical change they need to know that some bonds get broken and some get formed and also the properties. They need to know that now you form a gas from a solid and a liquid.*
>
> *There is the idea of exothermic and endothermic and spontaneous and non-spontaneous, which in reality at this stage I think it will be hard for them.*
>
> [pre-lesson interview, p. 1]

It is clear that his knowledge extends beyond the depth required at this level. Although he did not refer to the test for hydrogen in the interview, in his teaching he was able to give the chemical equation for this test and also to explain the reason for the characteristic popping sound. He also elaborated on how this reaction could be used as a possible source of fuel in the future.

> *… Ok, that pop sound that you get from the eh, it is the energy that's comes out of that particular reaction, it is an explosive reaction, hydrogen in the near future it might be used as a source of fuel neh, so you find that even at the moment there's a lot of experiments that I did in advanced level, trying to work hydrogen to be used as a source of [indistinct] so it produces a very, very explosive reaction.* [lesson 1, p. 9]

We turn now to his knowledge of the scientific procedures. Batandwa is aware of the dangers associated with working with reactive metals, as he cites the danger as a reason for doing a teacher demonstration rather than allowing the learners to work with the metals themselves. He seemed quite comfortable handling the metals, and was obviously aware that these should not be touched by hand, and he took the necessary precautions. Yet he failed to take the precautions to safeguard the learners in the event of an accident. He demonstrated the reactions of the alkali metals with water on a table in glass bottles, whilst learners were sitting right up against the table, without a safety screen in place. This could have resulted in injury, especially since one of the bottles in fact cracked unexpectedly during the demonstration. He also gave each group an entire roll of magnesium ribbon when doing the combustion reaction despite the damaging effect the light produced by this reaction could have had on the observers' eyes.

In discussing some of the other practical activities he had engaged in it was clear that he has a good understanding of some of the equipment necessary for certain experiments. He is able to identify, more effective equipment than that generally recommended, and he also knew where to source the necessary equipment.

Batandwa is cogniscent of factors that influence the reliability of scientific information and drew learners' attention to this when he said:

> *So, all of you will repeat the experiment twice. Why do you have to do this experiment twice? Its because at times you might have done what you call an error, you might have done an error in the first instance, you see? So because you've done an error there, that might affect your results, so that's why at times you do the experiment twice, in order to verify the results, verify that in the first instance we didn't have errors. … the more you repeat the experiment the better … and then you must come up with some average …* [lesson 6, p. 6]

It thus appeared that Batandwa has a good understanding of the scientific concepts linked the topic and how these are related to each other. He has some knowledge of the instruments required and safety issues associated with the particular experiment and understands that attention must be paid to the reliability of scientific information. It was, however, interesting that although aware of the potential dangers, he failed to take the precautions necessary to safeguard those learners observing the experiment. Based on the data available, no claims could be made about his knowledge of the historical development of ideas, or whether he understood the distinction between the nature of observation and inference; and the distinction between theoretical explanations and empirical accounts.

5.4.3 Knowledge of curriculum

Batandwa seemed familiar with the general content and practical assessment requirements prescribed in the Grade 9 work schedule. However he did the reactions of metals with water that was not included in the curriculum. He motivated its inclusion by stating that without an oxygen tank, the reactions of water was a good alternative to demonstrate the reactivity of metals. He also felt that those reactions were important anyway:

I: All those sections that you mentioned before, the periodic table, atoms, elements, reactions with water. Is that part of the Grade 9 syllabus?

B: We used to do it. I don't know when they released that document why they couldn't focus on that. I don't understand how someone does metals without understanding where they are coming from with the prototype. Maybe it is our own bias. That is how we looked at it. [pre-lesson interview, p. 5]

The activity on the combustion of magnesium is an activity recommended (not prescribed) in the provincial work schedule (Western Cape Education Department, 2010) and may be the reason for its inclusion in the series of lessons observed.

It appears that Batandwa also has a good understanding of what should have been done in Grade 8. For example he says:

… they could also see a litmus paper, I mean, becoming acidic and all those things, ja. Although that was quite a lot of information for them … [laughs] … but they have done acids and bases in grade 8, so, those who are up to scratch, they know exactly what is going on.
[practical work interview, p. 6]

He was also aware of the types of practical activities the learners were exposed to prior to Grade 9, but highlighted the problem of learners not remembering what they had done before:

I: So, in Grade 8, you had all of those headings on the board. Do they know all of those headings and what all of that means?

B: They should know but that is the issue, whether they remember all of that!

I: Do you know that it has been done in Grade 8?

B: It has been done. [post-lesson interview 1, p. 3]

His knowledge of the vertical curriculum was also manifested by his ability to identify the main ideas in the teaching of this topic, and its links with work covered in Grade 8 and Grades 10 and 11. Having taught each of the grades, from 8 to 12 for more than 14 years, it was not unexpected.

The Grade 9 science teachers decided to study the reaction of oxygen with metals, but based on their knowledge of the subject and the vertical curriculum, they decided to do the periodic table first, then look at elements, molecules and compounds, followed by reactions of metals with water. This and the first excerpt from the interview under knowledge of curriculum demonstrate a degree of curricular saliency.

Batandwa was familiar with the formal science curriculum from Grade 8 to Grade 12 and was prepared to deviate from it both in terms of content and the sequencing of topics, based on his own knowledge and beliefs about what works best. He made no cross-curricular links and there was no other evidence of his knowledge of the horizontal curriculum.

5.4.4 General pedagogical knowledge

The discussion in this section will focus on pedagogical issues related more specifically to practical work (as discussed in Chapter Three). It will describe Batandwa's knowledge and beliefs about general laboratory management, the organization and management of group work and materials during practical activities in general, and in the observed lessons.

It appeared that Batandwa has a good idea of how the laboratory or practical work is managed at the school. Firstly with regard to the physical resources, he was able to describe the procedures involved in the acquisition of smaller items, as well as more expensive items. There was no one person overseeing the laboratory resources, and it seemed that Batandwa was able use his own initiative to source and purchase smaller items.

> *So, but lucky enough I do research a little bit and, ja, we didn't have the equipment, ja, so I had to go to Goodwood. There's a place there, which is called Progressive Electronics. And then I bought the multi-meters and the capacitors and then I had to … because this capacitors, different colours there they give you certain capacitors all those type of things.* [practical work interview, p. 3]

However, his requests for larger items such as an oxygen tank and scales were not approved by the School Governing Body.

Previous difficult experiences influence the decisions a teacher makes in the future, and this seemed to be true for Batandwa when he explained why he had done a teacher demonstration rather than a hands-on experiment.

> *It is a combination of things. The best would have been to have them to do more practicals and all that. But the issues there are too many of them. There are about 50 something of them and sitting with those and trying to conduct a practical with them. Previous experience has shown it is a bit tricky…*
>
> *One could actually manoeuvre that with a relatively good class, let us say of a selection of bright learners who are focused. Most of them are not and will try to steal some chemicals and try to do some naughty child things. That is the challenge with a class of that nature.* [pre-lesson interview, p. 3]

This extract also highlighted one other challenge Batandwa faces, that of large class sizes. He seemed to deal with this by reducing the number of hands-on activities with the class but also by enlisting the help of others. In the one lesson observed he asked the student teacher to supervise one half of the class while conducting a practical with the other.

In class, however, he told learners that he would ideally have had them actually do the experiment themselves, but he cited safety and lack of resources as the reasons for doing demonstrations instead.

Reflecting on the demonstration he said:

> *OK, because everything can be seen from where the learners were sitting, you know. I mean, the flame and the sound and everything, you know.*
> [practical work interview, p. 5]

However, being an observer at the back of the room, it was clear to me that the learners at the back were able to see the flame and hear the sound, but were unable to see the evidence that a gas was produced and the change in the colour of the litmus paper. He was aware of this during the lesson and said he is going to pass the bottle along but then failed to do so. The demonstration was thus not that well-managed.

Batandwa recognised that doing practical work required lots of planning, and although reluctant to talk about what his colleagues do, he did say

> *though, I must say, practical work adds to the work load because if you are going to do a practical work lets say the following day you know, make sure you are staying after school, may be just to make sure everything is there, everything works, like you are trying to, trying to use, you know. If, like something does not work, you try to see, OK, what is an alternative that they can use, there, and all that. So, that's why some people will avoid it, ja… because I've seen cases where someone tries to do the practical and then it doesn't work because they did not really test it, that it works, that it is working first, you know. … so, that's the problem with a practical … it needs a lot of planning, a lot of it, ja.*
> [practical work interview, p. 4]

Learners' absenteeism sometimes meant that the practical had to be repeated after school, which further added to a teacher's workload.

As indicated above, the large classes posed a major stumbling block. He was aware of the benefits of working in groups when resources were limited but admitted that he found it difficult to manage a large number of groups. His concerns were safety when working with hazardous substances and that he would have been unable to assist when required. In terms of formal assessment requirements, learners must submit individual work, but he managed the large classes by allowing them to work in groups:

> *… they did some groups, they did some groups. Though, each individual had to do their own report, but they, because the equipment is a bit scarce, so they did it in groups, ja.* [practical work interview, p. 2]

Batandwa has a sound knowledge of how the laboratory and resources are managed at the school and is able to conduct practicals despite the challenges of large classes, and the lack of certain resources. He uses group work to overcome these difficulties but also realises that the nature of the practical and safety considerations sometimes makes a teacher demonstration a safer option. His demonstrations are, however, not always conducted as effectively as possible.

5.4.5 Knowledge of instructional strategies

In this section Batandwa's knowledge and use of the seven different types of practical activities as categorized by Windschitl (2004) will be discussed.

Batandwa is familiar with a number of types of practical activities and was observed using three different types. He firstly did a teacher demonstration of the reactions of metals with water and in the same lesson used models to show the chemical reaction on a microscopic level. Lastly learners did a hands-on activity in which they are given a set of instructions to investigate the reaction of magnesium with oxygen, a discovery learning activity.

His decision to conduct a demonstration to show the reactions between some metals and water, as discussed above, was influenced by his perceptions of learners as academically poor and undisciplined. Other constraints were the number of learners in the class, his knowledge of the actual experiment and the hazards related to the experiment. The demonstration was done in the front of the room where only a few learners were able observe what the teacher intended them to. He also did not make the purpose of the demonstration explicit before hand and opportunities for deeper questioning and discussion at the end of the demonstration were missed. The accompanying worksheet focused on the content and paid little attention to the scientific method, although learners were afterwards expected to write it up in the form of a standard scientific report.

He not only used of models in his teaching but also explained to learners the purpose of using models to the learners:

> *When we say something is a model we don't mean hydrogen is this big, it is a billions times or even more than that smaller than this but now we get a picture in our minds of how it may look like you know because in reality no one has ever seen an atom so we imagine it to be like this and the theories that we've got up to now is to just they help us to this model that we've got. So relatively smaller than the oxygen that we have.* [lesson 1, p. 2]

He believes that models are particularly useful for teaching weaker learners.

> *These particular learners are a bit of a slow learners. It is a hassle. That is why I land up using models. It is a hassle. With bright kids, it might not have been necessary to use those models.* [pre-lesson interview, p. 2]

Yet on reflection he admitted that all learners did not learn what he expected them to say and said "It would have been nice for them if we had more time to play around with those models more and stuff." Although the combination of the teacher demonstration and use of models were a good strategy, the written and oral responses seemed to indicate that very little learning took place.

In a discussion on other types of practicals he had done in the past, it appears that in many of the activities learners were engaged in 'discovery learning' activities, in order to verify ideas or relationships, as in the combustion activity observed. Learners had also been given more open-ended investigations, which he described as ''following the scientific method'', and thus would be classified as a school science activity. The process skills required for doing a scientific investigation are highlighted in the curriculum, yet his assessment of and feedback on, the scientific reports paid very little attention to these skills except for elaborating on what a hypothesis is. Learners responded to the question "What do you predict will happen?" and he then says

> *What you are doing now is what they call a hypothesis hey? You are predicting what might be the outcome of this experiment ne so we do this experiment and check what is it that is going to occur …* [lesson 1, p. 3]

As pointed out earlier, Batadwa invested a lot of time on getting learners to write a scientific report and I suspect that this is so because in recent years, this has been the required format of all the summative practical assessments in Grades 10 to 12.

The teacher also commented on the effectiveness of particular types of practical activities. He believes mistakes made during hands-on practical activities allows learners to engage more meaningfully with the activity, compared to a teacher demonstration, since it encouraged critical reflection on what they are doing.

> *it get's very easy when someone is doing it. But, when they are doing it, it might be something else, you know. Ja, it takes more time, actually for them to do it, because, they might make little mistakes, because they, it's the first time, then they try again, you know, but then, they think that they are making a mistake and think about it and try to do it right …* [practical work interview, p. 6]

Although there was no evidence of the teacher ever planning an activity with the specific purpose of developing any of the laboratory or other procedural skills, he did focus on some of these skills in the other activities, as described earlier.

In the first lesson a combination of different instructional strategies were used, including a demonstration, models, different forms of assessment and all of these were completed within the one lesson as planned, indicating that the teacher was aware of the time required for the different aspects of the lesson.

Batandwa was thus familiar with five of the seven types of activities included in the table, but did not refer to any activities that would be considered problem solving or authentic science. In the first lesson observed he used a combination of these types of practical activities and other strategies were used in subsequent lessons. However, whether he achieved the learning objectives normally associated with these types of activities, is questionable since the verbal responses of learners in class, and their written work, suggested that a number of learners did not learn what the teacher had intended them to learn.

5.4.6 Knowledge of learner understanding

According to Windschitl, “meaningful learning is a product not of activity *per se*, but of *sense-making discourse’* aimed at developing conceptual understanding and the links between theory and observable phenomena” (2004, p. 6). Discourse here includes not only talking, reading and writing but also getting learners to think by engaging them actively in activities, which, for instance, involve problem solving, classification, logical reasoning and in which cognitive conflict may need to be confronted. By including such activities in their teaching repertoire, teachers would scaffold learners’ understanding of science concepts and skills. The data suggested that Batandwa has limited knowledge of how to scaffold the development of scientific ideas and skills.

In his introduction of the first lesson, Batandwa linked what learners were about to do with their knowledge of the periodic table, so there was some type of sense making discussion. And although he used the chemical reactions to relate the concepts of chemical change, the making and breaking of chemical bonds, balancing equations and acids and bases, these links were not made explicit to the learners. The main concept he was targeting in the combustion experiment was the law of conservation of mass but there was very little discussion about this concept before, after or during the lesson.

As shown earlier, Batandwa understands the difficulty learners have in visualizing substances at an atomic level and thus decided to use molecular models to show the microscopic changes taking place during the reaction. He also illustrated the idea of a balanced chemical equation. He attempted to scaffold learners' understanding of balancing chemical equations and formulating a conclusion of an investigation, by working through one example with learners and then expecting them to apply it to different examples. During the lesson he became aware that this strategy was not very effective because, although learners seemed to understand as he worked through the example, some learners experienced difficulties when required to apply it in a slightly different context.

Using the analogy of trying to teach someone how to dribble a ball, he pointed out that it was much easier for someone do learn by doing, rather than by being told what to do.

> *… OK, in fact when you do something, the way you capture the whole thing, it's better than when you are told about something … let's say, about kicking the ball, you know, something, or dribbling, let's say, OK, when you are dribbling someone, you do this. … but then, it's different when you say, OK, go in there dribble You see … it get's very easy when someone is doing it.*
>
> [practical work interview, p. 5]

Whilst this may be true for learning a skill, being able to do a practical does not necessary mean that the learners understand the targeted science concepts or ideas (Abrahams & Miller, 2008, Windschitl, 2004), and this was found to be true when learners conducted the combustion practical.

Besides the one instance when Batandwa linked the test for hydrogen to the hydrogen fuel cell, he made no other links between the ideas he was teaching with everyday examples, or with ideas in other domains or disciplines, in order to scaffold learners' understanding. Given the context in which he taught and his perception of his learners, it was not surprising that he did not set tasks that required learners to do any background reading.

The data suggested that Batandwa had some understanding of how to facilitate learning and attempted to use these strategies to scaffold the development of knowledge and skills. He engaged in limited sense-making discussion, with minimal input from learners. He was also aware of the difficulties learners experience conceptualising what happens at an atomic level, and when attempting to apply their knowledge in a slightly different context. He employed appropriate strategies to address these difficulties. However, he did not seem to combine his knowledge and strategies for effective learning, and acknowledged that he had not achieved his intended learning objectives in the first lesson.

5.4.7 Knowledge of assessment

In the first interview when asked about the types of assessment he intended conducting during this series of lessons, he stated his intention was to ask learners to complete a worksheet, to write a scientific report, to write a "home test", as well as giving learners lots of practice in balancing chemical equations. None of these activities were for formal assessment purposes and, although not always stated as such, were for formative assessment purposes. However, Batandwa was fully aware of the summative assessment requirements and his intention was to use the informal assessment activities to prepare learners for these summative activities. Although he did not refer to this as assessment, the types of questions he asked will also be discussed. Each of these assessment activities will now be discussed in terms of what was being assessed, what some of the learner responses were, and the way in which the teacher assessed these activities.

The objective of the worksheet (Appendix N) that accompanied the teacher demonstration appears to have been to assess mainly learners' content knowledge and observation skills. The teacher assisted the learners with completing the first reaction in the worksheet, and expected the learners to be able to complete the rest themselves. During the lesson, very few learners actually filled in the worksheet.

In the follow-up interview, when I asked if he had achieved his learning objectives, Batandwa noted:

> *Somehow, in fact when I looked, not really 100%, because the only way to see whether you have obtained your objective is when the kids actually can understand everything there. I remember I did with the models and everything for the first problem, which was with lithium with water, to get lithium hydroxide and hydrogen, and then I left the two for them to see. Some of the kids managed to see what the product would have been in the other two. But some of them still could not really see. So it was partially achieved really.*
>
> [post-lesson interview 1, p.1]

And in a subsequent interview:

> *I gave them a worksheet you see. Then I moved around to check. So, that tells me that some who are actually lost, and then I saw some that could actually manage something.* [post-lesson interview 2, p. 1]

This worksheet was not marked by the teacher but as seen in the excerpt above and captured on video, he went around and checked the work of some of the learners. Eventually the teacher worked through the solutions on the board with some learner input.

Although Batandwa was expecting leaners to write a scientific report based on the demonstration, learners were not told beforehand that they were expected to do so. He assumed that learners had a basic knowledge of the structure of such a report based on work they had done in Grade 8, but he nonetheless guided them by giving them the headings they needed to include, and a brief description of what was expected under each of the headings in the following lesson (Figure 5.1).

A sample of five scientific reports were collected and analysed. One learner handed in only a list of chemical equations (words and symbols) and did not present it in the prescribed format. Three were able to state the aim of the investigation, while the fourth learner did not understand the relevance of the demonstration at all, as seen in the excerpt from report shown in Section 5.4.1

Not one learner was able to name all the apparatus used. The apparatus listed by the four learners were:

1. Hydrogen, lithium, sodium and potassium
2. We used razor, twiser and water
3. We used water, metals, lithium for this investigation
4. Water we put in with lithium

The only comment the teacher made on these scripts with regard to apparatus was that he added ‘3 bottles’ on two of the scripts. The marking and lack of feedback below, as in the example of the learners’ work above, in no way assisted in the learner’s understanding.

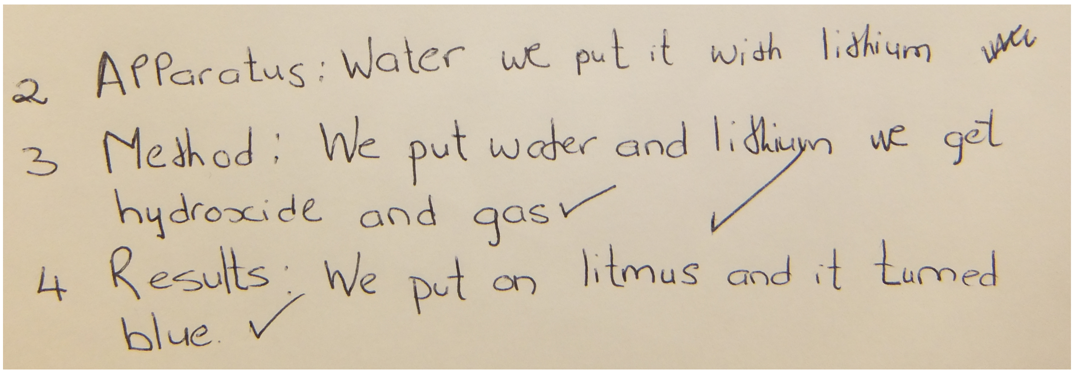


Figure 5.4 Extract from learner’s scientific report marked by teacher

Reflecting on his assessment of these reports Batandwa says:

> *What surprised me is that when I was asking about some of the sub-topics there, like method what is it that is expected, some of them seemed as though it was something new. That is one thing that really surprised me. …*
> *What did not really work is the fact that what is assumed as pre-knowledge is not really pre-knowledge.* [post-lesson interview 1, p. 3]

A scientific report could be used to assess learners' knowledge and skills to follow the scientific method. Although the teacher emphasized that the purpose of the exercise was to develop these skills, he gave no constructive feedback on any of the scripts. In an interview Batandwa explained that he used the coke bottles instead of using laboratory equipment to show learners that they could experiment at home, yet none of the reports included the bottles as the apparatus. This could explain why this was the only comment he added to the lists of apparatus. One wonders if the reason learners did not include bottles under apparatus was that they did not consider it to be laboratory apparatus. After marking some of the reports he spent quite a bit of time talking learners through a 'model scientific report' on the experiment conducted.

Except for the question about predicting what would happen during the reaction, oral questions during the lesson were mainly lower order questions, which often elicited choral responses from the learners. The teacher also tended to answer many of his questions himself.

It thus appeared that the teacher's perceptions or knowledge of learners not only influenced the type of practical work he engaged in, but also influenced his assessment strategies.

> *OK, the second one. Remember I did that orientation of that work on the scientific report and all that. Things that I would add, if I had a more powerful type of student, it would be issues around hypothesizing the question and all of those things. This is more of a short experiment and not a long investigation, so I thought "No" let me leave that.* [post-lesson interview 1, p. 4]

However, this excerpt also shows that Batandwa purposefully selected the focus of assessment in different assessment tasks.

He recognised the limitations of some of his learners but due to the pressure to complete the content specified in the curriculum, he felt compelled to "move on" despite the learners' lack of understanding:

> *With those ones it is a bit of a problem. I managed to see at least what's going on. But, some of them really it is beyond their capacity. Maybe some of those might not even take science next year that is why I thought let me move on. Otherwise if I stay there, because of those, I might end up not covering everything in the syllabus.* [post-lesson interview 2, p. 3]

In an examination about a month after the practical, a question on the combustion of magnesium experiment was included. The questions focused mainly on writing the balanced chemical equation, and although this had been included in the practical worksheet, learners achieved an average of only 13% for this question. This question did not refer to the law of conservation of mass, which was the main concept the teacher intended focusing on in the experiment. In an interview with learners a few days, after the series of lessons observed, when asked what the popping sound they heard during the demonstration indicated, the learners' responses included: ' it is dangerous',' don't put fire near dangerous chemicals', but none of them mentioned that the gas produced was hydrogen. Or when asked what reacted with magnesium in the combustion experiment, none of them knew, and all they remembered was that magnesium burns with a bright white flame.

In conclusion, Batandwa is knowledgeable about formative and summative assessment, recognized his learners' limitations and was able to develop assessment tasks that assessed both skills and content. The nature of these assessment tasks were sometimes influenced by his perceptions of the learners. However, poor marking and lack of constructive feedback in the assessment of these tasks hampered the learners' potential to have a positive impact on learning in his class.

5.4.8 Knowledge of context

Batandwa's knowledge of the learners seemed to be a significant determinant of the nature of the practicals he engaged them in. It was not clear how much he knew about individual learners. The only learner whose name the teacher used was one learner who has a history of disruptive behaviour. He identified one 'bright' learner in the class but did not know her name, and on a number of occasions he referred to male learners as 'boy'. He was however, aware of the general academic ability of the class, and their general lack of discipline and made numerous references to this.

> *These particular learners are a bit of a slow learners. … Most of them have been promoted not because they passed but because of age-wise from Grade 8.*
>
> *You are very unfortunate to observe that lesson because maybe there is a collection of those naughty kids and all that. They don't really worry about homeworks most of the time. It is not just me. Most of the teachers will tell you that. You can ask that teacher she teaches them Xhosa and she will tell you that. So it is a common problem.*
>
> *I don't like the Grade 9's that I am teaching. If that was a very good class that would motivate you as well as you teach. But, those guys – I am thinking that we are forcing them into Science. I think that if there was an option they would be doing other subjects. It is a bit heavy for them. I notice also with Maths, it is a bit heavy for them.* [pre-lesson interview, p. 2]

As other extracts quoted before indicated, the teacher's perceptions of the learners strongly influenced the decisions he made about practical work. In an interview he talked about his experience at a relatively well-resourced school, where more of the parents were able to assist their children with their schoolwork:

> *I remember when I was at ……. High one time, I had a learner who actually made a lift, you know? Ja, they designed it but he was helped actually by the father, because the father used to work in a …, so the father supplied the material, but they managed to make a small lift that could, … that worked on a battery, you see, 12v battery.* [practical work interview, p. 8]

He seemed to imply that learners in his class would not be able to do a similar activity because they did not have access to the same type of support at home, and were, therefore, constrained by their social and economic background. This perception was probably reinforced when he asked learners to analyse the nutritional information on their cereal boxes only to discover that most of the learners did not have cereals at home. This incident made him more aware of the general background of learners and the difficulties they may experience finding resources for investigations.

An analysis of learners' examination scripts shows that a number of learners were unable to understand or read or write in English (Appendix R shows one learner's response to the question on the combustion of magnesium referred to above). Batandwa was conscious of this and compensated for this by code switching (talking in their home language) occasionally.

He also had some idea of how curriculum development process worked at a regional or national level:

> *Yes, if it is not changed. They are also reviewing it because they think that it is a lot of information. That is what most schools are saying. It is a lot of information. They want next year to have a common exam. This year schools are going to write their own common exams.*
>
> *The subject advisor, we just tell him - maybe email. Some other schools may be advising with email. They will then look at the whole thing and email National the different provinces will email National and then sit down with the different comments and then see how they change it.* [post-lesson interview 2, p. 8]

In terms of science practical work more specifically, as discussed previously, the teacher was aware of the resources available, how to access them and the procedures for arranging access to the laboratories. He was able to tap into other human resources available at the school to facilitate his practical work.

The contextual factor that seemed to have the greatest influence on the practical activities Batandwa included in his teaching was his perceptions of the learners, which more specifically were, their academic ability, behaviour and economic constraints. To some extent access to laboratory resources and his knowledge of the hazards associated with certain activities, also impacted on his decision-making.

5.5 Summary

The purpose of the case study presented above was to get a sense of the usefulness of the PracK Table and its accompanying codebook as a heuristic device. This pilot study shows that the rigorously validated PracK Table served its intended purpose. It highlighted the strengths in the teacher's practice, as well as the areas that needed further development for effective practical work.

Deeper reflections on the use of the PracK Table are discussed in the next chapter.

Chapter Six
Discussion and Conclusion

6.1 Introduction

As stated in previous chapters, despite its prominence in the science curriculum, very little effective practical work is being conducted in most South African high schools. It was thought that by understanding the knowledge base teachers draw on when thinking about and engaging their learners in practical work, some insights could be gained that could be helpful in addressing this problem.

The aims of the study were thus two-fold:

- to develop an instrument to facilitate the identification and descriptions of teachers' knowledge for practical work
- to determine if this instrument effectively served its intended purpose.

The development and validation of the instrument outlined in Chapter Four, and the use of the instrument in the pilot case study presented in Chapter Five, will be discussed. These reflections will answer the two research questions:

1. How may an analytical instrument be developed to identify and describe natural sciences teachers' knowledge associated with practical work?
2. How useful is such an instrument in analyzing a natural sciences teacher's practice, in order to identify and describe the knowledge types evident in planning, enacting and reflecting on practical work?

6.2 Reflection on development of the PracK Table

A number of different instruments have been developed to measure (Ndlovu, 2013; Mavhunga & Rollnick, 2011; Lee, Brown, Luft & Roehrig, 2007), capture (Loughran *et al*., 2004; Luft & Roehrig, 2007) and analyse (Park & Oliver, 2008) teacher knowledge in specific science topics. However, no instruments which focused on the knowledge required for engaging learners in practical work, were available. The PracK Table was thus developed to analyse teachers' knowledge with a focus on practical work. It is the product of the rigorous design and development process described in Chapter Four.

6.2.1 Selection of categories and sub-categories

The main categories and sub-categories of knowledge included in the table were selected, based on the literature on teacher knowledge, as discussed in Chapter Two, but largely influenced by the work of Shulman (1986,1987), Magnusson *et al.* (1999), and Windschitl (2004). The first draft of the instrument was called the PPCK Table, since at that stage of the process, the notion of PCK for practical work was thought to be appropriate.

The testing of the instrument in a local school revealed some unnecessary sub-categories, missing sub-categories and certain ambiguities which could then be addressed by removing or re-wording certain main categories, and by combining, removing and adding certain sub-categories. Feedback from experts in the field of PCK, forced me to question the notion of PCK for practical work. They argued that PCK is topic-specific and whereas practical work was not. The idea of PCK for practical work was problematic. In hindsight, I agreed that practical work is a strategy used to teach particular science content or skills, and not a body of knowledge in the traditional sense. The notion was thus abandoned, but those categories of knowledge considered components of PCK still proved to be useful. The testing of the instrument and the input from experts improved the construct and content validity of the instrument, which was then re-named, the PracK Table 1.

The content validity of the instrument was further improved by using the PracK Table in two other educational contexts. Through this process the retention of some categories, not evident in the first evaluation of the instrument, was justified and an additional sub-category was added.

In addition to these measures taken to ensure the content validity of the instrument,
fellow researchers in the field of teacher knowledge concurred, that on face-value, the categories and sub-categories appeared to adequately capture those aspects of teacher knowledge it purported to capture.

6.2.2 Interpretation of categories and sub-categories

An instrument such as this will only be reliable if the categories and sub-categories are interpreted and assigned in the same way. A clear description of each of the sub-categories was given in the codebook which accompanies the PracK Table. The inter-rater agreement was first determined in terms of percentage agreement in a two-stage process. By the end of the second stage, a percentage agreement of greater than 85% was achieved for each pair of raters, for most sub-categories. To accommodate for agreements due to chance, the Fleiss' kappa statistic was calculated for each of the sub-categories used in the second round of analysis. An average Fleiss' kappa statistic of 0,763 was achieved indicating an excellent level of agreement.

These inter-rater agreement processes resulted in further refinements to the table and the accompanying descriptions of the codes. The final version of the instrument was called PracK Table 2. By identifying and correcting the problems in this way, the risks of generating invalid findings and conclusions, when using the instrument, was reduced.

The strength of this instrument is that it was developed and validated based on literature, studies in different educational settings that involved lesson observations and interviews, and on the input from specialists in the field of teacher knowledge. The multiple levels of validation and refinement to ensure coding replicability, improved the trustworthiness of the instrument.

6.3 Reflections of the usefulness of the Prack Table

PracK Table 2 was used in the pilot case study described in Chapter Five. I will now reflect on the usefulness of the table in the development of this case study.

6.3.1 Usability of the table

During the development of PracK Table 2, a set of criteria was established to judge the usefulness of the table. When reflecting on the use of this table in the case study, all the criteria were met, namely, (i) all the main categories of knowledge and most of the sub-categories were used, (ii) there were no statements or observations which could not be captured by the categories and sub-categories, (iii) there was a good balance among the sub-categories, and (iv) the categories were unambiguous, and with the help of the codebook, the sub-categories were also relatively easily recognizable.

Identifying the main categories of knowledge which were evident, provided a good starting point for the first round of analysis. The eight categories, although not mutually exclusive, were relatively easily distinguishable, but, as noted in Chapter Four, care should be taken when deciding if the data suggests 'knowledge and beliefs about the education purposes of practical work' or 'knowledge of curriculum' or both. The teacher's knowledge was adequately captured in these eight categories and affirms that these are the cornerstones of the knowledge base needed, not only for teaching in general, but for practical work as well.

The sub-categories allowed for the fairly detailed exploration at the next level of analysis. This level of analysis required a deep understanding of the different sub-categories. Despite having developed the table myself, I still on occasion had to refer to the codebook to be sure of the categorization. Some understanding of teacher knowledge, and the clear descriptions in the codebook, are essential for raters who are not experienced in using the table. This detailed analysis, not only made it possible to identify and describe the teacher's knowledge, but also made it possible to make some judgments about the depth of certain types of knowledge.

A variety of data sources can be analysed using the PracK Table, which facilitates data triangulation. It seems to be particularly useful in the analysis of data sources such as interviews and lesson observations, which provide rich data, but can also be used to analyse learners' work and worksheets developed by the teacher.

However, of greater importance here are the insights gained on the teacher knowledge base required for effective practical work. Has the use of the PracK Table provided an understanding of teacher knowledge that could be useful in addressing the problem of limited effective practical work? I attempt to answer this by discussing:

6.3.2 Insights gained about teacher knowledge

Batandwa is an experienced teacher with a good understanding of the science concepts linked to this topic, he is familiar with the formal science curriculum from Grade 8 to Grade 12, and has used a range of approaches to practical work. This allowed him to select those activities he felt were most appropriate for his learners, given his particular objectives. His teaching was thus not constrained by limited understanding of the topic, as is often found (Toerien, 2013; Rollnick *et al.,* 2008). Furthermore, his knowledge of the school and its procedures, the resources and equipment required, and familiarity with the practical procedures involved, allowed him to conduct the observed lessons, with confidence. So he chose to do a demonstration rather than a hands-on activity, because it was a large class of unruly learners, resources were limited, and he was concerned about their safety. He used models, being fully aware of their limitations, because he knows that learners generally find it difficult to conceive the microscopic changes taking place during a chemical reaction.

One can only comment on the effectiveness of a particular practical task if the objectives of the task are known (Abrahams & Millar, 2008). The effectiveness of Batandwa's practicals were measured against his intended objectives which were mainly to:

- improve or develop the understanding of science concepts
- develop the knowledge and skills required to write a scientific report.

The other objectives included:

- to learn the scientific method
- to develop laboratory skills
- to stimulate interest and enjoyment
- to facilitate the recall of science concepts

There is no doubt that the demonstration, especially the test for hydrogen, generated excitement, and that most learners were fully engaged when doing the combustion practical and, therefore, the selected activities were successful in that regard.

But did learners actually learn what he intended through these activities? The absence of meaningful learner-talk during the lesson, the fact that only a few learners were able to complete the worksheets accompanying the activities, and the poor results obtained in the examination, suggested that no significant shifts in learners' conceptual understanding, or in the knowledge and skills required for scientific investigations, were made. This was so despite these being the teacher's main learning objectives. Learners' responses in the interview conducted with them a few days after this series of lessons, confirmed that they had not grasped the targeted concepts. Learners remembered mainly what they had observed and what they had done. As is often the case, the learners did not learn what he expected them to learn (Abrahams & Millar, 2008).

So what was missing? Were there gaps in his knowledge, was it that he was unable to transform his knowledge and experience into effective teaching, given the teaching context, or was it his general understanding and assumptions about how students learn?

The answer to these questions may lie in a combination of factors. Firstly, the teacher's focus seemed to be on the activity rather than on the learning intended through the activity. The focus was on the doing and he did not spend enough lesson time helping learners use the ideas associated with the activity, as suggested by Abrahams and Millar (2008). Despite being able to articulate the learning objectives for the practicals, these were not always made explicit to the learners, nor did the teacher's assessment of the tasks, or the classroom discussions before, during or after the activities, hone in on these objectives. Learners' awareness of the objectives is a pre-requisite for effective practical work (Abrahams & Millar, 2008; Gomes, Borges & Justi, 2008). With a mindset shift from teaching to learning, these same activities may have produced a more positive outcome in terms of learner understanding.

Secondly, assessment, which of course is closely linked to a teacher's knowledge of learning and understanding, has been highlighted as a problem. The level of questioning, his habit of answering his questions himself, providing the model answers and a lack of constructive feedback, point to a deficit in the skills required to scaffold learners' thinking and skills. He also avoided more learner-centred activities, but this could have been as a result of his negative perceptions of learners' ability and behaviour. A similar relationship between practical work and teachers' perceptions of learners was found by Hattingh *et al.* (2007).

6.3.3 The relationship between knowledge and practice

This study assumes some relationship between teacher knowledge and the quantity and quality of practical work, and, therefore, between teacher knowledge and teacher actions. In Chapter Two, based on the work of Clark and Markson (1986) and Ritchie (1999), it was argued that teacher action is influenced by teachers' personal theories of *teaching,* and I would here also add *learning*. A similar view is implied in the PCK summit consensus model (Gess –Newsome & Carlson, 2013), in that classroom actions are filtered or amplified by teachers' beliefs and orientations.

What this case study suggests is that the actions of well-qualified, experienced teachers with a good knowledge base across the different types of knowledge and who are teaching in well-resourced schools, are mainly influenced by their personal theories about teaching and learning. For Batandwa, who adopted a didactic approach, it was thus not surprising that the PracK Table identified gaps in his knowledge of learner understanding, since the sub-categories are associated with a constructivist approach to learning. This approach may also explain why he did not engage his learners in more open-ended, learner-driven practical activities. Teachers like Batandwa, may well include a number of different practicals in their teaching repertoire, but these are likely to be ineffective.

Teaching context influences teacher actions (Clark & Markson, 1986; Ritchie, 1999; Gess – Newsome & Carlson, 2013), teachers' knowledge or perceptions of their learners, particularly so, as seen in this case study, as well the study by Hattingh *et al.* (2007). A negative perception of learners' ability not only restricts the number of practical activities, but also the nature of the activities learners are exposed to. What I suspect, although it needs further exploration, is that this phenomenon is exacerbated if a teacher adopts a didactic approach. A good teacher, adopting a constructivist approach, should be able to set realistic targets for their learners, no matter what their abilities, and must execute the practical lesson in such a way as to make the targeted concepts understandable to the learners, or to improve the targeted skills.

A broad knowledge base is necessary to conduct effective practical work, but this is not sufficient. What Teachers' beliefs and theories of teaching and learning are often recognized, but not foregrounded as an important influence on what happens in the classroom. These theories and beliefs thus have to be constantly examined, and even challenged, in teacher professional learning programmes, including those aimed at improving practical work.

6.3.4 Towards a teacher development plan

One of the benefits of identifying and describing teachers' beliefs and knowledge for practical work, is that such insight could inform decisions around the interventions and support required, as part of context-specific in-service teacher development for effective practical work. But on a broader level, common trends found, using this analysis tool, could also inform the design of structured pre-service and in-service professional learning programmes.

According to Timperley (2008, p.8) "professional learning experiences that focus on the link between particular teaching activities and valued student outcomes are associated with positive impacts on those outcomes." A professional learning plan for Batandwa would thus, firstly, include a focus on learner-centred teaching, that would not only impact on his practical work, but also his teaching in general. This shift is not easy and teachers often dismiss suggested strategies as being inappropriate for their learners. The teacher's existing understanding of teaching and learning has to be overtly challenged and the alternative approach must be shown to be effective within that teacher's context (*ibid.*). The link between an activity and the desired learning objective must be made explicit to teachers, and modelling of learner-centred teaching in the teacher's own classroom, including practical activities, may prove useful.

A second focus should be on effective formative assessment strategies, especially the importance of the feedback given to learners, and linked to this, having clear ideas about the best way to scaffold the development of ideas and skills. It is hoped that the teacher would see small positive shifts in learner outcomes through these activities, and as a result, gain confidence in his learners' abilities.

Finally, Batandwa did not engage his learners in any 'authentic science' learner-driven investigations, such as the Science Expo, and he has not engaged in this type of activity himself. Giving him the opportunity to do so, together with greater confidence in his learners' abilities, may well encourage him to let go of the reigns, and allow the learners to engage, explore and learn from such an activity.

By shifting his focus to the desired learner outcomes, rather than focusing on the teaching strategies *per se,* and modelling these practices in his own context, I believed that his good knowledge base could be transformed into effective teaching.

The strengths and weaknesses in the teacher's planning, enactment and assessment of practical work were elucidated quite clearly, by identifying and describing the teacher's beliefs and knowledge using the PracK Table. This in turn facilitated the design of a possible context-specific professional learning programme for the teacher. A closer examination of the relationship between his existing beliefs and knowledge, and some of the strengths in his practice, which was revealed using this tool, could also be useful in the design of learning opportunities for novice teachers.

The detailed analysis facilitated by the use of the table made it possible for me to identify the key components needed in a professional learning plan tailored for this teacher. And, although one is aware of the risks of generalization based on the findings of a single case study, and given the personal nature of teacher theories of teaching, if case studies are done in similar contexts, those findings have the potential to inform more structured programmes, designed to improve the quantity and quality of practical work in schools.

6.4 Revised conceptual framework

In Chapter Two the following conceptual framework based on the literature was presented:

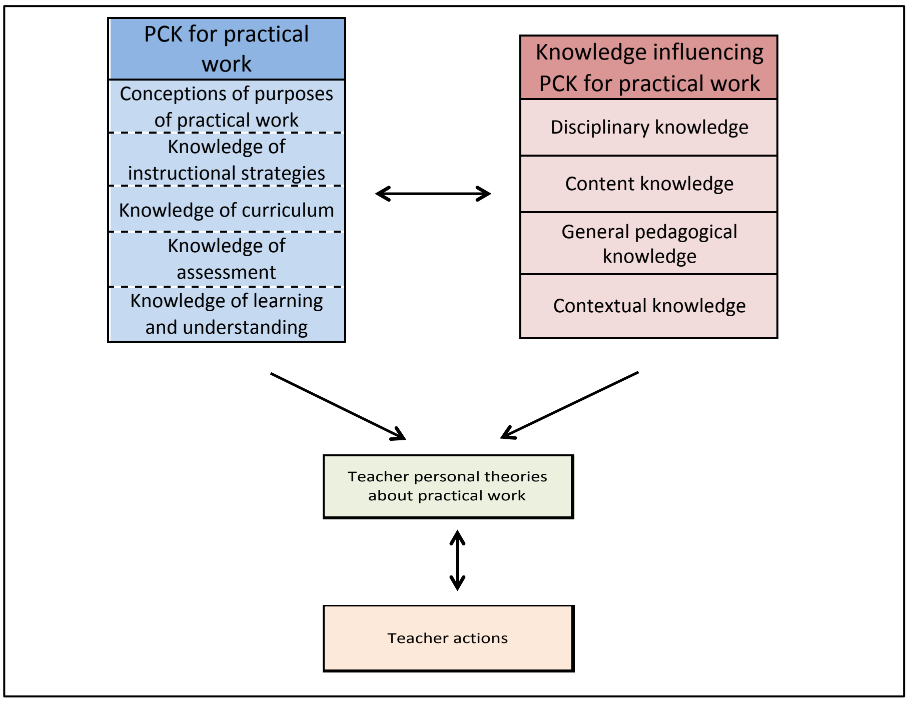


Figure 6.1 Conceptual framework for knowledge for practical work (repeat of Figure 2.1)

However, during the development and validation process, the framework was constantly being re-examined and based on the discussions above, it was revised (see Figure 6.2).

The following significant changes were made:

- the notion of PCK for practical work was discarded
- the category 'conceptions of purposes of practical work' was changed to 'knowledge and beliefs about purposes of practical work'
- the category 'disciplinary knowledge' was removed
- knowledge and beliefs about teaching and learning in general has been included in the framework

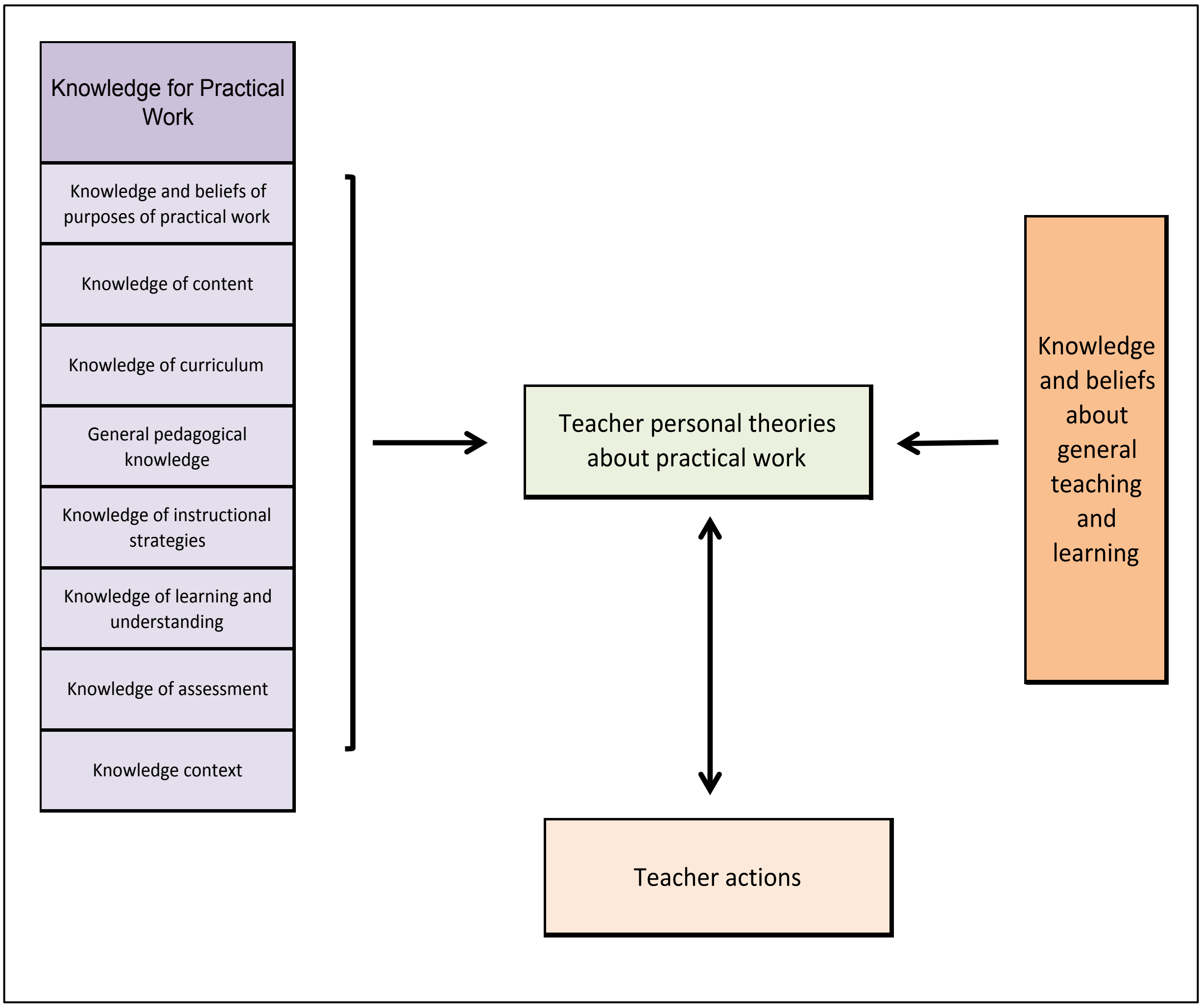


Figure 6.2 Revised conceptual framework

This study has shown that there are eight categories of science practical work knowledge that influence teachers' personal theories about practical work. However, teachers' knowledge and beliefs about teaching and learning in general have a significant influence on these theories. Thus, when exploring the teachers' knowledge that determines the practical work that plays out in sciences classes, teachers' conceptions about teaching and learning cannot be ignored.

6.5 Limitations of the study

There were three methodological limitations identified in this study – one is related to the development of the instrument, the other to the case study and the third is related to the study in general.

The inter-rater agreement on the understanding and interpretation of all the codes on the table were not determined because all the codes were not assigned in the interview used to determine the level of agreement. Presenting raters with de-contextualized text units, from different interviews, just to ensure that all the codes were included, would not have been wise. Therefore, the only way of increasing the number of codes examined, was to have raters analyse a number of different interviews. The scope of this study did not warrant the demands such a process would have required of the raters. Given that the level of agreement, on those codes that were included, was good and that it resulted in only a few adjustments to the instrument, this constraint would probably not have impacted significantly on the findings of this study.

The credibility of qualitative studies benefit from investigator triangulation, not only to check for consistencies in interpretation, but also for enriching the study by revealing deeper meaning in the data (Patton, 2002 cited in Guion, Dehl & Macdonald, 2011). Since the case study presented was a pilot study, as part of a minor dissertation, only my interpretation of the data is given and it was thought to be acceptable, given the purposes of the study.

During the development of the instrument and in the case study, the practice of teachers in working class, middle class and upper middle class were analysed. All these schools were relatively well-resourced with regards to science practical work. In South Africa there are many schools that have limited or no science resources and including a teacher from such a school may have improved our understanding of the relationship between teacher knowledge and practical work.

6.6 Recommendations

6.6.1 Methodological recommendations

There are a number of reasons why teacher interviews alone will not suffice when developing an analytical instrument such as the PracK Table or when using the PracK Table. These include the tacit nature of teacher knowledge (Berry *et al.*, 2009), the disjuncture between rhetoric and practice, and the bias of self-reporting, especially on the effectiveness of a lesson. A combination of interviews and lesson observations, as suggested by Abrahams and Millar (2008), is strongly advised in order to truly capture the essence of practical work.

These practical lessons are also best observed as they unfold in a more natural way, during the teaching of a particular topic, rather than a once-off observation of only the practical lesson. Understanding how the practical fits into the broader teaching plan for a topic yields useful and valid information.

The credibility of future studies using the PracK Table would be improved by having peers check the interpretation of the data, and by determining the inter-rater agreement on the understanding of as many of the codes as possible, using the methods outlined in this study.

6.6.2 Practical recommendations

The PracK Table may also be used as a self-reflective tool by a teacher. Using the instrument in this way, would require the teachers to reflect at a much deeper level, it may broaden the teachers' understanding of the different aspects of practical work, and, working with professional developers, may be able to identify those areas in which support is needed.

6.6.3 Recommendations for further study

In order to shed more light on the factors that influence the nature of practical work in South African schools, the PracK Table could be used to explore the relationship between teachers' knowledge associated with practical work, and:

1. the number of years of teaching experience
2. the educational contexts in which they work
3. their own experiences of practical work as learners or students at school or in higher education.

Natural sciences embraces three very different disciplines, namely physics, chemistry and biology. The knowledge and skills associated with practical activities in each of these disciplines may differ significantly, and studies focusing on each of these, may also provide some valuable insights.

6.7 Significance of the study

Despite an abundance of studies on the knowledge of science teachers, very few focus on the knowledge needed to conduct effective practical work. The strength of this study is that a validated instrument has now been developed to identify and describe this knowledge. This instrument may now be used in further studies and could contribute to the boarder body of knowledge on science practical work.

The instrument has also been tested in a typical South African school. And although the findings of the case study cannot be used to make claims about the knowledge of all natural sciences teachers in the country, it yielded information about practical work, which could be useful in the structuring of professional learning programmes for teachers with a similar profile. The findings of future studies, such as those recommended above, could also contribute significantly to the design of such learning programmes.

6.8 Conclusion

In this study an analytical instrument was developed and used to identify and describe the knowledge one teacher uses as he plans, enacts and reflects on practical work. It revealed that a valid and reliable instrument could be developed, if it is informed by authoritative literature, and if its validity and reliability are empirically tested in real contexts. Critique from knowledgeable outsiders at the early stages of the development of such an instrument is also important to verify the aptness of the conceptual framework on which the instrument is based.

The rigorously validated PracK Table proved to be a useful instrument for the analysis of a variety of data sources in the pilot case study, further validating the instrument. The study revealed the strengths and weaknesses in the teacher's knowledge and practice. It also revealed that a broad knowledge base, and access to laboratory resources, although necessary, does not always translate into effective practical work. Teachers' theories about teaching and learning seem to be the main factor that determines the effectiveness of practical work for well-qualified, experienced natural sciences teachers teaching in fairly well-resourced schools.

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Appendices

Appendix A: Evidence reporting table

Date: Class/Period: Teacher:

Orientations to Teaching Science		Types of Activitites	# of Activities	Types of Language Devices		# of Language Devices	Types of Content Elaboration	# of Content Elaboration	K of Students	# of Evidence of K of Students	K of Curriculum	# of Evidence of K of Curriculum	K of Assessment		# of Assess
Process	☐	Inquiry-based lab		Explanations	Metaphors		Depth beyond the intended goal of text (Topic Knowledge)		Miscon-ceptions		K of vertical curriculum		Types of assess.	Diagnostic	
					Analogies										
Academic rigor	☐				Similes									Formative	
		Hands-on		Examples	Related				Learning difficulty						
					Similar situation									Summative	
Conceptual change	☐	Demonst-rations			Dissimilar situation										
				Narratives	Stories/ Anecdotes				Motivation/ Interest		K of horizontal curriculum		K of assessment methods		
Didactic	☐	Simulation			Biography		Breadth beyond the intended goal of text (Domain Knowledge)								
				Illustration											
Activity driven	☐			Mnemonic devices					Need						
		Problem solving		Questioning	Recall/Factual Qs										
Discovery	☐				Attention focusing Qs										
					Problem posing Qs				Diversity		Curricular saliency		K of students learning goals important to assess in a given unit		
Project-based science	☐	Investiga-tion			Action Qs		Flexibility beyond the viewpoint of text								
					Reasoning Qs										
Inquiry	☐				Comparison Qs										
		Etc.		Argument	Logic				Background						
Guided inquiry	☐				Induction										
					Deduction										

(Park & Oliver, 2007) (redrawn)

Appendix B: Pre-lesson interview questions

1. What are the purposes of practical work?
2. What are the factors that influence whether you do practical work or not and what type of practical work you do?
3. Comment on your assessment of practical work.
4. Describe some of the other types of practicals you have done.
5. What topic will you be teaching and at what Grade?
6. What do you think the main ideas are that you need to tackle in that section?
7. What have you done in your lessons thus far?
8. What will you be doing in the next lesson?
9. Why do you think it is important for learners to learn about ….
10. Are there any ideas or concepts about … that you are deliberately not teaching the learners now.
11. What difficulties do you foresee when teaching this whole idea of ……..?
12. What do you know about the learners that will influence your way of teaching this topic.
13. What teaching strategies will you use to teach the idea and why do you choose that?
14. How will you check learners understanding of that and whether they have understood what you have tried to teach them or whether they have some misconceptions? How will you actually access that?

Appendix C: Post- lesson interview questions

1. What worked well?
2. Was there anything that did not work as well as expected?
3. What were you expecting learners to learn by doing this activity?
4. Why did you decide to do a practical activity to achieve these learning objectives?
5. What would you do differently?

Appendix D: General practical work interview questions

1. What are the purposes of doing practical work?

2. Do you think it is important to do practical work? Explain.

3. What do you intend learners to learn when you …. (link 1)

4. Why is it important for learners to know this?

5. What difficulties do you anticipate if you were to do practical work for each of the purposes stated earlier?

6. What do you know about learners that will influence your decisions about practical work?

Appendix E: Learner interview questions

1. What topics have you done this year?
2. Did you do any practical work when you did these topics?
3. What do you remember about the practical about the reactions of metals with water?
4. What do you remember about the practical about the burning of magnesium?

Appendix F: Example of data assimilation

Knowledge type	Specific knowledge type	Evidence	Description
KBEP	Concept acquisition & development	Pg 1 unit 6 Pg 2 unit 12	Ja, I'll say the to be able to notice that when there is a phase change you know the temperature is not you know increasing or decreasing, it remains constant. That's what I wanted them to see and then also to think also what was going to happen why was that the case. I have not taught them before about the latent hea of fusion, but I just wanted to see this is what is happening and I ant them to start thinking about why it was happening that way, using the knowledge they got , when we were discussing the structure of matter. Because at that moment I was expecting them to say. OK, they could, they kne w that when, when, when they were looking at the particles of …. Model I was showing them of how particles are arranged and they could see how they were moving but very slowly so but in the case of a liquid the movement was faster which means now in the case of a liquid now than the case of the solid. And where would they have got that kinetic energy from. From the heat you see. Ja, so that is what I wanted them to understand It's a hands-on activity so it. helps them to know it better.
	Teach laboratory skills	Pg 2 unit 6	And also to , to have practical skills to improve their practical skills you know. Like how to handle the equipment, how they should behave when they are in the lab and also they how they are conducting themselves when they are working in the …

Appendix G: Extract from an interview transcript

Interviewer: I

Interviewee: L

I: Good afternoon, Luvo, it is today the 24th June and thanks very much for allowing me to interview you. The purpose of the interview is just to get your views on the practical work and also to get an idea of some of your … some of the practical work you have done before … ja … so, I am just going to ask you a few questions and if you have anything else to add feel free to do so.

OK, firstly, in school science, what do you think the main, the purposes are for doing practical work?

L: OK, … you know, there are so many things that you deal with in science which are abstract, you know, to the learners, so I think the purpose, one of the reasons why we do practical work is to make, you know, things that learners need to learn in the class more real, you know …

I: OK

L: because they can be able to see, touch you know experience, those things that we normally talk about in class. And, also to stimulate their interests, because I think, like I said, seeing how science works, it's kinds of, it's kinds of it, it kind of stimulates their interest to learn science and … also … it's to really train them, you know, for practical exams in the future, you know. Well, I'm dealing with Grade 8's now who don't have practical exams but in the higher grades they need to develop those skills which are going to help them one day to deal with that … also to improve their skills because, you know, when they are doing practical work they have to observe, they have to communicate their findings, they have to interpret … sometimes they have to draw the graphs … they are thinking also because they have to think critically about, you know, what happens or what has happened or why it has this happened this way …

I: Is that about it in terms of reasons for doing practical

L: … the reasons, ja … some might, I might have forgotten some

I: right

L: [indistinct] in terms of how it goes

I: OK

L: … and I think, OK, and encouraging them to work together, also …

I: OK

L: what we call cooperative learning you normally find that in a practical you group them so that they are able to work together and also to improve their social skills, you know, they learn how, how each member of the group, you know, associates with each other, with the whole group

Appendix H: Extract from a lesson transcript

Teacher: **TEA**:

Learner: **LNR**:

Learners: **LNRS**:

[ongoing background noise/bad recording noises]

TEA: [class bell ringing] Please be careful of those burners there. [general class noise of students moving around, talking and getting seated] Right. I really do think [indistinct] it says here, this is the first [indistinct], but the other is… let me just [indistinct] you. I want you to sit down, right, I hope you are [indistinct] [background noises, coughing] for now and I'm [over talking] [indistinct]. Right, [indistinct] first.

LNR: [speaking amongst themselves]

TEA: Okay. Who knows what do we going to do today?

LNR: [speaking amongst themselves]

TEA: Hm?

LNR: [indistinct]

TEA: Yeah, you are going to do an experiment. I gave you the worksheet there. What is the experiment about?

LNR: [indistinct]

TEA: What is it about? Okay, what's, what's our aim, what is the aim? What is the aim of the experiment?

LNR: I would [indistinct] [over talking].

TEA: To find out how the temperature of water changes [class and teacher together] when it is being heated. You understand? So, as we heat ice and water how will the temperature, I mean, how will the temperature change as time goes along? That's what you are you going to see. Do you understand? So, what you going to do on this worksheet, before you start, right? Before you start you are going to group yourselves. You are going to sit in your groups and I said to you groups of four, five or six. And as you can see there are work stations there. There are different points that are going to seat to six people next to each on [indistinct] are going to be there, right? And then, when you are in a group I want you to tell me what you think will happen when we heat the mixture of ice and water, and that is your hypothesis, you can see there, where is it, what page is that?

LNR: [speaking together]

TEA: Yes. Page 1 you've got the aim there, then under the aim you've got what? Hypothesis. Now, how does the temperature change as we heat ice ? What do you think will happen? Is the temperature going to go up or is it going to be constant, if it doesn't, I mean, wouldn't change or is it going to go down, right? That's what you're going to tell us because remember the hypothesis is what? What is the hypothesis rule whatever [over talking by class] hypothesis is?

LNR: [speaking together].

Appendix I: PracK Table 1 codebook

Knowledge and beliefs about educational purposes of practical work - KBEP		
Sub-category	**Code**	**Description**
concept acquisition & development	KBEP1	Learning new science concepts or ideas or developing a deeper or broader understanding of known concepts and ideas
recall of concepts	KBEP2	Enabling learners to remember scientific concepts or ideas
motivation by stimulating interest & enjoyment	KBEP3	Motivate learners to participate or learn science during the lesson or to motivate them to further their studies in science by making lessons interesting and enjoyable to learners
teach laboratory skills	KBEP4	Teach the mental and physical processes required to perform a scientific investigation e.g. using instruments, drawing graphs, argumentation, observation
learn scientific method	KBEP5	Learn the steps involved in a scientific investigation. Generally in the following sequence: observation; investigable questions, hypothesis, method, results and discussion, conclusions
develop scientific attitudes	KBEP6	E.g. Curiosity, open-mindedness, creativity, intellectual honesty, objectivity, willingness to change opinions
Knowledge of Content - KCt		
Sub-category	**Code**	**Description**
scientific concepts related to the practical	KCt1	Understands the concepts under discussion or being addressed (at a surface or theoretical level) in a lesson
instruments and technology	KCt2	Is familiar with and/or is competent in using the necessary instruments or technology
how key ideas and skills are related	KCt3	Self-explanatory
nature of observation vs. inference	KCt4	Understands the difference between deriving conclusions based on observation as opposed to conclusion based on premises assumed to be true
historical context of development of ideas	KCt5	Understands how earlier held theories and experiments contribute to the current understanding of a scientific concept or idea
distinction between theoretical explanations and empirical/descriptive accounts	KCt6	Understands that would is observed or experienced is not necessarily the same was that predicted by theory or logic
evaluation of validity & reliability of scientific information	KCt7	Cognizant of factors that influence validity and reliability when conducting an experiment and when evaluating scientific claims
Knowledge of curriculum - KC		
Sub-category	**Code**	**Description**
curricular requirements	KC1	the content and practical work prescribed or recommended in curriculum documents and the related assessment requirements
vertical	KC2	Aware of what learners had studied in previous grades and what they are expected to study in subsequent grade
horizontal	KC3	Understanding of how certain elements within the science curriculum at a specific grade are related but also how elements of the science curriculum relate to the curricula of other subjects at the same grade level
curricular saliency	KC4	ability to identify core concepts, make decisions about sequencing and pacing, evaluating materials etc. based on knowledge of the curriculum

General pedagogic knowledge - GPK		
Sub-category	**Code**	**Description**
manage laboratory	GPK1	Includes management of access to laboratory, procurement of equipment and consumables, safe storage and disposal of chemicals, behaviour in laboratory, safety policy
organise and manage group work	GPK2	Techniques to ensure all/most individuals in a group are meaningfully working towards achieving the expected outcomes
organise and manage materials	GPK3	The organization of equipment, chemicals and writing material before, during and after the practical activity
organise phases of activity	GPK4	Able to deconstruct longer tasks into meaningful units that could be covered in shorter periods e.g. segments within a single lesson, single lessons, double lessons, months, terms etc.
Knowledge of instructional strategies - KIS		
Sub-category	**Code**	**Description**
models & modelling	KIS1	The use of models or modeling to achieve a particular objective
demonstration	KIS2	Teacher-guided illustration through the use of materials and procedures
skill building	KIS3	Students engaging in manipulative activity following procedures or practising intellectual skills (e.g. tranforming data from table into a graphical representation)
problem solving	KIS4	Students use their understanding to solve self-defined or teacher-defined problems and/or teacher understands that real science investigative questions are grounded in current knowledge of the phenomena and is not the linear process as portrayed in the 'scientific method'
school science	KIS5	Hypothesis testing via empirical investigations following the "scientific method"
discovery learning	KIS6	Students working in structured or semi-structured ways to "discover" or confirm an idea or set of relations
authentic science	KIS7	Students work more independently in open ended empirical investigations emulating the work of scientists and it could thus include a variety of types of investigation. The teacher's role is that of mentor and the learner is the apprentice.
avoids activities or representations that give rise to alternative conceptions	KIS8	e.g. Inappropriate analogies, confusing diagrams
combines different forms of instruction for effective learning	KIS9	e.g. Simulations combined with hands-on experiment
aware of time scale of potential activities or investigations	KIS10	Self-explanatory
Knowledge of learning and understanding - KLU		
Sub-category	**Code**	**Description**
sense making discussions	KLU1	discussions before an activity to focus attention on the relevant phenomena or skill and afterwards to focus on the link between the outcomes of the activity and the phenomenon to ensure greater understanding.
scaffold ideas to related contexts	KLU2	Provide support needed for learners to see how focal ideas can be applied in or are related to other contexts
scaffold integration of ideas with ideas in other domains	KLU3	Provide support needed for learners to make the links between focal ideas and ideas explored in other fields of study e.g. cross-curricular links
scaffolds development of skills	KLU4	Provide the support needed for the development of the mental and physical skills of learners
scaffold understanding of appropriate use of skills	KLU5	Provide support needed for learners to understand when it is appropriate to use particular skills

appropriate background reading	KLU6	Understands what prior knowledge is necessary to effectively engage in an activity
Knowledge of assessment - KA		
Sub-category	**Code**	**Description**
formative	KA1	Assessment for the explicit purpose of promoting learning (assessment for learning) –used to adapt teaching practices to meet the needs of the learners
summative	KA2	Assessment which indicates what a learner has learned at a specific point, including standardised tests
elicit existing conceptions and skills	KA3	Techniques used to ascertain learners current understanding of scientific concepts and their proficiency in particular skills
recognise limitations in learners' thinking and skills	KA4	Self-explanatory
recognise flaws in problem solving approaches and conceptual thinking	KA5	Self-explanatory
Knowledge of context - KCx		
Sub-category	**Code**	**Description**
learners	KCx1	Personal circumstances which may impact on learning, behaviour patterns and academic potential
classroom	KCx2	The perceptions, dynamics and behaviour patterns within a particular class
school	KCx3	The opportunities and challenges at school and general routines and practices within the school
district	KCx4	The expectations of the local education districts and the support they may be able to offer
community	KCx5	An awareness of the opportunities and challenges within the broader school community and the relationships between the school and other institutes, organisations or businesses which may be able to support the school
province/nation	KCx6	Understand the educational landscape at the provincial and national level and the relationship between provincial and national education departments

Appendix J: Extract from transcript used to determine inter-rater agreement

Please code each unit of data using the codes on the *PracK Table Codes and Description* document as shown in the example below:

Example:

Text	*code*	*unit*
B: One of the things is that maybe it would have been ideal to give a group of four or five to do that experiment on their own. Different groups you know. But with the type of students I have there, it was a bit tricky, I didn't trust them to be frank	*KIS3* *KCx1*	*1*

Data source: Interview 1
I: - interviewer
B: - teacher

Text	**Code**	**Unit**
I: Good afternoon Mr B. Thanks very much for agreeing to this interview. I would just like to ask you a few questions about your planning of the section on reactions of metals with oxygen, so I am going to ask a few questions, but if you want to add anything else, ask any other questions, please feel free. B: OK I: So firstly we are looking at topic: Reactions of metals with oxygen. What do you think the main ideas are that you need to tackle in that section? B: OK. One of the things is to reinforce the idea of the chemical reaction, because it is not – I mean they are not so familiar with it. They have done it but they are not so familiar with it. Also the other issue is the balancing of the equations will be reinforced in that topic as well. The other thing is we look at the products and then we check whether it is basic or acidic. The use of the litmus paper and all that, so that is what we are going to do. It must dissolve that in water and see how it is like. Those are the main ideas. The other idea is the whole idea of the scientific investigation. We have done a section on reactions of metals with water, so I think from there they will get an idea of how to get data and report the data and then later on to write a scientific report based on that. So, when they come to this one, they start to look at the quantitative aspects. They can measure. We are going to do it with magnesium metal. We measure the strip of magnesium metal and then we try and see how it reacts and then at the same time, we are going to see the products and analyzing those products. I: So if I can just check if I am correct. You are firstly going to do an investigation on the reactions of metals with water?		Unit 1

Appendix K: PracK Table 1 with codes

PracK Table 1 with codes

KBEP	KCt	KC	GPK	KIS	KLU	KA	KCx
concept acquisition & development **KBEP1**	understands the scientific concepts related to the practical activity **KCt1**	curricular requirements **KC1**	manage laboratory **GPK1**	models & modelling **KIS1**	sense making discussions **KLU1**	formative **KA1**	learners **KCx1**
recall of concepts **KBEP2**	instruments and technology **KCt2**	vertical **KC2**	organise and manage group work **GPK2**	demonstration **KIS2**	scaffold ideas to related contexts **KLU2**		classroom **KCx2**
	understands how key ideas and skills are related **KCt3**			discovery learning **KIS3**		summative **KA2**	
motivation by stimulating interest & enjoyment **KBEP3**				skill building **KIS4**	scaffold integration of ideas with ideas in other domains **KLU3**		school **KCx3**
	understands nature of observation vs inference **KCt4**	horizontal **KC3**	organise and manage materials **GPK3**	problem solving **KIS5**			
teach laboratory skills **KBEP4**	historical context of development of ideas **KCt5**			school science **KIS6**	scaffolds development of skills **KLU4**	elicit existing conceptions and skills **KA3**	district **KCx4**
				authentic science **KIS7**			
learn scientific method **KBEP5**	understands distinction between theoretical explanations and empirical /descriptive accounts **KCt6**	curricular saliency **KC4**	organise phases of activity **GPK4**	avoids activities or representations that give rise to alternative conceptions **KIS8**	scaffold understanding of appropriate use of skills **KLU5**	recognise limitations in thinking and skills **KA4**	community **KCx5**
develop scientific attitudes **KBEP6**	evaluation of validity & reliability of scientific information **KCt7**			combines different forms of instruction for effective learning **KIS9**	appropriate background reading **KLU6**	recognise flaws in problem solving approaches and conceptual thinking **KA5**	province/nation **KCx6**
				aware of time scale of potential activities or investigations **KIS10**			

Appendix L: Contingency tables

Comparing coding of Rater 1 and Rater 4

	ROUND 1		ROUND 2	
KBEP1	0	3	3	1
	0	11	0	10
	0,786		0,929	
KBEP2	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP3	0	0	0	0
	0	14	0	14
	1,000		1,000	
KBEP4	0	2	1	1
	0	12	0	12
	0,857		0,929	
KBEP5	0	3	3	0
	0	11	0	11
	0,786		1,000	
KCt1	3	1	6	0
	2	8	0	8
	0,786		1,000	
KCt3	0	5	1	3
	0	9	0	10
	0,643		0,786	
KC1	2	0	2	0
	3	9	3	9
	0,786		0,786	
KC2	3	0	3	0
	1	10	0	11
	0,929		1,000	
KC3	0	0	0	0
	1	13	0	14
	0,929		1,000	
KC4	0	1	1	0
	0	13	0	13
	0,929		1,000	
KIS1	2	1	3	0
	0	11	0	11
	0,929		1,000	
KIS3	0	0	1	0
	2	12	1	12
	0,857		0,929	
KIS5	3	0	3	0
	0	11	0	11
	1,000		1,000	
KIS6	0	0	0	0
	0	14	0	14
	0,786		1,000	
KLU2	0	1	1	0
	0	13	0	13
	0,929		1,000	
KLU4	0	1	1	0
	0	13	0	13
	0,929		1,000	
KA1	0	2	1	1
	0	12	1	11
	0,857		0,857	
KA2	0	2	1	1
	0	12	0	12
	0,857		0,929	
KA3	0	3	2	1
	0	11	1	10
	0,786		0,857	
KCx1	3	1	4	0
	0	10	1	9
	0,929		0,929	
KCx2	0	1	0	1
	0	13	0	13
	0,929		0,929	
KCx3	0	1	3	0
	1	12	0	11
	0,857		1,000	
KCx4	0	2	1	1
	0	12	0	12
	0,857		0,929	
Average	**0,864**		**0,945**	

Comparing coding of Rater 2 and Rater 3

	ROUND 1		ROUND 2	
KBEP1	0	3	4	0
	1	10	0	10
	0,714		1,000	
KBEP2	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP3	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP4	0	0	2	0
	1	13	0	12
	0,929		1,000	
KBEP5	2	1	3	0
	0	11	0	11
	0,929		1,000	
KCt1	1	2	6	0
	0	11	0	8
	0,857		1,000	
KCt3	0	1	3	1
	0	13	0	10
	0,929		0,929	
KC1	0	1	2	0
	1	12	2	10
	0,857		0,857	
KC2	0	0	3	0
	2	12	0	11
	0,857		1,000	
KC3	0	0	0	0
	2	12	2	12
	0,857		0,857	
KC4	0	5	1	2
	1	8	0	11
	0,571		0,857	
KIS1	1	1	3	0
	0	12	0	11
	0,929		1,000	
KIS3	0	0	0	0
	0	14	0	14
	1,000		1,000	
KIS5	0	0	3	0
	1	13	0	11
	0,929		1,000	
KIS6	0	0	0	0
	1	13	0	14
	0,929		1,000	
KLU2	0	0	1	0
	1	13	0	13
	0,929		1,000	
KLU4	0	0	1	0
	0	14	0	13
	1,000		1,000	
KA1	1	1	2	0
	1	11	0	12
	0,857		1,000	
KA2	0	1	1	1
	0	13	0	12
	0,929		0,929	
KA3	1	1	3	0
	1	11	0	11
	0,857		1,000	
KCx1	0	3	4	0
	0	11	0	10
	0,786		1,000	
KCx2	1	0	1	0
	0	13	0	13
	1,000		1,000	
KCx3	2	1	3	0
	1	10	0	11
	0,857		1,000	
KCx4	0	1	2	0
	1	12	0	12
	0,857		1,000	
Average	**0,877**		**0,974**	

Appendix L: Contingency tables (cont.)

Comparing coding of Rater 1 and Rater 2

Code	ROUND 1		ROUND 2	
KBEP1	2	0	4	0
	1	11	0	10
	0,929		1,000	
KBEP2	0	0	0	0
	0	14	0	14
	1,000		1,000	
KBEP3	0	0	0	0
	0	14	0	14
	1,000		1,000	
KBEP4	0	2	2	0
	0	12	0	12
	0,857		1,000	
KBEP5	3	0	3	0
	0	11	0	11
	1,000		1,000	
KCt1	4	0	6	0
	0	10	0	8
	1,000		1,000	
KCt3	1	4	4	0
	0	9	0	10
	0,714		1,000	
KC1	1	1	2	0
	0	12	0	12
	0,929		1,000	
KC2	0	3	3	0
	0	11	0	11
	0,786		1,000	

Code	ROUND 1		ROUND 2	
KC3	0	0	0	0
	0	14	0	14
	1,000		1,000	
KC4	1	0	1	0
	4	9	2	11
	0,714		0,857	
KIS1	2	1	3	0
	0	11	0	11
	0,929		1,000	
KIS3	0	0	0	1
	0	14	0	13
	1,000		0,929	
KIS5	0	3	3	0
	0	11	0	11
	0,786		1,000	
KIS6	0	0	0	0
	0	14	0	14
	0,786		1,000	
KLU2	0	1	1	0
	0	13	0	13
	0,929		1,000	
KLU4	0	1	1	0
	0	13	0	13
	0,929		1,000	
KA1	2	0	2	0
	0	12	0	12
	1,000		1,000	

Code	ROUND 1		ROUND 2	
KA2	1	1	2	0
	0	12	0	12
	0,929		1,000	
KA3	2	1	3	0
	0	11	0	11
	0,929		1,000	
KCx1	3	1	4	0
	0	10	0	10
	0,929		1,000	
KCx2	1	0	1	0
	0	13	0	13
	1,000		1,000	
KCx3	1	0	3	0
	2	11	0	11
	0,857		1,000	
KCx4	1	1	2	0
	0	12	0	12
	0,929		1,000	
Average	**0,912**		**0,990**	

Comparing coding of Rater 1 and Rater 3

Code	ROUND 1		ROUND 2	
KBEP1	1	2	4	0
	0	11	0	10
	0,857		1,000	
KBEP2	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP3	0	0	0	0
	2	12	0	14
	0,857		1,000	
KBEP4	1	1	2	0
	0	12	0	12
	0,929		1,000	
KBEP5	2	1	3	0
	0	11	0	11
	0,929		1,000	
KCt1	1	3	5	1
	0	10	0	8
	0,786		0,929	
KCt3	0	5	3	1
	0	9	0	10
	0,643		0,929	
KC1	0	2	2	0
	0	12	2	10
	0,857		0,857	
KC2	2	1	3	0
	0	11	0	11
	0,929		1,000	

Code	ROUND 1		ROUND 2	
KC3	0	0	0	0
	2	12	2	12
	0,857		0,857	
KC4	0	1	1	0
	1	12	0	13
	0,857		1,000	
KIS1	1	2	3	0
	0	11	0	11
	0,857		1,000	
KIS3	0	0	0	1
	0	14	0	13
	1,000		0,929	
KIS5	1	2	3	0
	0	11	0	11
	0,857		1,000	
KIS6	0	0	0	0
	1	13	0	14
	0,786		1,000	
KLU2	0	1	1	0
	1	12	0	13
	0,857		1,000	
KLU4	0	1	1	0
	0	13	0	13
	0,929		1,000	
KA1	1	1	2	0
	1	11	0	12
	0,857		1,000	

Code	ROUND 1		ROUND 2	
KA2	0	2	1	1
	0	12	0	12
	0,857		0,929	
KA3	1	2	2	1
	1	10	0	11
	0,786		0,929	
KCx1	1	3	4	0
	0	10	0	10
	0,786		1,000	
KCx2	1	0	1	0
	0	13	0	13
	1,000		1,000	
KCx3	0	1	3	0
	3	10	0	11
	0,714		1,000	
KCx4	1	1	2	0
	0	12	0	12
	0,929		1,000	
Average	**0,860**		**0,971**	

Appendix L: Contingency tables (cont.)

Comparing coding of Rater 3 and Rater 4

KBEP1

ROUND 1		ROUND 2	
0	1	3	1
0	13	0	10
0,929		0,929	

KBEP2

ROUND 1		ROUND 2	
0	2	0	0
2	10	0	14
0,714		1,000	

KBEP3

ROUND 1		ROUND 2	
0	2	0	0
0	12	0	14
0,857		1,000	

KBEP4

ROUND 1		ROUND 2	
0	1	1	1
0	13	0	12
0,929		0,929	

KBEP5

ROUND 1		ROUND 2	
0	2	3	0
0	12	0	11
0,857		1,000	

KCt1

ROUND 1		ROUND 2	
0	1	5	0
5	8	1	8
0,571		0,929	

KCt3

ROUND 1		ROUND 2	
0	0	1	2
0	14	0	11
1,000		0,857	

KC1

ROUND 1		ROUND 2	
0	2	2	2
6	6	3	7
0,429		0,643	

KC2

ROUND 1		ROUND 2	
2	0	3	0
2	10	0	11
0,857		1,000	

KC3

ROUND 1		ROUND 2	
0	2	0	2
1	11	0	12
0,786		0,857	

KC4

ROUND 1		ROUND 2	
0	1	1	0
1	13	0	13
0,929		1,000	

KIS1

ROUND 1		ROUND 2	
1	0	3	0
1	12	0	11
0,929		1,000	

KIS3

ROUND 1		ROUND 2	
0	0	0	0
2	12	2	12
0,857		0,857	

KIS5

ROUND 1		ROUND 2	
1	0	3	0
2	11	0	11
0,857		1,000	

KIS6

ROUND 1		ROUND 2	
0	1	0	0
0	13	0	14
0,929		1,000	

KLU2

ROUND 1		ROUND 2	
0	1	1	0
0	13	0	13
0,929		1,000	

KLU4

ROUND 1		ROUND 2	
0	0	1	0
0	14	0	13
1,000		1,000	

KA1

ROUND 1		ROUND 2	
0	2	1	1
0	12	1	11
0,857		0,857	

KA2

ROUND 1		ROUND 2	
0	0	1	0
0	14	0	13
1,000		1,000	

KA3

ROUND 1		ROUND 2	
0	2	1	0
0	12	2	11
0,857		0,857	

KCx1

ROUND 1		ROUND 2	
0	0	4	0
4	10	1	9
0,714		0,929	

KCx2

ROUND 1		ROUND 2	
0	1	0	1
0	13	0	13
0,929		0,929	

KCx3

ROUND 1		ROUND 2	
1	2	3	0
0	11	0	11
0,857		1,000	

KCx4

ROUND 1		ROUND 2	
0	1	1	1
0	13	0	12
0,929		0,929	

ROUND 1	ROUND 2	
0,851	**0,932**	**Average**

Appendix M: PracK Table 2 codebook

Knowledge and beliefs about educational purposes of practical work - KBEP		
Sub-category	**Code**	**Description**
concept acquisition & development	KBEP1	Learning new science concepts or ideas or developing a deeper or broader understanding of known concepts and ideas
recall of concepts	KBEP2	Enabling learners to remember scientific concepts or ideas
motivation by stimulating interest & enjoyment	KBEP3	Motivate learners to participate or learn science during the lesson or to motivate them to further their studies in science by making lessons interesting and enjoyable to learners
teach laboratory skills	KBEP4	Teach the mental and physical processes required to perform a scientific investigation e.g. using instruments, drawing graphs, argumentation, observation
learn scientific method	KBEP5	Learn the steps involved in a scientific investigation. Generally in the following sequence: observation; investigable questions, hypothesis, method, results and discussion, conclusions
develop scientific attitudes	KBEP6	E.g. Curiosity, open-mindedness, creativity, intellectual honesty, objectivity, willingness to change opinions
Knowledge of Content - KCt		
Sub-category	**Code**	**Description**
targeted scientific concepts and / or procedures	KCt1	Understands the concepts and procedures under discussion or being addressed (at a surface or theoretical level) in a lesson
instruments and technology	KCt2	Is familiar with and/or is competent in using the necessary instruments or technology
how key ideas are related	KCt3	Self-explanatory
nature of observation vs. inference	KCt4	Understands the difference between deriving conclusions based on observation as opposed to conclusion based on premises assumed to be true
historical context of development of ideas	KCt5	Understands how earlier held theories and experiments contribute to the current understanding of a scientific concept or idea
distinction between theoretical explanations and empirical/descriptive accounts	KCt6	Understands that would is observed or experienced is not necessarily the same was that predicted by theory or logic
evaluation of validity & reliability of scientific information	KCt7	Cognizant of factors that influence validity and reliability when conducting an experiment and when evaluating scientific claims
Knowledge of curriculum - KC		
Sub-category	**Code**	**Description**
curricular requirements	KC1	Explicit reference made to the content and practical work prescribed or recommended in curriculum documents and the related assessment requirements
vertical	KC2	Aware of what learners had studied in previous grades and what they are expected to study in subsequent grade
horizontal	KC3	Understanding of how certain elements within the science curriculum at a specific grade are related but also how elements of the science curriculum relate to the curricula of other subjects at the same grade level
curricular saliency	KC4	ability to identify core concepts, make decisions about sequencing and pacing, evaluating materials etc. based on knowledge of the curriculum

General pedagogic knowledge - GPK		
Sub-category	**Code**	**Description**
manage laboratory	GPK1	Includes management of access to laboratory, procurement of equipment and consumables, safe storage and disposal of chemicals, behaviour in laboratory, safety policy
organise and manage group work	GPK2	Techniques to ensure all/most individuals in a group are meaningfully working towards achieving the expected outcomes
organise and manage materials	GPK3	The organization of equipment, chemicals and writing material before, during and after the practical activity
organise phases of activity	GPK4	Able to deconstruct longer tasks into meaningful units that could be covered in shorter periods e.g. segments within a single lesson, single lessons, double lessons, months, terms etc.
Knowledge of instructional strategies - KIS		
Sub-category	**Code**	**Description**
models & modelling	KIS1	The use of models or modeling to achieve a particular objective
demonstration	KIS2	Teacher-guided illustration through the use of materials and procedures
discovery learning	KIS3	Students working in structured or semi-structured ways to “discover” or confirm an idea or set of relations
skill building	KIS4	Students engaging in manipulative activity following procedures or practising intellectual skills (e.g. tranforming data from table into a graphical representation)
problem solving	KIS5	Students use their understanding to solve self-defined or teacher-defined problems and/or teacher understands that real science investigative questions are grounded in current knowledge of the phenomena and is not the linear process as portrayed in the ‘scientific method’
school science	KIS6	Hypothesis testing via empirical investigations following the “scientific method”
authentic science	KIS7	Students work more independently in open ended empirical investigations emulating the work of scientists and it could thus include a variety of types of investigation. The teacher’s role is that of mentor and the learner is the apprentice.
avoids activities or representations that give rise to alternative conceptions	KIS8	e.g. Inappropriate analogies, confusing diagrams
combines different forms of instruction for effective learning	KIS9	e.g. Simulations combined with hands-on experiment
aware of time scale of potential activities or investigations	KIS10	Self-explanatory
Knowledge of learning and understanding - KLU		
Sub-category	**Code**	**Description**
sense making discussions	KLU1	discussions before an activity to focus attention on the relevant phenomena or skill and afterwards to focus on the link between the outcomes of the activity and the phenomenon to ensure greater understanding.
scaffold ideas to related contexts	KLU2	Provide support needed for learners to see how focal ideas can be applied in or are related to other contexts
scaffold integration of ideas with ideas in other domains	KLU3	Provide support needed for learners to make the links between focal ideas and ideas explored in other fields of study e.g. cross-curricular links
scaffolds development of skills	KLU4	Provide the support needed for the development of the mental and physical skills of learners
scaffold understanding of appropriate use of skills	KLU5	Provide support needed for learners to understand when it is appropriate to use particular skills

appropriate background reading	KLU6	Understands what prior knowledge is necessary to effectively engage in an activity
Knowledge of assessment - KA		
Sub-category	**Code**	**Description**
formative	KA1	Assessment for the explicit purpose of promoting learning (assessment for learning) –used to adapt teaching practices to meet the needs of the learners
summative	KA2	Assessment which indicates what a learner has learned at a specific point, including standardised tests
elicit existing conceptions and skills	KA3	Techniques used to ascertain learners current understanding of scientific concepts and their proficiency in particular skills before being taught these concepts or skills
recognise limitations in learners' thinking and skills	KA4	Self-explanatory
recognise flaws in problem solving approaches and conceptual thinking	KA5	Self-explanatory
Knowledge of context - KCx		
Sub-category	**Code**	**Description**
learners	KCx1	Personal circumstances which may impact on learning, behaviour patterns and academic potential
classroom	KCx2	The perceptions, dynamics and behaviour patterns within a particular class
school	KCx3	The opportunities and challenges at school and general routines and practices within the school
district	KCx4	The expectations of the local education districts and the support they may be able to offer
community	KCx5	An awareness of the opportunities and challenges within the broader school community and the relationships between the school and other institutes, organisations or businesses which may be able to support the school
province/nation	KCx6	Understand the educational landscape at the provincial and national level and the relationship between provincial and national education departments

Appendix N: Lesson 1 worksheet

Grade 9 INVESTIGATING THE REACTIONS OF GROUP 1 METALS WITH WATER

Aim:

Apparatus:____

(1) Lithium + Water ⟶

Symbols ____

Observations with red and blue litmus paper

Other Observations__________________________________

(2) Sodium + Water ⟶

Symbols ____

Observations with red and blue litmus paper

Other Observations__________________________________

(3) Potassium + Water ⟶

Symbols ____

Observations with red and blue litmus paper

Other Observations__________________________________

Apparatus:____

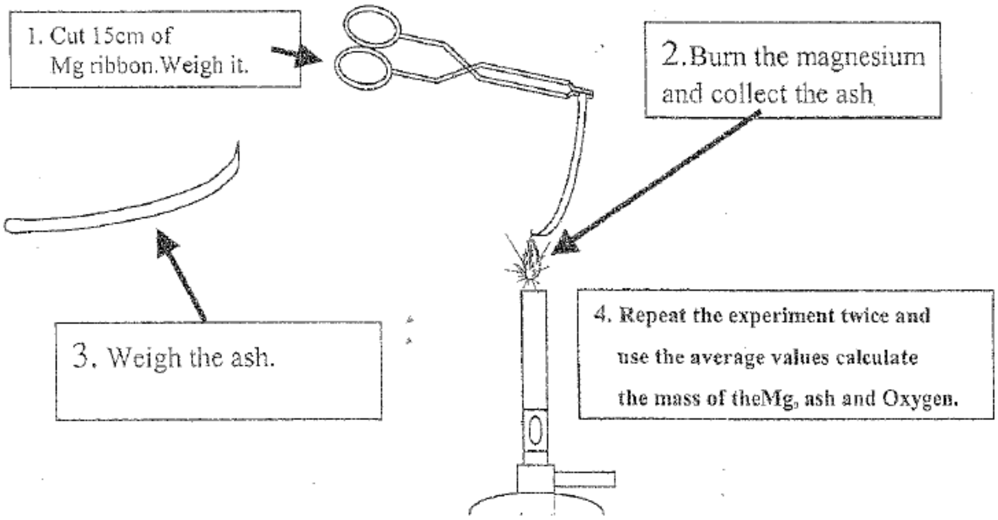
Appendix O: Practical instruction sheet

Reacting metals

Act 1 Marks: 20

Outcomes: (1) Balance a chemical equation.
(2) Record experimental data.
(3) Interpret experimental data.

You are required to look at how much metal oxide is formed when a metal burns. For this experiment you have been given some magnesium ribbon. Magnesium is a metal with a low density and a greyish colour that comes in thin strips about 5mm wide and less than 1mm thick. The long strip is wound into a roll like a roll of sticky tape for parcels and letters. Repeat the experiment twice and then use the averages to do your calculations. Here is the possible experimental design.



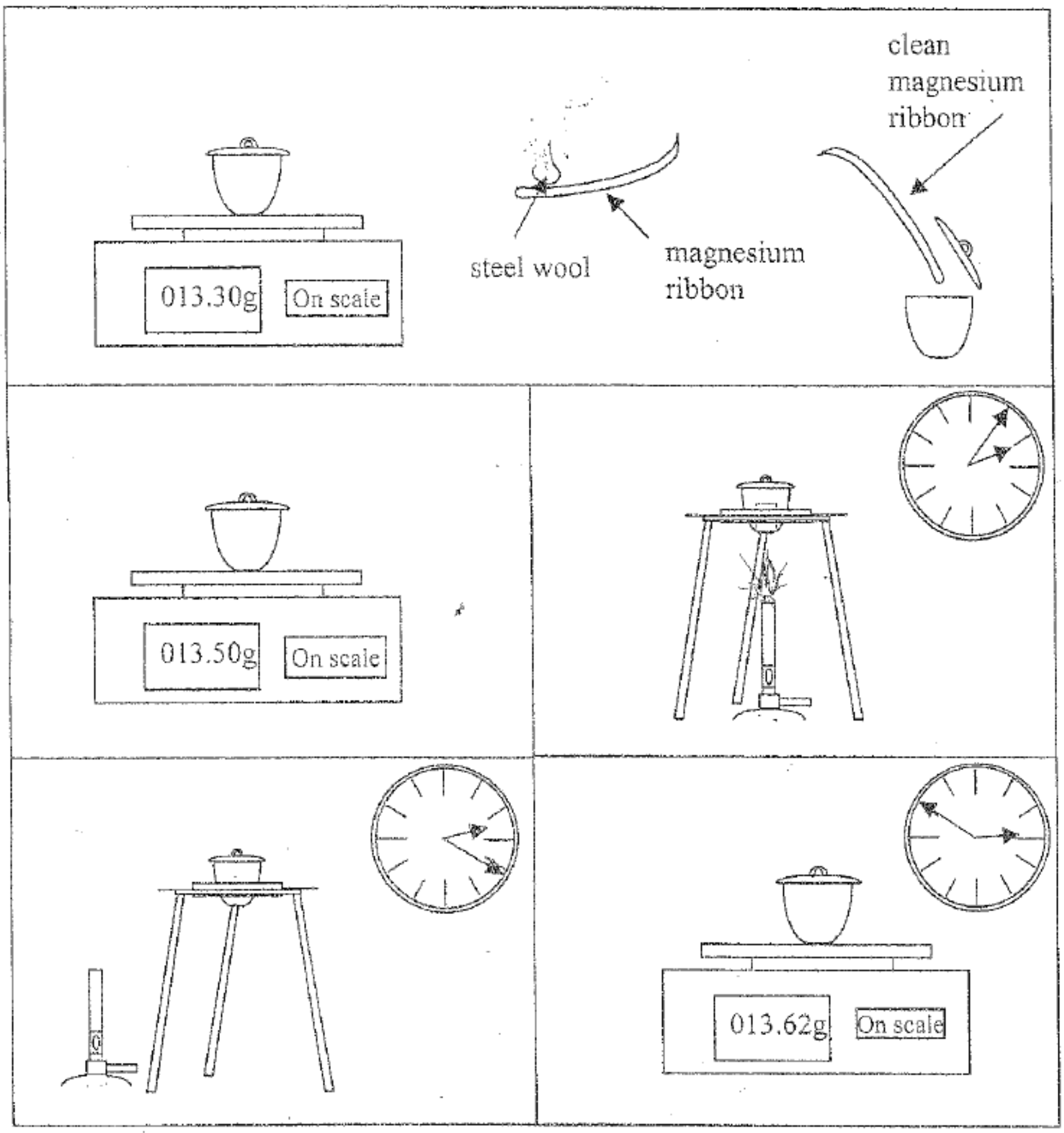
1 Record your results under the subheadings.

	Mass of crucible	Mass of crucible + Mg ribbon	Mass of crucible + ash	
1.				
2.				
Average				(3)

2 Calculate the mass of the magnesium ribbon. (2)
3 Calculate the mass of oxygen that reacted. (2)
4 Calculate the mass of the ash (2)
5 Complete and balance the equation in symbols
Magnesium + Oxygen → Magnesium oxide (5)
6 How does the total mass of the reactants compare with the total mass of the products. (3)

Reacting metals

This is what you could do to get your results.



☞**Observe** the steps in this experiment and describe in your own words what happened. (5)

Appendix P: Batandwa's PowerPoint presentation

AIM

- To investigate the reactions of group 1 metals with water from the atmosphere

Apparatus

- Three empty bottles of coke
- Sharp razor blade
- Matches
- Reagents (Litmus paper, Li, Na, K & H_2O)

Method(procedure)

- Half fill the three bottles of coke with water
- Cut a small piece of Li metal and put it into water in one of the bottles. When a gas is released light a match and put it into the mouth of the bottle. A pop sound indicates the release of hydrogen from the bottle. Put a red litmus paper into the solution in the bottle. The litmus paper turns blue indicating the presence of a base. Repeat the procedure with Na and K using the other bottles

Results and interpretation

Reaction with Li	Reaction with Na	Reaction with K
$2Li + 2H_2O \rightarrow 2LiOH + H_2$	$2Na + 2H_2O \rightarrow 2NaOH + H_2$	$2K + 2H_2O \rightarrow 2KOH + H_2$
Pop sound heard Reaction slow	Pop sound heard Reaction speed moderate	Pop sound heard Reaction fast
Litmus turns blue Hence LiOH is basic	Litmus turns blue Hence NaOH is basic	Litmus turns blue Hence KOH is basic

Conclusion

- Group 1 metals react with water to get a basic metal hydroxide and hydrogen.

Gr 1 metal + water → metal hydroxide + H_2

- $2Li + 2H_2O \rightarrow 2LiOH + H_2$
- $2Na + 2H_2O \rightarrow 2NaOH + H_2$
- $2K + 2H_2O \rightarrow 2KOH + H_2$

Appendix Q: Combustion worksheet

THE REACTION OF METALS WITH OXYGEN.

Aim: To investigate the reactions of metals with oxygen.

Apparatus: Tile, matches, Magnesium ribbon and a spirit burner.

Method:
We light the spirit burner using our matches. We then burn our 15 cm magnesium ribbon. We observe the flame. We then took the ash and dissolve it in water and put a litmus paper. The litmus paper changes from red to blue showing that the MgO is basic.

Results and interpretation:
The reaction $2Mg + O_2 \rightarrow 2MgO$ takes place
Awhite blinding flame is observed.
The red litmus paper turns blue because the metal oxide is basic.

Conclusion:
Metal + Oxygen $\rightarrow$ Metal oxide
Metal oxides are basic.
The total mass of the reactants is always equal to the total mass of the prodcuts.

Worksheet on metal oxides:
The following problems are based on the law of conservation of mass which states that the total mass of the reactants is always equal to the total mass of the products. Fill in the missing spaces.

1 $4Na + O_2 \rightarrow 2Na_2O$
Mass 92g + 32g $\rightarrow$ 124g Solved for you as an example

2 $4Li + O_2 \rightarrow 2Li_2O$
28g + __g $\rightarrow$ 60g

3 $4K + O_2 \rightarrow 2K_2O$
39g + 8g $\rightarrow$ __g

4 $2Mg + O_2 \rightarrow 2MgO$
24g + 16g $\rightarrow$ __g

5 $4Al + 3O_2 \rightarrow 2Al_2O_3$
__g + 96g $\rightarrow$ 204g

6 $2Ca + O_2 \rightarrow 2CaO$
__g + 32g $\rightarrow$ 112g

7 $2Be + O_2 \rightarrow 2BeO$
18g + __g $\rightarrow$ 50g

Appendix R: Extracts from question paper and learner's examination script

The question

4.6 A group of grade 9 learners did an investigation of the reaction of magnesium with oxygen.
They: a) used a ruler to measure and cut 20 cm of magnesium ribbon
b) measured the mass of the of the (sic) 20 cm magnesium ribbon
c) burnt the 20 cm magnesium ribbon.
d) collected the ash and measured its mass
The reaction of the 20 cm magnesium ribbon with oxygen gas is given in words below:

Magnesium + Oxygen $\longrightarrow$ Magnesium Oxide

4.6.1 Write the chemical symbols of magnesium, oxygen gas and magnesium oxide (3)

4.6.2 Which of the chemicals magnesium, oxygen gas and magnesium oxide is a compound? (2)

4.6.3 Write a balanced chemical equation of the reaction:

Magnesium + Oxygen $\longrightarrow$ Magnesium Oxide (3)

4.6.4 How many protons are found in a magnesium atom? (2)

Learner's answer

4.6.1 The measure and cut 20cm of magnesium ribbon X

4.6.2 The burnt 20 cm magnesium ribbon X

4.6.3 They measured its mass X

4.6.4 The measured the cut 20cm of magnesium X

(reproduced to improve clarity)

APPENDIX S: Ethics documents

University of Cape Town: Faculty of Humanities :School of education

Consent Form

Name of researcher: Gillian Kay

Department: School of Education, Faculty of Humanities, UCT

Telephone: 021 650 5326 ; 084 4611217

Email: gillian.kay @uct.ac.za

Name of participant:

Name of School:

Nature of the research: Interviews; classroom observation; audio-taping

Purpose of the research

I am in the process of doing my research towards the dissertation that forms the conclusion of a Masters in Education degree. This research project will explore the knowledge teachers draw on when engaging Grade 8 or 9 learners in science practical work.

I am therefore requesting an opportunity to interview you, to observe you teach one lesson involving science practical work and copies of learners work related to the lesson observed. All interviews and lessons will be audio-recorded.

At all stages of the research process, I will not use your name, and will only use biographical information relevant to my research. If you should feel at any stage of the research process (before, during or after your interview) that you no longer want to participate in the research, you can withdraw your consent, and all data you have provided will be destroyed.

Although there are no foreseeable risks to taking part in this research, should you feel at risk in any way, you have the right to inform me, and I will work with you to address any risk factors to the best of my ability.

Should you need any further information, or should you wish to contact my supervisor, please contact Annemarie Hattingh at 021 650 2755.

What is involved: (Please tick what is appropriate)

- ☐ You agree to be interviewed regarding your views on teaching and learning at your school. The interview will be audio-taped and transcribed. You may ask to view a copy of the transcripts at any time and they will be made available to you at a suitable time.

- ☐ Your regular classroom practice will be audio-taped and used to analyse the knowledge bases you draw on when doing practical work. All learners in your classroom will be informed verbally as to the purpose of the recording and they may ask questions of the researcher.

- ☐ You agree to allow me to make copies of learners work related to the lesson observed. The names of the learners will not be revealed.

Risks: No risks have been identified that might befall you.

Costs: No costs or payment are involved.

Participant's involvement: Consent to take part in the research

- I agree to participate in this research project. I have read this consent form and the information it contains and had the opportunity to ask questions about them. I understand that I will be given a copy of this completed form, to keep.
- I agree to my responses/classroom practices being used for education, research and conference presentations on condition my privacy is respected, subject to the following:
- I understand that any personal details included in the research will not be able to be traced back to me.
- Pseudonyms will be used when referring to the school and individuals.
- I understand that I am under no obligation to take part in this project.
- I understand I have the right to withdraw from this project at any stage.

Name of Participant : ______________________________

Signature of Participant: ______________________________

Name of Researcher: ______________________________

Signature of Researcher: ______________________________

University of Cape Town Faculty of Humanities

Consent Form

Title of research project: Maths and Science Education Project (MSEP)

Names of principal researchers: Prof Rudi Laugksch & Dr Jonathan Clark

Department/research group address: School of Education & Schools Development Unit, Faculty of Humanities, UCT

Telephone: Dr Clark: 021 650 3363

Prof Laugksch: 021 650 2777

Email: jon.clark@sdu.ac.za; rudiger.laugksch@uct.ac.za

Name of participant: ————————————————————

Name of School: ————————————————————

Nature of the research: (Please tick what is appropriate)

INTERVIEW/ FOCUS GROUP INTERVIEW/ CLASSROOM OBSERVATION/ PHOTOGRAPHS /VIDEO-TAPING

Purpose of the research

The overall aims of the project are to investigate curricular adherence within MSEP schools and to improve our understanding of the teaching and learning contexts of each school. This so we can design appropriate interventions to address areas of weak curricular coherence within Mathematics, Science and English

Our immediate goal is to investigate each school context with a view of tailoring interventions to fit the context. In light of this goal, we are conducting teacher interviews, focus group meetings with the learners, classroom observations and selected documentation review. We also hope to video tape everyday classroom activities and take photographs of the school buildings and classrooms.

We are therefore requesting an opportunity to interview you as part of our research. This will involve a twenty minute session in which a fieldworker will ask you questions pertaining to your experiences of and opinions about teaching and learning in your school.

At all stages of the research process, we will not use your name, and will only use biographical information relevant to our research. If you should feel at any stage of the research process (before, during or after your interview) that you no longer want to participate in the research, you can withdraw your consent, and all data you have provided will be destroyed.

Although there are no foreseeable risks to taking part in this research, should you feel at risk in any way, you have the right to inform the researchers, and we will work with you to address any risk factors to the best of our abilities.

Should you need any further information, or should you wish to contact the researchers, please contact Rudi Laugksch or Jon Clark at the above numbers.

What is involved: (Please tick what is appropriate)

- □ You agree to be interviewed regarding your views on teaching and learning at your school. The interview will be audio-taped and transcribed. You may ask to view a copy of the transcripts at any time and they will be made available to you at a suitable time.
- □ You agree take part in a focus group meeting on issues pertaining to your school practices. This will be audio-taped and transcribed. You may ask to view a copy of the transcripts at any time.
- □ Your regular classroom practice will be video-taped and used as a means from which to share ideas and concerns on issues of curriculum adherence and teaching methods. All learners in your classroom will be informed verbally as to the purpose of the video and they may ask questions of the researcher.
- □ You agree to have photographs taken of your school/classroom that will focus on material conditions of the buildings and use of space within your classroom.

Risks: No risks have been identified that might befall you. In particular, this research will not be available for use by the WCED which might affect your teaching career in any way.

Benefits: Participants (mainly teachers and management) may benefit from critical engagement with School of Education and Schools Development Unit staff. Furthermore it is hoped that classroom pedagogy and school management will be enhanced by its involvement with MSEP.

Costs: No costs or payment are involved.

Participant's involvement: Consent to take part in the research

- I agree to participate in this research project. I have read this consent form and the information it contains and had the opportunity to ask questions about them. I understand that I will be given a copy of this completed form, to keep.
- I agree to my responses/classroom practices being used for education and research on condition my privacy is respected, subject to the following:
- I understand that any personal details included in the research will not be able to be traced back to me.
- Pseudonyms will be used when referring to the school and individuals.
- Videotapes of my regular classroom practice will be viewed by researchers on the project only. Videos will be shown at public arenas such as conferences and presentations **only with my explicit consent**.
- I understand that I am under no obligation to take part in this project.
- I understand I have the right to withdraw from this project at any stage.

Signature of Participant /
Guardian (if under 18): ________________________________

Name of Participant / Guardian: ________________________________

Name of Researcher: ________________________________

Signature of Researcher: ________________________________

Signatures of Principal Researchers: a) ________________________________

b) ________________________________

Date: ______________________________

Schools Development Unit

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Level 5, Hoerikwaggo Building, North Lane, Rondebosch
Tel: +27 (0) 21 650 3368 Fax: +27 (0) 21 650 5330
Internet: www.sdu.uct.ac.za

Date: 28 April 2010

An Invitation to Participate in MSEP Research Project

As part of the MSEP strategy to support the School's effort to enhance the teaching of Science in a sustainable way through directed professional development, we need to make an informed decision about the focus and nature of support offered to teachers.

In order to do this, we have to examine what teachers do in the classroom and why they do what they do. This will require engagement with teachers over a short period of time in the data collection phase, followed by the analysis of this data and the implementation of an intervention strategy.

The proposed research programme is as follows:

1. The researcher will decide on the topic and grade to be targeted by looking at the teacher's planned learning programme for the next term.
2. Prior to the teaching of this topic, the teacher and researcher will engage in a discussion on the teaching of the topic.
3. A number of lessons on the selected topic will then be observed and this will be followed by a reflection session as soon as possible after the lessons. The data may be collected using video or audio recordings when appropriate but will be treated with the strictest confidentiality and will be used anonymously.
4. The data will then be analysed and an opportunity will be created to discuss the draft findings with all the participants and the School management as soon as possible thereafter.
5. Based on the conclusions of the study, appropriate intervention strategies will be developed for implementation in 2011.

Your support will be appreciated.

Gillian Kay

Schools Development Unit

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Schools Development Unit
School of Education

12 May 2010

Mzali Obekekileyo Womntwana okuGrade 9

Ndingumphandilwazi kwiYunivesithi yaseKapa. Ndiphanda ngendlela esifundiswa ngayo isigaba sezifundo zeNatural Sciences kwiBanga lethoba (Grade 9). Nje ngenxenye yesisifundo okanye oluphando, ndingathanda ukuba nodliwanondlebe nabafundi besisifundo, ukuze ndifumane izimvo zabo namava abo ngohlobo esithi isifundo seScience sifundiswe ngayo kwizikolo zabo. Ndingathanda ukushicilela okanye ukukopa iiWorkbooks kwakunye namaphepha emibuzo neempendulo zeemviwo zabo zeScience.

Oludliwanondlebe luquka ukushicilelwa kwamazwi. Lonke ucishilelo luyakuthi lube yimfihlo, kwaye namagama abafundi nezikolo zabo akayi kukhankanywa naphi na. Umntu uyazikhethela ukuxhasa nokuba yinxenye yoluphando, kangangoko anganako ukuyeka nangasiphi na isigaba, engakhange anike zizathu zoko.

Ukuba ngaba uyamnika imvume umtwana wakho yokuba athathe inxaxheba koluphando, nceda ugcwalise eliphetshana lingezantsi, uze wakugqiba ulibuyisele esikolweni.

Owenu othembekileyo

Gillian Kay
Education specialist: SDU

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Mna, ………………………………………………….…. , umzali/mgadi ka ……………………………………………………………….
Igama neFani

Ndiyavuma ukuba u …………………………………………. angaba yinxenye yoluphando lukhankanywe ngu Gillian Kay, umhla 12 May 2010.

Signature: ………………………………………………………….   Umhla/Date: ……………………………………………………….

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12 May 2010

Dear Grade 9 parent

I am a researcher at the University of Cape Town. I am investigating how a section of the Grade 9 Natural Sciences syllabus is being taught in schools. As part of this study, I would like to interview some learners about their experiences of learning science. I would also like to make copies of their workbooks and exam answers.

The interviews will be voice recorded. All recordings are confidential and the names of the learners and their school will not be mentioned. Participation is voluntary and a learner can withdraw at any stage, without giving reasons for doing so.

If you grant your son/daughter/guardian permission to participate, please complete the reply slip below and return it to school.

Yours sincerely

Gillian Kay
Education Specialist: SDU

-

I, …………………………………………………..…… , parent/guardian of ………………………………..,
Name and surname

give him/ her permission to participate in the study as outlined in this letter by Gillian Kay, dated 12 May 2010.

Signature: ………………………………………………….. Date: ………………………………………

UNIVERSITY OF CAPE TOWN

Gillian Kay

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The Principal

MASTERS DEGREE RESEARCH

I, Gillian Kay, am presently registered at the University of Cape Town for the M.Ed degree in Science Education. I have had an exploratory discussions with Ms Botha.

I now formally request permission to conduct research activities, at the school, that will constitute the basis of my research project. The research project will explore the knowledge teachers draw on when engaging Grade 8 or 9 learners in science practical work.

My intended research work at the school will entail:

(a) Interviewing one Grade 8 or 9 Natural Science teacher before teaching a topic in which some practical work will be included.
(b) Observing the lessons in this topic which involve practical work with one class. Audio recordings and field notes will be made. No video recordings will be made.
(c) Conducting follow-up interviews with the teacher.
(d) Making audio recordings of all interviews.
(f) Collecting copies of some learners work related to the practical lessons.
(e) Collecting my research data during the first term of 2014.

I undertake

(a) not to cause undue disruption to the normal teaching programme
(b) to negotiate the most appropriate access times with yourselves as principal, the science HOD and science teacher.
(c) to ensure the anonimity of the learners, teacher and the school.
(d) not to use the data to make any inferences about Springfield Convent School, as an institution of teaching and learning
(f) to ensure that interview records will only be viewed and discussed by myself and others directly involved in the research process.
(g) to conduct my research with integrity and with the utmost respect for the dignity of every person involved in this research project
(h) that the research participants can withdraw at any time without fear of retribution

(i) to share my research findings with the school on request

Please contact me (contact details above) or my supervisor on 021 650 2755 if you require additional information regarding my reseach.

I trust that my request will be given your approval.

Thank you.

Yours sincerely

Gillian Kay
Student number: NWMGIL002

Transcription file name: Batandwa Lesson 1

Teacher: **[TEA]**

Learner: **[LNR]**

Learners: **[LNRS]**

LNRS: [settling down]

TEA: OK do you remember that last time was a brief introduction into chemical reactions, those chemical reaction metals ne. We just want to continue today [indistinct] chemical reaction of metals with water. We will be looking at the specific matter Group 1 elements from the periodic table. I don't know if you still remember these Group 1 elements. Right at the top we have hydrogen, H for what?

LNRS: hydrogen

TEA: How about Li stands for what?

LNRS: Lithium

TEA: Lithium, ok

TEA: And then Na stands for?

LNRS: Sodium

TEA: Sodium, good and then K?

LNRS: Potassium

TEA: Potassium OK we spoke about that the last time, the elements of the periodic table especially the first 20 elements. We need to know all those elements from the periodic table. Can you take out your book there your exercise book. Ok I've got a short worksheet here that is going to guide you as we go through these experiments hey I need someone to help me in the front as we go through the experiments.

What is necessary when we are doing an experiment is to observe exactly [hands out papers] Can you give the rest to them. Give out this handout also this side one person each and then … just be patient there where you are it can't be in an instant scenario there, you will all get this shsh OK. Just be patient ne. Just take one and then any extras bring them forward shsh OK.

[Lifts his hand] raise up if you don't have a paper.Ok you do have now. Those extras bring them this side thank you [collects papers] one there, one by the corner OK [indistinct]

Boy, come and help me [Puts glass bottles and plastic jug with liquid on the table] You are going to help me with a few things here.OK. What we have here is water ne. What we are going to do is just to put water into each of those bottles ne. first we don't have shsh any [indistinct] do it outside put water into each of those three bottles [gives bottles and plastic container to LNR]. Half fill each of those three bottles with water hey. [LNR goes outside].

OK while he is doing that I want us to think of something here, when we talk of water [indistinct]what are the elements that make up water. Of those elementson the periodic table, what are the elements that make up water, hey. You guys wanted to say something [points to a LNR] hey, one of the elements that make up water?

LNRS: Hydrogen

TEA: It's what? Hydrogen ok that's good. Hydrogen is one of the elements that make up water. OK today what we are going to do we are going to use [writes on the board] a model to show what we mean by hydrogen so we've got a few models here for example this one is like our hydrogen [shows an item to the LNRS]you see?

[5:00 mins]

TEA: So when we talk of water there will be how many of these hydrogens?

LNRS: two

TEA: Two hydrogens. They make up water. So what is the other element that makes up water? [indistinct] oxygen OK so let's takes this white for hydrogen OK [writes on the board] this white stands for hydrogen. OK and then this other colour which is red [indistinct] a red pen ne. We will just say red will stand for this is not really red but understand, it's orange. But then we just take or to make it more better what we are going to do instead of using those there we are going to put this up I am going to use Prestik to put this up.

[LNR comes in and out of the classroom]

This one is going to be our?

LNRS: Red

TEA: Red for what?

LNRS: Oxygen [talk amongst themselves] [LNR from outside comes in and puts bottles on the table]

TEA: And then we've got our white ne, let me just put this on our prestik there for our white for hydrogen ne. OK let's say this one is the other element that you've got here [points to the chart] Li Lithium then we put this one here shsh Can you be quiet guys? Ok thank you those are the models we are going to do. These are just models. When we say something is a model we don't mean hydrogen is this big, it is a billions times or even more than that smaller than this but now we get a picture in our minds of how it may look like you know because in reality no one has ever seen an atom so we imagine it to be like this and the theories that we've got up to now is to just they help us to this model that we've got. So relatively smaller than the oxygen that we have.

OK? So this young man has perfectly put some water in these three bottles so this we are going to call them we are going to give them a special name [draws a square on the board] the things that actually react we are going to give them special names. What do we call the things react in a chemical reaction hey?

LNR: *reactants*

TEA: Reactants, very good. Reactants but you must raise up your voice say reactants.

LNRS: [laugh]

TEA: That's better, that's better so one of the reactants is this model that we've got here. What is that?

LNRS: molecule

TEA: Molecule of what? No, no, no we said that this white stands for hydrogen ne, this one stands for oxygen. So if we've got, two what is this? [LNRS chanting] two hydrogens and one oxygen There is a molecule made up of those three?

LNRS: Water

TEA: Water, very good water is made up of oxygen and two hydrogen ne. Ok let's say for arguments sake we've got two of these but we don't means to say that in reality in the bottles we got trillions and trillions of those water molecules there are so many but we'll just show an example by this two that we've got here otherwise there will be too many to represent on the board OK?

And then we want to look at the three elements we are going to be looking at today. Lithium,we didn't have lithium the other day I should showed you something about sodium to show you how the reaction takes place hey?

[10:mins]

TEA: And I say this elements are very active hey they are very active we will see exactly how they react in this case. And then looking back at this piece of paper that I've given you shsh just check the piece of paper I have just given you. What are we investigating there?

LNRS: [indistinct]

TEA: [indistinct]Group 1 metals with water. OK so the first one ne. What is the first one that we are going to be investigating?

LNRS: [chanting]Lithium plus water

TEA: Lithium plus water. Shsh OK who can predict what wil be the products there. Who can predict what will be our products?

LNRS: *Sound*

LNRS: [indistinct] sound

TEA: Uh sound, I am not looking about that sound maybe there might be sound I'm not sure but in terms of the elements that are going to be formed. Or rather the compounds that are going to be formed.

LNR: a gas

TEA: A gas is going to be formed, you think a gas is going to be formed. Ok, shshh yeah there will be movement

LNRS: Heat

TEA: OK heat might be there. OK What you are doing now is what they call a hypothesis hey? You are predicting what might be the outcome of this experiment ne so we do this experiment and check what is it that is going to occur[indistinct] OK so?

This is our lithium that we have got here. To be frank with you this experiment would have been nice if you are all doing it by your desks there but the chemicals that we got here are very, very dangerous elements and I don't believe… and also we've got little of these you see. This is the only sodium that we've got in school so its very very small [holds up and looks at an item] so it won't be enough for all of you to actually do it ne. Ok but on the other hand also it is very, very dangerous. Ok we'll start with lithium. This is our lithium shsh [LNRS talking] We will first characterise it. We'll check there they are metals hey? Let's just see what happens there.

LNRS: stone … e black

TEA: it looks like a stone[indistinct]

LNRS: [indistinct]

TEA: What colour is it?

LNRS: Grey

TEA: Greyish and then I am going to use a plate just to cut through this because these metals are actually soft they are not like those metals that are hard like copper.

What are the other metals that you know?

LNRS: [indistinct]

TEA: Zinc and copper.[indistinct] Ok it's not dangerous people don't worry, don't worry. [holds up bottle] this is lithium [indistinct] actually if you check this can you see something happening there, just pass it around.

LNRS: [indistinct] It looks like eno sir.

TEA: Yeah shsh I am putting it in a bottle shsh you see it's not uh there's something coming out there ne ne.Maybe the person who spoke about gas his hypotheis or her hypothesis was correct what [indistinct] can you see something coming out there.

LNRS: [indistinct]

TEA: Shsh there's something coming out there shsh. This reaction, was this reaction fast or slow?

LNRS: Slow!

TEA: Very, very slow [indistinct]

LNRS: [indistinct]

TEA: Very very slow because it is taking some time. Maybe relatively slow lets say we'll see when we compare with the other reactions [working with items on the table]OK shsh quiet ne. OK we put [indistinct]more of this and see what happens. let's just put some little more of that you see these gases continues to come out, let's check what gas this might be [takes out his matches]

LNRS: [cry out in mock fear]

[15:00 mins]

TEA: [lights a match] Shsh I just want to see if this gas if I put a match there whether ….[small explosion]

LNRS: [shout as they got a fright]

TEA: [gives a kindly laugh]

LNRS: [clap their hands]

TEA: [opens the door]

LNRS: *you can put down meneer when you finish*

TEA: Shsh OK what we must do, as we move on we must complete that template we've got there, the experiment so we've got there in words [writes on board] [indistinct] we've got there lithium plus water

LNRS: agreeing

TEA: Shh ok, so, [indistinct] in this particular case, we take our lithium here, so this way, our reactants, we did put some bit of lithium there, I put in what we said there we said our lithium is gonna be that colour there, and then let's put more lithium there. Ok so that's half our lithium there, [learner opens door] we gonna let some air come in so that the gas can escape, for a few minutes then we're going to close neh?

LNRS: *Don't lie, meneer*

TEA: Ok, so these we call them reactants neh?

LRS; yebo

TEA: These are the substances that are actually reacted. So, in the process someone said there was a gas , there was a gas there. Which of these form a gas, because out of these we've got here Oxygen, we've got hydrogen, we've got lithium, which of these will be a gas then?

LRS: Lithium, lithium

TEA: lithium is a gas?

LRS: Hydrogen, Hydrogen

TEA: Hydrogen is better, lithium is a what?

LRS: Metal, metal

TEA: Metal, it cannot be gas, never be gas, soit means that one of the products here is hydrogen

LR: loudly calling out

TEA: [writing on board], Ok so you can complete that work sheet as we move on neh? So it is hydrogen, so if it's hydrogen so that means at the end there we ended up with a few, shh, shh, molecules of hydrogen, and hydrogen is actually a di, this diamond is, a diatomic eh?

LRS: Laugh

TEA: it's Diatomic, so in the process, in the process, these reactants they, they, the bonds break so the bond between the water, shh, shh, bond between the water and the hydrogen it broke. That's what was happening, it's just that it was very hard to see with the naked eye.So the bond between the hydrogen and the oxygen broke, ok, and also the bond between the hydrogen and the oxygen in the other molecule also broken and then it formed this gas, the gas that is formed is diatomic, when we say it is diatomic, it has got two molecules of hydrogen, so this was the hydrogen that was formed neh? We'll put them here as our products neh? [writes on board]. We've got that there, and in addition to that can you be quiet neh

LRS: mumbling

TEA: [name of learner] [asks pupil to close door] in addition to that, we had the bond between the lithium, lithium was a loose bond, so lithium actually bonds with the oxygen that is also bonded to the hydrogen there, so this is the molecule that's formed, so it's part of the molecule that's formed. Ok, because there is enough of these so they would actually form two molecules of these, you see, so we have another one neh?

[20:00 mins]

TEA: ok, that's fine, and the reactants, because the lithium that we put in there,there was a solid substance that we put in there, it's no longer there, can you see that it's no longer there?

LRS: Yes!

TEA: So, the reactants during the reaction, most of the time it was actually used up and they form new substances altogether, with new properties, let's see what is it that you are going to call them? This we call them what?

LRS: Products

TEA: Products? Ja, when you make something then you actually produce something, this one which is two hydrogens together, we said the hydrogen the symbol for hydrogen is what?

LR: White

TEA: Ja, white in this case, but it's an H, the symbol is an H neh, so it's H, but because there are two, we've got two of those there neh?

LR: H

TEA: Ok, that is falling apart, things falling apart [talking about the chalk] Ok, who can predict what that element can be? This green we said is what?

LRS: Lithium

TEA: What is the symbol for lithium

LRS: Li

TEA: Li, Ok very good, Li ok and this one, the red one's what?

LRS: Oxygen

TEA: and the white one neh?

LRS: Hydrogen

TEA So these are the things that we produce do you see, during a chemical reaction the bonds are broken and new bonds are formed. We didn't have this bond between lithium and oxygen there, it was a bond between oxygen and nitrogen, did you notice that?

LRS: Yes!

TEA: Ok, so when we look at the products here, shh, shh what will be, if we had to write that in words, what will be the name of that in words?

LRS [indistinct] lithium oxide

TEA: [points to learner] lithium?

LR Lithium Oxide [indistinct]

TEA: lithium, no not really

LR: lithium, oxygen, hydrogen

TEA: Lithium, oxygen, hydrogen, no, no

LR: mumbling answers

TEA: Can you check with, just the other day, what we did the other day.

LR: lithium hydroxide

TEA: Lithium what!?

LR: lithium hydroxide

TEA: Hydroxide, very good, this is lithium hydroxide. This OH there is for hydroxide, so therefore it means what is formed is Lithium Hydroxide neh? Lithium hydroxide, ok? So, let's look at it in, eh, symbols now. In symbols, write there as we continue there's a space for you to write in symbols. Lithium, what is the symbol again?

LRS: Li

TEA: Li, neh, plus water, what is the symbol for water?

LRS: O, HO, O, H

TEA: H, how many hydrogens are there,

LRS: two

TEA: H_20 neh? And then sisi, Lithium Hydroxide? Lithium hydroxide is what?

LRS: Li, lo

TEA: Li

TEA: Li plus the hydrogen, we've got it here HO, H2, but remember from one O, how many lithium atoms did we have, how many did we have at the beginning here when they, were are still reagents, when there was no products, how many did we have?

LRS: mumbling, two

TEA: Who remembers eh? Two eh? So there's for every two atoms of lithium, and how many water molecules did we have there?

LRS: Two

TEA: Also two atoms of water. You see, and, Hydrogen there how may hydrogen?

LRS: Two

TEA: No, no, it's just one molecule of hydrogen, its just one atom divided, neh, it's diatomic. But how about lithium hydroxide, how many are there?

LRS: Two

TEA: Two. You see, so you must have a two, you see that? So when you have got a chemical equation, you've got the left hand side and you've got the right

[learner enters the room]

TEA: [to learner] *Where do you come from*? *Sit down,* you've got the right hand side, so in this particular case, we've got atoms of lithium, we've got atoms of hydrogen, atoms of oxygen so let's check now on the left and on the right there. Lets analyse now. Shh, on the left, how many lithium do we have there?

LRS: Two

TEA: Two, on the right, two times Li there, how many do we have?

LRS: Two

[25:00 mins]

TEA: Ja, these green things there, are what?

LRS: Lithium

TEA: so there are how many? And then for the hydrogens now, if you check these white things, one, two …how many do we have?

LRS: four

TEA: four, so there are four on the right hand side neh, and each water molecules, how many? Two, two plus two, how many. So it means this side two times two is how many? Four

LRS: Four

TEA: this side four that we have got. Lets look at oxygen now, shh, shh, we've got one oxygen there, but in there are two molecules, two times one is what?

LRS: two

TEA: so it's two there, and on the right hand side, let's see, two times, no one, how many do we have?

LRS: Two

TEA: Two, so it means that, it's called this balancing the equation neh, so there are equal number of atoms of each type on the left hand side and the right hand side, so in an equation, if the number of lithium's are not equal on the left and on the right hand side, then we say the equation is not balanced, you see? Ok, that's good neh? So, that, we've done every thing about the lithium.

Something last thing, we're going to check *this* shh, shh,

[Learner approaches and ask to leave room, teacher grants permission]

TEA: We're going to check using the lithium paper, I mean the litmus paper a product that we've got. We're still investigating this product. We want to see how the litmus paper is gonna change the colour inside the …

LR: Bottle, Coca cola

TEA: It's not really coke we've put water there neh, for example [indistinct], let's just put the litmus paper in there and check there what happens there huh? Hey, this litmus paper is a bit old, but you can see some colour change there

LRS: No

TEA: [indistinct] compare this one this two, there's some light blue that you can see, on that one, there's some light, but this one really should have [indistinct] more light than that. It means that the amount of lithium hydroxide inside there is very, very little so it is basic, the lithium hydroxide, it's basic, because it changes what, red litmus paper blue. Ok so that is the situation. We done with this one. Can someone do the same with the oxygen, come this side and do the practical, the practicalities around that, eh?

LR: Yes Meneer, coming

TEA: Who is coming?

LRS: calling out name of pupil

TEA: I want someone to come … *don't make a noise …* I want someone to come out, no I will show you exactly what to do, practice neh, I will show you exactly what to do

LRS: talking loudly

[Learner approaches the front] [Clapping, whistling and shouting]

TEA: Shh, shh. *Come*, you are now the Scientist. You want to show the rest of them [indistinct] how to do things.

LR: Scientist of the arse!

Learner comes back into the room

[30:00 mins]

TEA: So, try not to touch anything, just use the equipment that you've got here. *You can do this, I'll show you if you don't know* [preparing experiment] [indistinct] …so it will take us … [indistinct]

LRS: talking amongst selves

TEA: Ok its fine, shh, shh ok, so. Use this and cut it as small pieces lets see shh shh the rest of you guys watch.

LR: [loudly] *Quiet, class, please* [laughing as learner tries to carry out experiment]

TEA: laughing, quiet guys, *don't mind,* ok, that's good,

LRS: jeering

TEA: ok and then take it this and put it in there [points to cola bottle]

LRS: calling out

TEA: ok, *Listen,* let's see, *quiet,* just put it [indistinct] so that it can [indistinct]

LR: it's a bomb!

TEA: Ok, shh, shh, can you check there the hissing sound [indistinct]

LRS: shouting

TEA: do you hear that sound?

LRS: Yes, Acid! [Laughing, shouting]… it's a bomb!

TEA: there is, there is some hissing sound, shh, shh, and then [teacher takes matches from pocket and lights end of bottle, small pop occurs]

LRS: Squeal in surprise, laughing

TEA; ok thank you, you can sit down,

LRS: Applaud and shout [teacher opens door]

TEA: Shh, Shh, that pop sound that you heard there

LRS: Pop, pop, pop, giggling

TEA: all right, remember this S, this S below the lithium there, what does it stand for?

LRS: Sodium

TEA: Solid, and this L there?

LRS: Calcium, calcium

TEA: liquid, neh? The AQ?

LRS: Aqueous

TEA: Aqueous neh Aqueous solution, and the G for what

LR: Gas, Giraffe

TEA: Gas, Ok. Thank you, [name of learner] *come and sit here,* quiet please. [name of learner]Ok, [name of learner] We have been speaking about this gas, about this gas, when I light the match there, that is the test for hydrogen what I have been hearing that's the pop sound neh…that's the test for [writes on board] for hydrogen, so that hydrogen there combines with the oxygen shh, shh from the atmosphere, and this is a very, very explosive reaction there, and then forming some a bit of water, but that come out as water vapour there but and some heat plus sound, shh, ok there was a sound there which was what? Pop sound

LRS: [calling out in Xhosa] [indistinct], [Pop sound]

TEA: [name of learner] can you please pay attention boy? Ok, that pop sound that you get from the eh, it is the energy that's comes out of that particular reaction, it is an explosive reaction, hydrogen in the near future it might be used as a source of fuel neh, so you find that even at the moment there's a lot of experiments that I did in advanced level, trying to work hydrogen to be used as a source of [indistinct] so it produces a very, very explosive reaction

[35:00 mins]

TEA: of that produces a lot of reaction, in fact that is the reason why I used Cokes, otherwise I would have used a beaker, but in the beaker, then the hydrogen will just move, I mean it wont be concentrated in one point. In this case because hydrogen concentrates in one point, then we can actually test for it nicely neh. Ok lets do the last one now, which will be the lithium, ok, just because of time I'm gonna do this one very quick neh?

LRS: Yes, chatting amongst selves.

TEA: Shh, shh, quiet thank you. So as you move on, I expect you [indistinct], this was number one, experiment number two that we did which was sodium, I expect you to be able to add this two, and predict, and predict the outcome based on this one, because we have already seen that one. So that worksheet I will take it in, but I want you for number two, the one that we just did neh, sodium plus water, so what do you think are gonna be the products there? So write that in the spaces that I provided [indistinct] neh?

LRS: Yes

TEA: Also write any observations that you have seen there, the sounds that we heard, the hissing sound and also when we tried to test for the hydrogen there, try to write that down as well. I will take those in at the end of the experiment. Ok this is the last one now, which is

LR: big?

TEA: not very big, don't worry, no it's not that big don't worry. You see that one?

LRS: calling out

TEA: In terms of speed there, do you see that it was quick?

LR: yes

TEA: it was a quick reaction and there was a bit of a flame. Describe the reaction on the worksheet that I have given you. [Lights bottle again]

LRS: call out, [jeering as matches fail] don't be scared Sir, don't be scared Sir! Ah Sir!

TEA: Ok be quiet guys, lets get a little more of this, because, so it means you shh, shh you might affect [indistinct] the reactions there. so This is our Potassium now, so we want to check what we are able to test for

LRS: [leaving their seats, calling out] giggling

TEA: This one not give the expected results

Learners: shouting

TEA: did you get that sound

LRS: No, [shouting] bang!

TEA: All right, otherwise that's it neh? This one is our third experiment, neh? Shh, be quiet guys, shh, shh we [indistinct] discussing what we mixing there [indistinct] [points to periodic table] what were we mixing there? We started with lithium, went on to sodium with Na, quiet guys, and then we went to the K there, what does that K stand for [name of learner]?

LR: Potassium

TEA: Potassium, very good. Potassium. So we're having Potassium still with some water and then, what are the expected results? And also noticed how fast it was [indistinct] quiet neh, *boy, you want to go out?*

LRS: talking loudly

TEA: This in each case, let's try to check for the litmus paper, how it's gonna change neh? [Drops the litmus into bottle and as he tries to lift the bottle the top half of the bottle comes off]

LRS: Laughing and cheering

[40:00 mins]

TEA: Shh, shh can you see, from there shh, shh be quiet, can you please compare these two Do you see how it is now. It was red litmus paper it has turned to light blue, light blue neh

LRS: Light blue, shh

TEA: to blue, ok, so it means that what we have in there is what? Is a base [indistinct] remember all bases change red litmus paper blue

[bell sounds]

TEA: Ok this one as well, you can see there, the same reaction, shh. *Listen*

LRS: agreeing in, *staying away*

TEA: Ok *We will stay here today if you don't listen to me.* I want you to comment

LRS Sir? [Talking loudly amongst selves]

TEA: Shh. I want you to comment on how these experiments have taken place in terms of how fast each has taken place, and then you've record each observation that that you observed in each case and then fill in that worksheet that I have just given you, and then come up with a conclusion at the end, how the activity of the group one elements are in terms of their speed, how fast each is as we went down so we started with lithium, we went on to sodium, then we went on to potassium neh? Ok, otherwise have a nice day

LR: Goodbye

[41:29 mins]

Transcription file name: Batandwa Lesson 2

Teacher: **TEA**:

Learner: **LNR**:

Learners: **LNRS**:

Lesson starts with teacher at front of class, laughing and chatting to learners. A group of learners leave the class.

TEA: Shh, shh, *collate the papers in my classroom*. What are we doing … that piece of paper that we were dealing with yesterday, I just want too…

LNRS: talking, shouting amongst selves, settling down

TEA: Shh, shh, OK, who remembers yesterday, be quiet neh, what were the experiments that we did yesterday?

LNR: lithium

TEA: points to learner *I need somebody to help me please …* Sodium, with what?

LNR: [indistinct]…with water

TEA: We combined sodium with water that was one of the experiments; in another instance we combined something else also…

LNR: Lithium

TEA: We also combined lithium with water, the third one, what did we do?

LNR: Potassium

TEA Potassium with?

LNR: Water

TEA: water, very good, but the first one we did to together, so I've actually got it on the board here. From the data that you've got, I said you must be completing that data reporting that you were doing yesterday, so you must be accurately reporting things that we're doing yesterday. So number one, I can complete it because it's on the board, for you. So lithium plus water, what were the products there, can you remember that? When you combined, shh, shh

LNRS: mumbling

LNR: Hydrogen

TEA: Hydrogen was one of the products, what other product did we get there?

LNR: Gas? Hydroxide?

TEA: Shh, shh Hydroxide? But ja

LNR: Oxygen?

TEA: Oxygen, no, hydroxide is all right but it's just not complete, if we combine lithium with water, what do we get?

LNR: Lithium

TEA: lithium?

LNR: Lithium HO

TEA: Lithium HO. Which is lithium hydroxide neh? So in words we can write here and say, ok we can write here and say this is lithium hydroxide, ok? And then we have also the hydrogen there neh? So we had also we hydrogen in there. But you see this can be written in symbols eh? If you check the worksheet that you've got, it has got a space for you to write in symbols neh? Can you take out that, that worksheet that I gave you yesterday?

[5:00 mins]

TEA: I mean this one, you remember this one? [Holds up worksheet]

LNRS: Yes

TEA: Ok, just take yours so that we can do everything together. So that, we can do everything together. Hi…[Indistinct] [Talking to someone at door] [Learner enters and sits down]

LNRS: [start to talk amongst selves]

TEA: Ok can you be quiet guys, so that we are all together. Shh, shh so this is the chemical reaction in words, that we did yesterday, neh, and also we did write the symbols for all that. What is the symbol we need for lithium?

LNR: Li

TEA: Li neh? Li plus, shh, shh

LNR: HO

TEA: H…What?

LNRS: [talking]

LNR: H20

TEA: H2O Neh?

[learners enters class]

TEA: [to learners finding their places] can you be quiet [name of learner] neh? Ok and then say, we're getting, lithium hydroxide on both sides. How do I get them on each side?

LNRS: [mumbling constantly]

TEA: Eh? [To learner who raises hand]

LNR: LiOH

TEA: LiOH, that's good so it's LiOH

[Shouting from outside the class]

TEA: Ok, and then it's hydrogen, which is H2, Ok, and then it's something that I referred to yesterday, we didn't do a lot of it yesterday, but I did refer to balancing the equation neh?

LNRS: Yes

TEA: What is the essence of balancing an equation? Do you remember, why do we have to balance an equation?

LNRS: mumbling

TEA: Eh? [Approaches learners at back of class] I hear you talking there, you know ah, why do you have to balance an equation? MM?

LNR: [You want to be equal

TEA: *Yes, I want to be equal*, you want them to be equal, the number of atoms of a particular element; they must be equal on both sides neh? Ok, *English is not easy,* neh?

LNRS: [laugh loudly]

TEA; Ok, thank you, so, shh, shh. *Listen*, to everyone else, the overall objective for balancing neh, in fact the word balance, when you are going to balance something, it means that you want things to be equal on the left hand side and on the right hand side. Ok, looking at these two, lithium and water, if we we're to classify them as either 'product's' or 'reactants', what would you call them [name of learner]? [Points to leaner]

LNR: *Product*

TEA: Choose between those two words, 'Products' or 'Reactants'?

LNR: What sir?

TEA: Lithium, Shh, shh, quiet guys, I am asking her.

LNR: [indistinct]...laughing

TEA: Reactants neh? So these are reactants, and [points to learner][name of learner], this one, these two are, these are?

LNR: [indistinct] Products

TEA: They're products, very good. We spoke about that yesterday. So let's now then do what we said [indistinct] when we are balancing an equation we are trying to make the number of atoms of a particular element equal on the left and on the right hand side. So let's just check first, how many lithium atoms do we have there?

LNRS: Two

TEA: No there's just one

LNRS: one, one

TEA: Ok [indistinct] and how many lithium do we have there?

LNRS: One, one

TEA: One Shh, Shh but now, we've got how many hydrogens there? Two,

LNRS: one, two

TEA: Plus this one makes them three, and this side we've got a two, do you see? So we must make these ones more so that their equal, so we do that, we did put a two there yesterday, yes? And then, two times two?

LNRS: four

TEA: Four. So this is now a [indistinct] we've got two there and one there, what can we do to this one in order to be four, we must put a two there neh? We did say that yesterday. When you put a two there, it affects lithium as well.

LNRS: [talking at back of class]

[10:00 mins]

TEA: Guys can you please focus for a [indistinct] pay attention as well.

LNR: Sorry Meneer

TEA: OK, once you've put that two it doesn't only affect that hydrogen it affects also the lithium, so how many lithium do we have there?

LNR: Two

TEA: Two times one, which is two neh? So, what we need to do is put a two so that there will be the same number of lithiums on the left and on the right. Ok, yesterday when I said that you must complete for sodium with water, we did the equation first and then balancing, you see? I just want to see who has managed to do that. Ok, the question, which was the second experiment there, it was Sodium there with water and it was giving us sodium, what, what, what was the products neh?

LNR: NA

TEA: NA [points to learner]

LNR: NAH2O

TEA: NAH2O, it's right but there's something else.

LNR: NA

TEA: NA? Who? Someone else? [Points to learner] NA?

LNR: NA

TEA: N?

LNR: NACH2

TEA: H2, no NA, here it's Li and what is that?

LNRS: H, H, O, NA

TEA: So here, what are we going to have, OH you see, do you notice that? That's plus what, plus H2O… all right, I there anyone who has noticed how do we balance the equation, making them equal on the left and on the right? Those belong to the same group in every instance…anyone who thinks that they can balance the equation there? Think, just take a minute there, think about it and then see what I can go up there and balance it for us. We want a star, very quick to learn, who will be able to balance that for us.

LNRS: Mumbling

LNR: [indistinct]

TEA: Eh, you want to try, Ok

[Learner goes to write answer on chalkboard]

TEA: Ok let's see how she's gonna do it, neh.

LNR: Too short! [Mumbling]

TEA: Quiet guys, I did ask everyone, you just kept quiet. Let her now try her best neh. Ok, Ok that's good there, that's good. How many sodiums do you have on the left hand side, you need two neh. On the right hand side, two, two as well neh. How about hydrogens on the left hand side? Boys at back there, neh.

LNRS: Sorry [at back laugh]

TEA: Ok, how many sodiums do we have, two?

LNR: two

TEA: two, on both sides neh? How about Hydrogens on the left hand side, no left is this side, is there two, now

LNRS: One, four

TEA: two times two is

LNRS: one? Two? Two times two? Three, four

TEA: Four, ok that's good, but let's just check on the right hand side now, add all the hydrogens that are on the right hand side up, how many are they?

LNR: Two

TEA: Is it two, plus?

LNRS: Four, one

TEA: Is that one, shh, so if it's two plus one, then its three

LNRS: Yes!

TEA: but there's this two here. Two times *two plus two is four*

LNR: [indistinct]

[Boys at back still constantly talking]

TEA: Two plus two?

LNRS: Four

TEA: Four, so hydrogens, how many on both sides?

LNR: Four

TEA: Four neh? And how about oxygens then?

LNRS: Two

TEA: shh, shh, Oxygens, before you sit down, how many on the left hand side

LNRS: two

TEA: two times [indistinct] neh? [Indistinct] Ok and on the right hand side?

LNRS: One!

TEA: *You see, very good,* very good, very good,

[**LNR**S applaud and cheer as she sits down]

TEA: That's good neh, the other thing then was the last problem that we had yesterday, it was Potassium combined with water neh? I want someone who is very clever there, who can predict…boy who just *came and helped me*   [points to learner]

[15:00 mins]

LNR: *Sorry*

TEA: Ok, shh, shh someone who has been very observant

LNRS: [names of learner]

TEA: if you have got potassium with water, what is it that you think that you get? Take a minute there, think about it.

LNR: Must be you

TEA: Here we had [indistinct] …we had a metal group [indistinct] with metal with water. And what did we get there, that symbol of one metal which is lithium, four H, you see, plus?

LNR: Hydrogen

TEA: Hydrogen, and here we have yet another group one element which is sodium now with water, same with the, I mean same with the number one there, we've got [indistinct] we still have water neh? And what did you get? Sodium, which is the metal, with what four H neh? *Sit down*

LNRS: [Name of learner] [indistinct] am not [indistinct] about this Meneer

TEA: Shh, shh … [indistinct] *Those three boys, come and sit here*

LNR: *Quiet, class*

TEA: All right, Ja. *Can you answer my question?* Shh, shh. The next problems, you are going to be helping me neh? [Learner approaches chalk board]… [Indistinct] especially now neh… [Passes him chair] Ok, you will sit there and then you observe it. I want you to be able to complete here. When we've got potassium with water, what is it that you expect us to get?

LNRS: [Loud noise from learner] [indistinct] calling out.

TEA: Yuh, shh, shh

LNR: K

TEA: K, ja,

LNRS: O

TEA: [indistinct]

LNRS: H

TEA: H, very good. Plus what?

LNRS: H2

TEA: H2?

LNRS: Yes sir

TEA: Ok, very good, neh, very good. Ok. What did you say was the state of this one, is it a liquid, is it a gas, is it a solid this one?

LNRS: Solid, solid

TEA: Solid, we saw that yesterday, do you remember, and this one?

LNRS: Yes, Liquid

TEA: liquid, and then

LNRS: aqueous

TEA: this one aqueous neh? Shh, and the hydrogen

LNRS: yes H

TEA: But then how did you see that it was hydrogen?

LNR: by the pop

TEA: Pop sound neh, pop sound, so when we lit there, we're getting that pop sound.

LNRS: Pop, pop, pop sound

TEA: Shh, shh, ok something else eh, this one is it a liquid or solid, liquid or gas neh?

LNRS: Solid

TEA: Solid neh? And this one?

LNR: Liquid

TEA: liquid, and this one?

LNRS: Aqueous

TEA: Aqueous Ok? And the last one? Gas, which had the pop sound. And then this other one neh?

LNRS: solid

TEA: Ok, very good. And this one?

LNRS: Liquid

TEA: liquid, and this one?

LNRS: Aqueous

TEA: Aqueous Ok. And the last one?

LNR: Pop sound

TEA: the pop one, the pop sound, which is the gas neh?

LNRS: [making noise]

TEA: Ok shh, shh, something else before, we used the litmus papers neh? We used the litmus papers inside, remember? Ja, when we used the litmus paper what were we trying to find out? Whether it is an acid or base neh? OK, so red litmus paper *blue*

Learner: blue

TEA: and this one is going to change to blue, light blue and this one is also blue blue, blue. Which showed us that this one was what? Was a base neh? And also this one [indistinct] light blue as well so which shows that the sodium hydroxide is a what? Is a base?

LNRS: is a base

TEA: and then this one, the last one, also it was what?

LNR: a base

TEA: a base. So, *it's easy*

[20:00 mins]

TEA: what we were doing yesterday is data collection by doing an experiment, as you do the experiment you collect your data. I want you to tabulate this data and then present it to me in the form of a scientific report, neh.

LNRS: no

TEA: you remember what is a scientific report?

LNRS: no

TEA: you can't remember? In grade 8 you did scientific reports. There's Shh, shh there's something right at the top of a scientific report, starting with an A. The aim of a scientific report, do you remember an aim now neh?

LNR: Yes, no

TEA: Are you trying to know what is an aim? [Cleaning board]…this is [indistinct] in grade 8, but since you don't know it I will tell you about it, scientific report. Ok so what I want you to do is write a complete scientific report about the reaction of group one metals, neh? With water. Ok thing should be easy because you've got the information available. If you are reporting there, I am gonna check whether each of you have reported these things that we were just talking about, and also as you record, you record everything even how we tested for that hydrogen, you should be able to describe what we did neh?

So, a scientific report is what scientists use whenever the are doing a [indistinct] or any experiment, they must come up [indistinct] these days it's a bit standardised way of reporting to someone else who may not have been there when the experiment was taking place neh? So whether you're going to be a very eh big scientist, like in the future, like working in a research centre or wherever, whatever the outcomes of the particular research you do, you must present them in the form of a scientific report. You have been doing this in grade 8, since before that, the teaching of the scientific report has been there, and I want us to also focus on that this year as well.

So first thing then, is the topic, what is it that you have sectioned there? We've got it here, for that; we know that because it's here. Ok, that's the topic that we have sectioned…and then …number one, we are going to look at the aim. So it is the purpose of the experiment, in this case we are doing an experiment so the purpose of the experiment. So you must come up with the purpose of the experiment, neh? OK? And then the second one, we are going to list the apparatus that we used. The apparatus, what are the apparatus by the way? The word 'apparatus', too big for you? Anything that you use during an experiment is an apparatus, neh? Ok, so here we are looking at anything that we used. Ok? And then three, the method. This is how the experiment was done. Ok, four, then we need the results; what we have been doing here is recording the results of the experiment.

[25:00 mins]

TEA: We mixed the lithium with water and we got that, neh? So those are the results, you must them in any form that you might think fits there, neh, you must put them in any form that you might think fit, whether it is in the form of [indistinct] *Stand up* [learner leaves class]…

LNRS: mumbling

TEA: Shh, ok, when we look at the results we're looking at eh, in the form of tables, or anything that was observed there, any observations that you might have seen, neh? You might want to use, eh, graphs if possible but its not every experiment where you can use a graph, neh? In this experiment it was not a quantative experiment is was a qualitative, we didn't put measurements and all that, so maybe forget about the graph for this one, neh? And then five, the conclusion, shh ok. What is a conclusion, eh?

LNR [answers] [indistinct]

[Another teacher enters room and takes something from chalkboard learners call out, laugh]

TEA: [laughs] *You are lying* …Ok… [*You don't know* ok shh, to a certain extent. [Indistinct]. Yourselves. All right [indistinct]…a summary neh? In conclusion. Is not a, I mean though it might be related to a summary it's not exactly that 's the outcome, the final outcome, so what I want you to, to observe here, there is a trend of such that you might observe here, that's a common trend that I want you to see. Here you've got a group one element, for example, combining with water, there's something that you always get here, what is it that you always get there? In number one, what did you get?

LNRS: Hydrogen

TEA: and then when we are looking at this sodium with water, it's still a group one element with water, what did we get?

LNRS: Hydrogen

TEA: and when we were looking at the third element in group one, what did we get?

LNRS: Hydrogen

TEA: we can then come up with a conclusion, based on that we can come up with the conclusion that whenever you react base one elements with water you get that, and that, you see? Do you get the idea neh? So, the conclusion is the, ja it sis the final trend or outcome.

LNRS: mumbling

TEA: it could be a relationship as well. So, it's a trend, a relationship or an outcome of an experiment, neh? So that's what I'm expecting. So I am gonna give you some pieces of paper, neh? First before I give you this I just want to see how you have reported that small piece of paper, those things there, neh? Because you need to have collected your data, so that you use your data to form the results, neh? Ok,*Listen,* ok, for you to have been able to write a scientific report, you need to have collected your data, all the data that was on the experiment, neh? And then you should be able to put it under 'results' there. Ok? So lets see, *let me see* [to learner][handing back papers]

LNRS: [talking amongst selves]

[30:00 mins]

TEA: shh, ok *What do you write* tomorrow

LNRS: Tomorrow, Sir?

TEA: Aye tomorrow because you have got the results already eh? So tomorrow before you need this eh? You've got the results of this experiment. *listen [name of learner*] you can ask from someone, eh?

LNR: [indistinct]

TEA: It's that experiment there, and then you must write the scientific report, the scientific report has got those subjects in it, ok? The aim, papers of the [indistinct] most of the time it starts this way, you find out, you know, most of the time to find out how something occurs, or something like that, or how something works or this or that, that's good.

LNRS: talking

TEA: there boy *close your mouth*

LNRS: laughing with teacher

TEA: *Listen*

LNR: [Indistinct] I haven't got one sir

TEA: Shh,

LNRS: talking loudly amongst selves

TEA: Ok, just give it that side, ok, give it at the back there, that side, that side. *Why didn't you get a paper?*, can you be quiet guys, did anyone [indistinct]… Ok thanks, all right, you can be starting now, neh? Just to make sure that we get started, eh, is there anyone who has got an idea [indistinct] quiet neh

LNR: *Come to me*…come again Sir

TEA: [indistinct] can you take some, two to three minutes neh, think about the aim. The plan when we leave here, that these two have a common aim, what you think could have been the aim of the experiment that we did there? You know the type; it was the reaction of metals with water, so, shh, shh, normally the aim would start with two …*give us* [to learner still handing out papers]

LNR: *Give me* [sits down]

TEA: [Indistinct] Ok think about the aim for that, I just want us to have a common aim, at least

[35:00 mins]

LNR: [indistinct]

TEA: *Sorry,* the aim, *listen*

LNRS: [talking to each other]

TEA: [to one learner] to balance the equation. Ask your question. But because we're balancing *can you lend me a rubber* to investigate…it was in the experiment…but you know what, what experiment, because there's so many [indistinct] a particular one [indistinct] to investigate one

LNR: Lithium plus water

TEA: but you, it wasn't only lithium with water, if you check there [points to board] the number two it was what? Sodium, so there's something common about lithium, sodium and potassium. Look at you product there, there's something common about it, there's something common [walks away] [approached by another learner] [indistinct]

LNR: [indistinct]

TEA: ok. All right, out, out

[Learner leaves class]

LNR: [asking questions] [indistinct]

TEA: *Come and a rubber* investigating what? Investigating what? That's it

LNRS: talking loudly

TEA: [indistinct] [name of learner] can you sit down, *You want to help us* investigate, so rephrase… [Name of learner] please the aim? [Indistinct] what?

LNR: [indistinct]

TEA: Ja, with? [Indistinct] Ok, shh, shh [goes back to front] all right, boy what are you doing now? Someone who thinks that he has got eh, the aim, phrased correctly, so that you just at least get something right, shh, shh, one thing forward for the aim, is very important neh, for the time you get affected some ideas, shh, who can phrase the aim for us? Eh Boy, [indistinct] to phrase the aim for us. What is the aim of this water experiment that we did yesterday?

LNR: the aim? *Write down …*

TEA: to what?

LNR: to investigate

TEA: to investigate, yes,

LNR: the reaction

TEA: the reaction, ja

LNR: of the metals with water

TEA: of the metals with water, that's good neh. You can just add, because those metals were group one metals, just add and say, it is the, to investigate the reaction of metals with group one metals with water

[40:00 mins]

TEA: that would be possible neh? The fact that it has been phrased this way does not mean that everyone can phrase it that way, someone might phrase it slightly differently, meaning exactly the same thing it's still acceptable, neh? So let me give you one thing, neh? That it's to investigate the reactions of…so, shh, shh, at least, shh, shh, scientific investigation, I mean scientific reporting, that is one of the things that I'm expecting, neh? The aim of the investigation, so any investigation must have an aim, neh? Number two is the apparatus that are used in the investigation. Boys, *quiet ,*because once we leave here, we forget about it, did you write down that thing?

LNR: Yes Sir!

TEA: *Write on a clean page,* what are you doing…so you must write topic first and then that… shh, shh, *where are your papers,* scientific report, so the first item there, [indistinct] …aim, first the topic, we have got it there, got a topic, and then the aim of the investigation, neh? No, no, no, no, in the [indistinct] paper that I gave you, I will need that tomorrow

LNR: Yes Sir

TEA: I will need that tomorrow; I want to see how you are going to write your scientific report

LNRS: talking amongst selves loudly

Bell sounds

TEA: Ok the next things [indistinct] the other four items there you should be able to do, neh? Have a nice day!

Ends [42:59 mins]

Transcription filename: Batandwa Lesson 6

Teacher: **TEA**:

Learner: **LNR**:

Learners: **LNRS**:

LNRS: [Singing and clapping, talking loudly, no teacher in class, learners coming and going]

TEA: OK can we please sit down guys, sit down neh?

LNRS: *Let's go*

[5:00 min]

LNRS: [arriving one by one, talking amongst self, moving furniture]

TEA: there are more people absent, than people here, it's very bad. What is the problem today, is it transport? Is it the trains, are they on strike?

LNRS: Ya, ya, trains.

TEA: Is it the trains, are they on strike?

LNRS: *to, homework* no, trains

TEA: Yuh, yuh, yuh **-** Shh, *we are not serious,* OK, shh, be quiet I'm reluctant to start the lesson with twelve, because the lesson that I was going to do today is a coordination of [indistinct] and if…

LNRS: [still arriving, moving desks and chairs]

TEA: *Where do you come from?* [seeing learners in at door] *Come to me, boy* [indistinct]

TEA: Is just a problem? Ok, this is going to affect what I was going to do today. I wanted just to analyse a little bit of the previous experiment that we did, cause we're going to try another experiment, so when we do another experiment you need to understand the previous ones that we did and also how we did them…important… [indistinct] it will affect, it will affect us quite a lot us quite a lot. Ok if you put what we have encountered last time, one, Ok. Some people got some the papers that came out, that I gave out, the following day they didn't have those that is the problem, how can we solve that? Ok, how can we sort that? On my part, on my part, I just want to have evidence that I've given you the hand out, so all the people that are present today I've given them neh? Cos this one is going to be part and parcel of the assessment for the end of the term neh, so this one that I am hand out today, is going to be part and parcel of the assessment at the end of the term. So if you actually listen [indistinct] Life…it will be our own responsibility, balancing…

LNR: [enters class and walks to seat]

LNRS: Yes, yes, yes

TEA: [indistinct] Eh, who is not [indistinct]… Who was not answering and then who is not here, [taking register] [names of learners]

LNRS: [answering teacher and talking amongst themselves]

[10:00 min]

TEA: Just raise your hand when I call your name. [Teacher continues to take register] [names of learners] Ok so the people who are here make sure, that the pages that I give you, just keep them safe. The page that we are going to use tomorrow, we need to make sure that you understand how you are supposed to do everything. Ok, ah, we've got this one first [handing out papers],

LNRS: [calling out] [4 learners enter class]

TEA: *You can stand there* [indistinct] Shh. Ok for the [indistinct] Shh, shh. Be quiet ladies

LNRS:[talking] *Sit down* [sneezing]

[15:00 min]

TEA: *Where do you come from?* [to learners at front], marks them on register

LNRS: [talking loudly amongst themselves]

TEA: OK, *Why do you come late?* If you look at that page neh, *Wait for me,* didn't you get that back page, Ok? [Goes to pupil at back] [indistinct]… you might want to have one page…

LNR: thanks

LNRS: [talking loudly, moving furniture]

TEA: *What's your name,*…shh, shh, be quiet neh. Sit. Ok, eh, look at that page neh, relating matters, this time the matters that we going to look at first, I just want you to end the understanding of this, because this will mean a lot [indistinct] what you get out of this, it's going to affect your reports neh! So we starting off the activity that is to be evaluated. So we're going to look at this one…*this is no time to come to school* [to learner] ok there's another one [indistinct] also that will have to be have to be validated this will be just about for 20 marks for the term neh. So one of the issues there that we are validating is the concept that we've dealt with, I just want to see whether you know how to balance an equation, a chemical equation, of a chemical equation…*Can you do it for me?* [indistinct]

LNRN: *It is not me, teacher* [indistinct] [laughing, making noises with chewing gum]

[20:00 min]

TEA: shh, shh, [indistinct] [name of learner] [teacher takes gum from pupil] thank you very much, eh, as I say one of these things that we are going to be validating, it's just gonna be for balancing of equations, we have dealt with this on three occasion in the past year. You might still want to do more with this, eh, if you will need more help then come to me after school on Friday for the help neh? Balancing equations neh, you need to understand how to balancing equations.

LNR:

TEA: what you will need to understand there is how we report experimental data, so when you do the experiment you will be reporting something, there will be some things that we will be reporting neh? Experimental data, you will be using some instruments and writing of data on those instruments, and then reporting it down, ok? [indistinct] you need to [indistinct] to indicate that experiment down neh? That is more [indistinct] …of this one. We have done that the reporting of experiments [indistinct]…I want your comments on that before we actually start so that you understand it so that where are you're short falls…I'm gonna give you those papers back today so that you can see where you are short [indistinct]..Ok, let's make this one simpler, [indistinct] and I am asking for less things the scientific report that I asked earlier about. OK so, the things that you might be new to you to, for example the magnesium ribbon…it is a strip of thing that we have there, just like this one neh?

[Noise from outside class, learner shouting]

TEA: that's a magnesium ribbon neh…so it is rolled around, you've got a lot of it there, almost a metre of it there, magnesium, so each of you've got your rulers neh, all of you? Ok, in a group, I will organise in groups, so let's say groups of five. Let's say groups of about five or six depending on total *… what's your number, …* neh? Eh, [name of learner]

LNR: Sir?

TEA: Boy can you pay attention to what I am saying? Neh, OK? So, in a, in groups, I am actually thinking of dividing you into two groups, I am gonna try to get the help of one of our student teachers that is there, so that some of you might do it in the Lab upstairs, you know that lab that is next to [indistinct], OK, and then there's another laboratory here, next door.

[Class door opens and closes, police sirens in background]

TEA: Shh, Shh, so I'm going to divide you into two because this number of people in a room trying to do an experiment it's gonna be a mess neh? So, then, we use a ruler, who has got a ruler there? Everyone is to have a ruler? We just use a ruler for this, I just want you to have an idea so that you don't mess up, and I don't want to be eh answering many questions as you do it in groups, it must be as independent as possible. Ok, you've got a ruler there [name of learner] so, we might want to take, let's say eh, fifteen centimetres, we measure fifteen centimetres, using that, this ruler. So you just measure that sixteen, fifteen centimetres there. Once you've measured fifteen centimetres

[More learners enter room]

TEA: Please stand there so I can [indistinct], what are you doing [indistinct] OK, you start from zero, when you are measuring neh, and then up to fifteen, I think all of you know how to measure.

LNR: Yes sir

TEA: You're at high school you should all know how to measure. Ok, so some of the apparatus that you'll be using is your ruler, and then shh, [to learner] what's the problem?

LNR: I'm sorry Sir *no problem*

TEA: [name of learner] [indistinct] your interrupting too much [indistinct]

LNRS: [laughing]

TEA: Shh, shh [name of learner] if you want to say something you can just raise your hand neh, not just say something as you like it. So the this thing, this thing you can actually cut it off even if you don't have something you can cut it, if you bend it several times neh?

[25:00 min]

TEA: It will be cut; just like this one it will be cut neh? Did you notice that?

LNRS: Yes

TEA: OK, see if can see on that picture there, shh, as you can see from that picture we will then use this instrument, this instrument which is like a tong to hold, to hold this. Why am I using the tongs neh? I can't use my hands because what happens I'm gonna burn this, when I burn it, it's gonna be, it's gonna burn a bit, so I don't wanna get hurt in the process. Neh? So that's why I am using this instrument. So I am gonna hold this, I think the diagram on the first page there, of that page there, is the best, that picture that I gave you, illustrates this very clearly, do you see that? Ok, that's fine, so the first thing there, number one, cut fifteen centimetres of magnesium ribbon, I will give you mm, eh, something that you will use to measure the mass, the balance that you are going to use to measure the mass of this fifteen centimetres, neh? So you take this and put it there to measures it's mass, if you check on the other side, if you look and you see what the balance will look like, it's just like the one that is there, next page there, and then, there are these things, which we call crucibles neh?

LNR: Crucible

TEA: This is a crucible for example. So we are going to use the crucible so that we, when we measure the ...[indistinct]

[Another latecomer enters the class]

TEA: Shh, *don't make a noise* Ok, *or do you want to go out?* What you might try to do as you measure this, you might want to fold it as you measure. First of all measure the mass of the crucible, so when you measure the mass of the crucible then, [writes on chalkboard] Ok, this mass of the crucible that we measure first, we call it the nett mass neh? Shh, shh if you've got a [indistinct], let's say this time it is five kilogram's, they mean the mass of the contents neh, so there is what you call the gross mass that will be the mass of the crucible plus the magnesium. [Writes equation on chalkboard] OK, the mass of the crucible plus the magnesium ribbon, this will be like the gross mass, right, but even if you don't use those terms gross and nett I don't really mind, if you don't use those terms, I don't really mind use those terms there, the most important thing is measure the crucible is the mass of the container only no the contents wont be there, but then you take the contents which will be the fifteen centimetres of magnesium ribbon.

[Another pupil enters the class]

TEA: put it inside

[Door closes]

TEA: *Where are you going?* Ok, and then you put it inside there. [Indistinct]…serious… Ok will you please come here so that [indistinct] on the list [indistinct]… understand. Be quiet; be quiet, so that you can see that [indistinct] *Why are you coming late* shh, shh *why are you sitting down* [to newly latecomers].

[30:00 min]

TEA: Boy at the back now. *and why are you coming late?* You must only answer when I ask you neh?

LNRS: [talking amongst themselves, answering teacher]

TEA: *and you, why are you coming late?* [name of learner] Boy, why are you late?

LNR: *I'm staying in Langa*

TEA: *and, you, why are you coming late …* so [indistinct] [name of learner] Boy why are…[*late*

LNR: [*because I'm sick*

TEA: *and why are you late …* so what time was the train? [Name of learner] *this is the last time you come late*? Ok [name of learner] what's the problem? [*and why are you coming late?* Eh why did you sleep outside? Quiet, quiet, be quiet

LNRS: [shouting and laughing]

TEA: Be quiet guy, be quiet, I want to understand what is going on. So, *where do you stay*, why you say *in Khayalitsha?*

LNR: *I stay with my uncle* A5

TEA: so you went to fetch money A5?

LNR: A5 yes

TEA: *Where do you stay* …who stays at A5

LNR: [indistinct]

TEA: [indistinct] …opportunity, what's the problem, what's the problem

LNR: *I'm not staying there*

TEA: the train, where do you stay?

LNR: [indistinct]

TEA: *Where do you come from? …* so what did you do?

LNR: [indistinct] hitch

LNRS: [laughing]

TEA: shh, *listen*, who's speaking?

LNRS: [shouting out name of learner]

TEA: *Sit down* [goes towards disruptive learner at back of class]

LNRS: [shouting and laughing]

TEA: *Quiet, please,* shh, shh, *listen*

LNRS: [at front take papers, and move to their seats, talking loudly, moving furniture etc]

[35:00 min]

TEA: Shh, Shh, sit down guys, Ok, *sit down, guys*

LNRNS: [talking, laughing amongst themselves, moving furniture]

TEA: [writing on chalk board] *come and sit on this side*…Shh, thank you. Shh, shh, Ok I have started a little about this whole thing, what we, eh, read on the page that I've just given you neh? You just need a ruler neh, [indistinct] also absent, it is an activity that we need to do, I am hoping that tomorrow we wont have to miss this lessons, cos I am going to set out this lesson, because other people come late, most of the people [indistinct] were late, it's not acceptable this problem. Ok what we are talking about, we're talking about the magnesium ribbon, the reaction of metals, oxygen. Where do we get oxygen by the way?

LNR: *listen, don't make a noise*

TEA: from the air, thank you. A certain percentage of the air is oxygen neh… so; we're going to burn the magnesium ribbon, so we're going to measure about fifteen centimetres of a strip of magnesium**.** According to the instructions that are on this page, so if you take only this part of the page there, you're going to cut, number one, fifteen centimetres of magnesium ribbon, and weigh it, two, burn the magnesium and collect the ash, three, weigh the ash, and then four, you repeat the experiment twice, why do we repeat twice, because in the first instance you might have made and error in measuring whatever you did…in measuring [indistinct]

LNR: the measure, [asks question] *meneer*

TEA: *Just quiet*…shh, shh, [to learner] *listen* [name of learner] tell me… [indistinct]

LNR: *what are you doing?*

TEA: Ok…[name of learner], these pages, these pages I'm gonna give you, are the page you are going to do a write up of this neh. You will put this page also in there and then you will hand it back to me neh?

LNR: Yes Sir

TEA: Ok, I will [indistinct]

LNR: Yes Sir

TEA: So, all of you will repeat the experiment twice, why do you have to do this experiment twice, it's because at times you might have done what you call an error, you might have done an error in the f first instance, you see? So because you've done an error there, that might affect your results, so that's why at times we do the experiment twice, in order to verify the results, verify that in the first instance we didn't have any errors. If it's the same or just about the same neh? [indistinct] an error, it can occur at times depending on how you stand, it's how we stand [indistinct] in front of … lets say the ruler itself. If its then, let me say, you might end up cutting a little more than you should, or if it stand I mean, straight, then you might cut exactly and things like that, ok, so you need to know all those things, so as you record there, that's why I said there you record one, two neh, I need to look at the first and second with you. Normally it can be that you waste a lot of time and a lot of the magnesium ribbon

[40:00]

TEA: do for it three times, the more you repeat the experiment the better, I mean, the [indistinct] three times because the more you repeat the experiment the more you [indistinct] actually. And then you must come up with,eh, some average, besides, [indistinct]

LNR: yes Sir

TEA: [indistinct] how do you get an average. [indistinct] first and second, what do you do in order to get an average?

LNR: Calculate Sir

TEA: Calculate but how, explain how do you calculate the average? Let's say here is I had thirty comma forty-nine, and here I had thirty comma fifty-one neh?

LNR: Fifty-Six

TEA: no sorry, thirty comma fifty-one for arguments sake, for the crucible I don't expect for the result to be different neh, in reality, for the crucible I expect the results to be about the same, but if it's for the ash here it might be different, let's say sixty one, thirty point [indistinct], and fifty-nine, so how do you find the average.

[Points to learner with hand raised]

LNR: *What's your problem?*

TEA: *I'm talking to you*, Shh, shh

LNRS: [calling out answers]

TEA: Shh, Shh [name of learner] can you focus on this? Shh, Ok Boy, if we want to find the average we've got two readings, we've done the first reading and the second reading, how would we find the average in those two there? *you don't know* …the answer? How do we find averages?

LNR: hundred

TEA: You divide… Which then of those do we divide by hundred, which of those values are you gonna divide by hundred?

LNR: the right maybe?

TEA: So I take thirty comma sixty-one and divide by hundred, and that will be my average, is that correct? *You lie.* Thirty comma sixty one, ja, plus

LNR: [indistinct]

TEA: very good, Ja, divide by two, very good, *very good, you are learning*

LNRS: [applaud]

TEA: Ok, the average always is the sum divided by the number of those items, the average of two things then they are divided, if your average is for three things, then you divide by those things neh? So in this case it will be thirty comma sixty-one plus thirty comma fifty-nine, divide by?

LR: Two

TEA: Two, and then we're going to get the average

LNRS: Yes

TEA: which will be thirty comma sixty, [indistinct]…correct neh. I expect you to be writing that somewhere so that when you move tomorrow I don't get questions this side, hey how do we do it, how do we do it. I expect you to be [indistinct]

LNR: [Loud sneeze]

TEA: *Just to know,* so write it somewhere so you can understand what happens neh?

LNR Yes Sir

TEA: Ok at the end, I also want the mass of magnesium only, and then also I want the mass of the ash ok, so those are the other things that I will need from there, but when you do that I am expecting you to be using average balancing. Shh, shh if there is a way, try to find the mass of the oxygen that we obtained, if possible there try to get that

[45:00 min]

TEA: so right at the end I am expecting you to fill up these gaps, in fact as you fill up those gaps you will notice that you'll be answering a lot of the questions that are on this page, because number one says to record the results under the sub-headings, mass of crucible, mass of crucible plus magnesium ribbon, mass of crucible magnesium ribbon plus ash, so you've got the first instance one, two and then the averages for all those. Two, you calculate the mass of the magnesium ribbon. So the mass magnesium ribbon on it's own, you just calculate, and then you calculate the mass of the oxygen that evaporated, try to calculate the mass of the oxygen evaporated, you might want to calculate the mass of the ash only first before you calculate the mass of the oxygen evaporated neh?

LNR: [approaches from door and points to side]

TEA: Shh, shh, ok,[Name of learner] once you have done that, number five, I want you need to complete this reaction. *Listen*

LNRS: [calling out learner leaves room]

TEA: *Quiet*… respond to what I say…*you can hear me* …OK let's look at them this side neh?

LNR: Sir? *I want to go out* [approaches and then leaves the room]

TEA: and then, shh, this magnesium will burn with the oxygen from the atmosphere and we are expecting to get some magnesium

LNR: Oxide

TEA: oxide. Ok, so I want you, because you know the symbol for magnesium neh? …on this side, so later on you write this in symbols, so after this you have to write this in symbols. So, magnesium symbol, oxygen, remember oxygen is diatomic neh?

LNRS: Yes

TEA: that will be O, O what?

LNR: O2

TEA: O2, very good, and then magnesium oxide, you know magnesium oxide is [indistinct] magnesium that side… and then you balance that equation, so it is gonna be some marks. [Towards the door] Oh is it your period now? Ok, I am sorry to hold you up. Ok how does the total mass of the reagents, at the end you must compare neh, from the information that you have got here, you must compare total mass of the reagents, so you've got to find the total of this, total mass here, compare to the total mass of the products neh? Yes. How do they compare, is the total mass of the reagents more than the total mass of the products, or are they equal or is it less than, so I want to just say that, based on the information that we're getting here, you see? So I hope [indistinct]. The magnesium you've got, you don't just get frightened when you burn it neh, it doesn't really do much, it's a matter of, maybe let me just show you just a little bit here of this. *Listen, s*o this magnesium ribbon, let me just do this so that you don't get frightened when you do it, [teacher lights the magnesium ribbon with match] …

LNRS: [talking]

TEA: We'll try again, ok, let's see, once more, for the last time, and if it doesn't we will try again tomorrow

LNRS: [Talking, calling out]

TEA: I just want to try and again tomorrow [indistinct] more, shh shh,

LNRS: shh, shh

[50:00 min]

TEA: we will try tomorrow before, I will just try to demonstrate once more before we start, because [indistinct] is already outside there, and also guys, you came a bit late, so we started late with this, so next time we will try to [indistinct] early. I know it's a bit cold these days but, wake up early, I know the story about the trains but if sleep, you wake up late you going to get the late train, not going to [indistinct] see most of your problems there is waking up late, *come to school early every day*] …ok. [Bell sounds, lesson ends]

[50:36 min]

Transcription filename: Batandwa post-lesson interview

Interviewer: GK
Interviewee: B

GK: OK, Mr … - if you go back to the first lesson that you taught. That was the lesson on where you did the experiment. I am just want to ask you a few questions related to that lesson. If you want to go back to the lesson and if you don't quite remember, I can go back and show it to you on the screen. No don't worry about showing me, I think I will remember exactly what happened.

GK: Alright. Firstly the first lesson, what was your main objective with the first lesson?

B: The main objective was to see how a chemical reaction occurs. Like that there is a change of properties, as I showed with solids. We had a solid and a liquid and then forming a solid and a gas, something like that – Ja, the transformation of chemicals during a chemical reaction.

GK: Do you think that at the end of the lesson, you achieved your objective?

B: Somehow, in fact when I looked, not really 100%, because the only way to see whether you have achieved your objective is when the kids actually can understand everything there. I remember I did with the models and everything for the first problem, which was with lithium with water, to get lithium hydroxide and hydrogen, and then I left the two for them to see. Some of the kids managed to see what the product would have been in the other two. But some of them still could not really see. So it was partially achieved really.

GK: In that particular lesson, what do you think worked very well and why do you think it worked well?

B: The idea of an experiment - some of them they get fascinated with that you know, though at times, even if we do experiments, they get fascinated by the action that is there and then they lose the content that is in the lesson. That is the only problem that is there you know. They like the sound you know. They laugh and then they clap hands and all that.

GK: I know that they got very excited. Anything else that you think worked well in the lesson?

B: The other thing that I was trying to show them is that it is not always in a laboratory type of set up where you can have the equipment, the formal laboratory equipment, that you can do the experiment. You can use anything. For example I was using the coke bottles and all that. That also is alright. Because they can do other experiments without having to be in the laboratory, you can do it at home or some place you know.

GK: If there is anything that you would change about teaching that particular lesson, what would it be?

B: Hey changing. In fact, there is something I am still asking myself about the way potassium reacted with the water. I have done that experiment - it has not responded in that particular manner. I am still to see that because the bottle just cut there. So I am still trying to find out. In fact, I will redo it on my own and see whether. I will do it several times and see what was going on. And then the other thing obviously, is that my litmus paper, maybe it stayed for too long or something – the colour blue there was not very, very bright blue that could be easily seen by those learners. That was the other thing I could look at there.

GK: You said you had done acids and basis before so they knew about the litmus paper.

B: They do it in Grade 8, so they know so they've got an idea about acids and bases. For those who can still remember. (laughter)

GK: What are the challenges you faced when planning that lesson and teaching the lesson?

B: One of the things is that maybe it would have been ideal to give a group of four or five to do that experiment on their own. Different groups you know. But with the type of students I have there, it was a bit tricky, I didn't trust them to be frank and more than that to manage that is a bit difficult with about 40 something or 50 learners there.

GK: When you say it is difficult to manage, is that just in terms of the numbers of students?

B: The number- it is especially the number. If you have got that number, for example you might have some kids in this group they want to ask something. As they want to ask you something, someone else wants to ask over there. If it is four groups they end up like this and you can manage that. But if you have 10 or 11 groups, then if you alone it is a tricky scenario.

GK: Anything else you would like to say about that particular lesson?

B: Yes, obviously there is something else there. Maybe it is about the periodic table I was also trying to show them the relative speed of the reactions from lithium sodium to potassium, you know something like that. And also a little bit of balancing in there, but I know that they would not capture the balancing nicely, but it would serve me for the following lesson where I would have looked at balancing in detail.

GK: I cannot remember if you mentioned the relative rates of the reactions with them or not.

B: I did it mention it once, but I did not really emphasize it. I mentioned it once that lithium was a bit slower, but then when it came down, it was a bit faster.

GK: OK. Thanks for that. Now let's go to the second lesson.

B: Where we are analyzing the data from the previous day.

GK: So, let us just go through some of the questions that we did before. What was the main objective of that particular lesson?

B: For them – for them because there is an activity that is coming up where they will have to do a scientific investigation. So I wanted them ..They have done some scientific investigations in Grade 8 and even maybe in primary school, but they always forget that. I wanted them to be able to take that information and analyze it. Then to be able to write a scientific report. That is something, because they are going to be evaluated on that. I have just taken that and I am still busy trying to see how they are doing with that thing.

GK: Just on that, how many of them have actually handed that in? Because you said not all of them handed it in.

B: About 30 of them handed it in.

GK: If you don't mind, I would like to actually see some copies of it just to see what they did. Will you be marking it or just checking it?

B: I will give you some of those copies. I will check it and make some corrections somehow, where I see that they have made mistakes. Then, I will then analyze the whole thing and then give an ideal sort of report that I will expect from them. That will inform them for the next time, when they are writing, maybe some of them will see something out of that.

GK: So, in Grade 8, you had all of those headings on the board. Do they know all of those headings and what all of that means?

B: They should know but that is the issue, whether they remember all of that!

GK: Do you know that it has been done in Grade 8?

B: It has ben done.

GK: Oh, that is good. Then just going back to the objectives. Do you think you have achieved your objective?

B: Like for the first one. Ja, somehow, they have managed as I say partially. With that large number of students, some of them did understand, but to say that 100% of them understand, is a bit tricky. It is scary to say that. Some of them did understand what happens there. There is breakings of some bonds and then some are formed on the other side. In those models, maybe somehow they help to a certain extent. It would have been nice for them if we had more time to play around with those models more and stuff.

GK: Are you quite restricted in terms of time in teaching this section?

B: Yes there is a problem there, because it is a short term, this one. On the 24th we are starting. So, we need to go onto nutrition and the respiratory system which will be the biology part before the exam.

GK: Before the exam? So have you already decided which topics are going to be included in the exam?

B: Yes, I have already decided.

GK: So, are you setting the Grade 9 paper?

B: Yes, I will set it this time around.

GK: So have all the Grade 9 teachers already decided on what topics are going to be included in the exams?

B: Yes they have. Though at times, some are moving really a bit faster than me for example, because my class (if you ask anyone in Grade 9) that would be the worst one in Grade 9s. That is the problem; my Grade might be a bit slower than some other peoples.

GK: So, talking about the 2nd lesson where you focused on the scientific investigation. What do you think worked well there and why?

B: In terms of working well, the problem with such a lesson, is that it is not a lesson that starts there and ends there. It is still an ongoing thing. I am still to see it from the written reports, whether they did understand everything. What surprised me is that when I was asking about some of the sub topics there, like method what is it that is expected, some of them seemed as though it was something new. That is one thing that really surprised me.

GK: When do you intend doing the investigation.

B: On Friday I am going to give them this. In fact, it will depend on this thing that we are doing, this balancing thing. When I wrap it up, then we will go to the investigation.

GK: Is there anything that you think did not work well?

B: What did not really work is the fact that what is assumed as prior-knowledge is not really prior knowledge.

GK: Anything you would change with that lesson?

B: With that lesson , I'm not sure. Maybe teaching different learners! With those learners, this is tricky. There is something also about those learners which you might have noticed. If you give them work for them to be doing in their places, most of them will not be doing exactly that. They are very naughty to be distracted in doing anything else. The only time you see that they are doing their work, is when you are at the front and you are in control. At times, it becomes a survival strategy. Otherwise they don't really apply themselves. That is really my biggest problem.

GK: In your lesson today, you were obviously trying to encourage them.

B: Yes, there is only one girl she is powerful - she understands this thing of balancing and all that. The small girl who came up there, who started with the two this side I was encouraging her to start with the oxygen, but she started with the lithium too. Then she went on that side and she noticed that oxygen needed to balance that side. She went back to erase the two and put a four. That one sees exactly what is happening. If all of them could be on that level then I would be alright.

GK: Anything else in that particular lesson that you want to comment on?

B: OK, the second one. Remember I did that orientation of that work on the scientific report and all that. Things that I would add, if I had a more powerful type of student, it would be issues around hypothesizing the question and all of those things. This is more of a short experiment and not a long term investigation, so I thought "No" let me leave that. We'll see later on.

GK: Thank you for that. Then, let's go onto the third lesson. The third lesson is the one where we do balancing of equations. Firstly what was the objective of the lesson?

B: Firstly for them to understand the balancing of the equation. It was more theoretical.

GK: Do you think that the objective was achieved?

B: No not yet. I am still to achieve that objective. Because that is not a lesson that you can start in one day and it can end. I can still remember way back when I was also doing balancing It was difficult the first few days, even for a good student. It would not be fair to say they understand that in one day.

GK: What worked well in that lesson and why?

B: The fact that they were balancing some of the equations that were actually used when we were doing the reactions, like in the first lesson. So, it was like a small transition. A few managed to see that OK if you put one there the balancing is almost like similar: If it is lithium with water - sodium with water. As I was moving around, I noticed that. It is more correct. Immediately it changes its thread, they start to be lost.

GK: What worked well in that particular lesson do you think?

B: The fact that they had actually done some of the reactions they could recognize some of the previous reactions from the lesson. I tried to send some of them to the board there.

GK: Do you think that strategy is a good one where you call them to the board?

B: No, especially for the naughty ones. At times, they start to think and focus. When they are sitting somewhere there, they are trying as much as possible to survive being called upon on thrown.

GK: Do you normally call the naughty ones up?

B: Yes, that is what I try to do. Then all the attention is on that person. So they really think about the whole thing. In some case you get someone after the lesson going and asking because they don't want to be caught napping.

GK: What would you change about the lesson?

B: Maybe if I had more time .Maybe I could use more of the models like I used in the first one. I could ask them to play around more. Then they would understand more.

GK: Why did you not do that? Was it because of time?

B: The main thing was the time.

GK: The challenges you have to overcome to improve that lesson? Was it only the shortage of time? Was there any others?

B: No, it is much more. It is the analytical skills. When someone does not know how to multiply 1 to get it to a 4, then even the models will not help that.

GK: Anything else on that particular lesson? I know that the siren has gone and you must go to your next lesson now.

B: I must say in general, maybe that it is a challenging lesson especially for those types of kids. Most of them are not going to do Science anyway. It is an unfair one to some of them. But for those who are going to pursue Science as a major subject, then maybe it is a fruitful lesson.

GK: See you tomorrow.

……………………………………………………………………………………… CONTINUED ………………………………………………………

Part B:

GK: I would like to ask you about your studies that you did in Cuba. How different is it to what we do here?

B: Not very different. The only thing is they specialize. Chemistry is a subject. Physics is a subject on its own. They have much more time on a particular topic and on particular issues than what we do. For example they are separating those for Grade 8 and Grade 9, so the learners have much more and a better opportunity of understanding what they are doing.

GK: So did you do practice teaching in the schools there as well.

B: The whole year they do practice teaching. My degree was actually five years. The fifth year, I did actually do teaching in the school. I was actually paid for teaching in a particular school

GK: So in the first three years you do your academic degree. And in the fourth year, what do you do?

B: You specialize. For example, I specialized in Chemistry. Also a little bit of teaching practice to observe, when you are in fourth year. In the fifth year, you do semi- research and all that. Mine was on applying computers to education as a means of helping learners as a teaching aid. In the fifth year, you go to a school. The schools that side work they this way. Four days in a week, you will have Chemistry, for example. There is one day (it was on Fridays) when you don't have chemistry at all. You will go to say MSEP central, there will be somebody like a Subject Advisor here, sharing ideas and looking at the challenges that you might be facing in the school and all those type of things.

GK: So all the teachers go on a Friday?

B: Yes. Then if there is some moderation, or things like that , it will be done on that particular day.

GK: So did you find that there was more support for teachers there?

B: Yes more support than here. Also more specialized.

GK: What do you mean that they are more specialized?

B: A teacher would just teach Chemistry and that is it. Or teach Physics and that is it. Or teach Biology and that is it. They don't have to worry about that and that and that.

GK: The learners there. Are they quite keen?

B: They are keen and compared to these, they are better disciplined. I find them better there. The other thing that they do, they have got boarding schools. They used to be called farm schools actually. Different farms will have boarding schools. So they mix manual labour with education and all that.

GK: So the kids actually need to do work on the farm as well.

B: So there is some community service that you need to do. About an hour per day, twice per week or something. They are divided in say four houses. So on one day somebody will be going for sport only. On another day, they will be going for that community service in a farm where there are fruits and putting them in a truck. Sports are repeated twice. On another day there was general cleaning of the toilets for an hour. The schools would start at seven. If a person is absent, it is a known case, because the doctor knows about it. Then around 10.30 there is a tea break. Thirty minutes and then they go back. At one o'clock, school knocks off. Then for an hour there is lunch, up until two. Two, they then go for studies. Learners are given homework for one and a half hours. After that they go for this community service. Up until 4.30. They come back they get some free time for one hour, then they go for supper at 6 for an hour. Then they go back at 7 o'clock for evening studies. Homework. They can read a novel. From 7 till 9.30 there is the evening studies. That helps a lot. If you look at the environment here, they do not have structure.

GK: When you were practice teaching there, did you also have to live on the farm school?

B: Yes, I had to live there. There were also rooms there for the teachers.

GK: If it is not on the farm, but say in the city, then how does the system work?

B: If it is in the city, then they move to school. So the evening studies are not there, but in a sense they still do the community work and all those other things.

GK: In your fourth year, when they do the teaching practice and observing, what kind of teaching strategies did they promote at that time?

B: It was still the old type of strategy that was used here also. They would do practicals as we used to do them. Their lessons would be arranged in this way – there would be one lesson where maybe the learners are in a lecture room. They would combine them, like in a university. There would be practice sessions where they would be smaller groups and they would do some more work there. In each lesson, in terms of evaluation, there was oral evaluation. On a particular day, in the first five minutes, the teacher can ask maybe about three questions or even maybe up to five questions. Then the three learners would come up to the board and the teacher would then analyze they got so many. They record. That was one evaluation that is not here at the moment. Then they would have the normal tests and the normal assignments that you give here. They do have that.

GK: Have you ever been back there? I would love to go there sometime.

B: Not yet.

GK: Thanks

Transcription filename: Batandwa post-lesson interview 2

Interviewer: GK
Interviewee: B

GK: This is my third interview with Mr …. Thanks Sir for giving me more of your time. I really do appreciate it. What I would like to do today is just to revisit some of the lessons that I have observed and get some clarification and some explanation on that. Firstly the lesson on balancing of equations. How do you feel that lesson went?

B: Balancing equations is a tricky thing even for good learners. Some of them take some time. With those ones it is a bit of a problem. I managed to see at least what's going on. But, some of them really it is beyond their capacity. Maybe some of those might not even take Science next year that is why I thought let me move on. If I stay there, because of those, I might end up not covering everything in the syllabus.

GK: Do you think that the majority of them don't know how to do it?

B: I can see it is just about half who don't know how to balance equations. I think just balancing an equation is an above average level sort of skill. In our time it is not everyone who manages to balance equations. Under normal circumstances, don't expect average learners to learn that.

GK: You say that you think that about half of them don't know how to balance equations, based on what?

B: I gave them a worksheet you see. Then I moved around to check. So, that tells me that some who are actually lost, and then I saw some that could actually manage something.

GK: Just on the balancing of the equations, one of the learners went to the board and was balancing the equation and instead of changing the number of moulds, he changed the chemical formulas. Do you think that is a common error?

B: It is a common error. You get quite a lot of them who try to change the chemical formula.

GK: Did you pick up any other students doing the same?

B: I did. I picked up one or two more as I was going around.

GK: What do you think is the best way to deal with that kind of problem do you think?

B: That is a hard problem. It is a difficult one. Just explain to them. They are bound to make that particular error. Some of them will end up getting it.

GK: OK. Then when you gave them the worksheets on the balancing of equations, a number of them did not do their homework based on what I observed in the lesson. You spoke to them about the fact that they need to do their homework. Is doing homework a problem?

B: It is with them, it is. You are very unfortunate to observe that lesson because maybe there is a collection of those naughty kids and all that. Most of them don't bother about homework. It is not just me. Most of the teachers will tell you that. You can ask that teacher she teaches them Xhosa and she will tell you that. So it is a common problem.

GK: Does the school have a homework policy or anything like that? What are the consequences if a child doesn't do their homework?

B: Some people punish as a sort of punishment. But the punishment means you are also being punished as you also will stay late after school and all that. That type of thing. That is how we deal with it. That is what we did with those who did not hand in the scientific report. They had to do the practical after school yesterday. At times, it is a punishment and that is how we deal with it. But at times it is a punishment that is a bit difficult to deal with. If at school, let's say with a common punishment policy, where we have duties, like today who is staying behind to deal with the punishment of the kids, but we don't have something like that. So you have to deal with it yourself.

GK: So, you don't have a detention system?

B: No. We don't have a detention system.

GK: So, do you find the homework problem is throughout the school or is it in that class in particular?

B: That class is more than the others you will find.

GK: Right. Then, the lesson on the actual practical that you did? How did you feel about that the lesson?

B: They actually managed to do the things that I expected them to do, like measuring and all that. Though, I would have wanted them each to have a scale on their tables. But, they didn't have enough and they had to queue for the one scale. I think that was the shortcoming. Otherwise, most of them seemed to understand what was going. I have collected their work and they seemed to see at least what was going on.

GK: What do you think the challenges were for that particular lesson?

B: There are many groups dealing with all their problems. That is a bit of a challenge. For example, I don't know what they did. They tried to tilt it. Did they want to prevent it to catch fire? They also get agitated by that. It attracts attention. The attention shifts from the actual practical to something like that. That is the problem. That is the challenge.

GK: So do you think you achieved your objective for that particular lesson?

B: Ja, I think so because they did record their results and all that.

GK: Only half the class, about half the class…not even half

B: A little bit more. It was about 28 there. The class is 51, so it is not that bad

GK: What did the other students do while they were doing the practical?

B: I talked to one of the other student teachers here and I tried to arrange for them to go and occupy them with some work – it was things on balancing and all that.

GK: So did you arrange another activity for them to do? Did you give them another worksheet?

B: It was actually written by her on the board. She wrote it on the board.

GK: Those learners, you said you were going to do it with them after school. Did you actually do that with them.

B: Yes, I did yesterday after school.

GK: Did all of them come?

B: No, actually some of them were absent. Yesterday was a bad day because a lot of people were absent. I still have to see some of them.

GK: You said some of them handed in their investigations. If you compared it to the first one that they handed in, did you see an improvement?

B: Yes, it was more structured. It was much better. Remember there were some spaces where they had to fill in. They seemed to have done this one better than the other one. It was not really structured for them. It was like out of the box type of thing, so it was a challenge to them. Maybe they need something that was more structured. But in real life situations the unstructured part is the one that works. But for them specifically, I think the structured thing works better for them rather than the one that is unstructured.

GK: So the second one that they did, the reactions of oxygen – are you going to use that as part of their Cas mark?

B: Yes, it is part of their Cass mark.

GK: OK. So, is it possible for me to get copies of those as well when some of them have handed them in?

B: No, they have – but I haven't marked it.

GK: I don't expect it to be marked. Just a few of them, so that I can see how they have done. I can compare with the other ones.

B: Did you see the other ones, by the way? The scientific reports that I gave you. Did you see most of them the problem is being ambiguous – they were saying add a chemical into it, they won't say what particular…? That was the general problem that I noticed.

GK: So for the second one, they didn't actually have to write it up in that particular format?

B: No. They are going to write that next term. We swopped around activities. We thought let them deal with it next term with the investigation – it is going to be actually longer, that scientific investigation.

GK: So, for the Cass mark for Grade 9. What is going to be the requirement?

B: The requirement is that there must be a controlled test first term and another activity. In fact there must be two or three activities. Last time we did three activities and one control test. This time around it is that activity. We started one on Nutrition. I gave you a copy, I think?

GK: No

B: So what I am going to do is compare Pro Nutro, Cornflakes and Wheet-bix and the nutritional information in there. There are three things they will look at. They are looking at the carbohydrates and the other things. Then they draw it by graph. There are some interpretation things that they will ask about that. This is the other one in this Chapter that we have just started now.

GK: What are the different types of activities in Grade 9 that they must do?

B: There must be one scientific investigation, which they must write it up, like the one that I gave them. That was a practice thing. It is not like I am going to record that. Then there must be other activities. One must incorporate LO3. Like this Pro Nutro thing, it incorporates some beautiful LO3 because it is things that see in their daily life. They must be able to make decisions about what to eat and what not to eat. Things like that. The other one can just be content. Like the other one that I have them. It is a practical, but there is also some content there - the law of the conservation of mass. They must be able to understand that. Then there is the June Exam. Then there will be the control tests in the third term as well. Then there will be a final exam. In the last term there will be a final exam only. It used to be CTA's, but now it is a final exam only. So third term is going to be that scientific investigation and that control test. This term is easy. Two activities and then the June exam, which is big.

GK: So the investigation that you are going to do in the third term, what is that going to be?

B: They must choose their own topic.

GK: Oh. When you say they must choose their own topic. Is it a literature research where they can find some information on something? How does it work?

B: It must be a scientific investigation.

GK: When you say they must choose their own topic?

B: Like for example, say someone might want to investigate fuel efficiency. Someone may want to compare mentholated spirits and gas and something else, to see which of those three are more efficient. We give them some topics to choose, if they want to. But, if they want to come up with their own topics, they can.

GK: How many topics do you have?

B: There are 12 topics that we have. But they can come up with any other topics. It also says: *"any other one".*

GK: Did you do something like that last year?

B: Yes, we did a similar activity last year.

GK: So how did it work? Did they come up with good ideas?

B: No, last year most of them tend to want to ask a lot. You end up giving them a topic. Only a few choose a topic and want to actually investigate something and then they will go out and investigate. Most of them, what I noticed is they like a type of investigation where it will be a research like where they write a questionnaire and then they do like that as it tends to be easy for them. But where they have to actually do an experiment, it tends to be difficult for them. That is the problem.

GK: Did anyone do anything like that last year in your classes?

B: There is someone who did something on trying to see the amount of electricity you can get from lemon - putting a lemon into Ceres and all that. It was an investigation - a scientific practical investigation.

GK: Then, if I can just ask you overall now. Can we come back to the topic we have just done. If you think of the whole topic, which of the lessons do you think worked well? Which didn't? What would you change when you teach it next year?

B: I think the ones where we were having the reactions with water. They were fine. The only problem, maybe before I teach that one, I will need to tell them a little bit more about the scientific investigation. They will need to revise a little bit because they didn't know beforehand. They had done it in Grade 8 but they forget quite a lot. They need to revise those concepts a little bit. When they write a scientific report they will then know about that.

The one on the conservation of mass, I think it worked fine. I can maintain it like that. Then we will try to order some more scales for next year, if the budget allows that. So we can have different kids doing it. If we have student teachers next year, I will do the same thing, putting half the students with the student teacher. Then the other half can do it another time.

GK: When you did the reaction of magnesium with oxygen in air. Do you have any other ideas around that?

B: The other perfect one is to have a gas tank. To have an oxygen tank, which has got pure oxygen, then it will work really well potassium, with lithium, with sodium. That will be fine. Then they can compare how they react in a group. That is the one thing I am also thinking about. An oxygen tank will be fine.

GK: Because I don't think you actually covered the reactivity. Did you?

B: No I didn't compare them. The other thing was time also. The others didn't react in pure air, they required some pure oxygen. Magnesium reacts very well. That is why I chose it.

GK: Just in terms of your Science Department, you said you would like to get scales and an oxygen tank. Who motivates for that?

B: We submit a budget this year and say we need that next year. Also through the school funds, we might just be able to help us there. So as we make the budget this year, we will try to remember that.

GK: When you do the Science budget, does the whole of the Science department meet or how does it work?

B: Ja we meet all of us. Yes …. will be there. We will record the things that we need. Then those things go to the office. The office will compile the whole budget for the school and then it must be approved by the Governing body. The Governing body might disapprove it or they might say: "*This is too much*" and then we will have to cut down some things. If we are unfortunate, some of the things that may be cut may be our things.

GK: So, generally if you think of the budget for this year…..

B: Last year there was an infighting in the Governing Body, so the Chairperson when they went there with the budget – they wanted an increase in the fees of R100 per learner. The chairperson refused with the Governing Body. There were some clashes with the chairperson with the principle and the other guys there. So, it was a bit of a problem. So the budget this year is like for the previous year's, even though those things normally have gone up. So this year we cannot really do much in the budget.

GK: So in Science what were the things in the budget?

B: The magnesium strips that we have there. Some of them were bought through that budget. This thing that we are talking about – the tanks and all that, we had put it there. But they said: "*No, the economic recession".* They explained it in different ways.

GK: So the oxygen tanks - are they expensive?

B: I don't think so. The last time we used when I was at …. High they were not expensive.

GK: Just again just talking generally how Science works at the school. Do you have regular Science Department meetings?

B: Yes, we do have some meetings. You did ask one time and then I said we are going to meet. You said you were busy that day, you remember? We do have those meetings once or so a month. They are not so regular like every week, but even if we don't meet every week, but once in a while when we are sitting here during break, we talk about things and say: "*Where are you?"* things like that. Like now, I am setting the June exams, so what I did I wrote the topics that are going to be there and then I distribute it with the teachers that are teaching natural science to that they know exactly what is coming.

GK: So, there is no formal timetable.

B: No, not really. At the beginning of each term, we must meet and once per month we also must meet, but we decide. It is not really timetable like you will think of in a Model C type of school.

GK: You mentioned one day that you share the Grade 12's with … . How does that work?

B: Oh yes. No I am teaching Grade 12B. He is teaching Grade 12A. Almost half of Grade 12B they are doing History and almost half of Grade 12A they are doing History. So at times - at the beginning we mix them together. Like if we are doing a new topic. Then we separate them when we are going to do problems.

GK: OK, so is that for all topics?

B: We only did this - this year. Last year we were doing it separately. We just want to see how it is going to work out.

GK: So, what is your motivation for doing it that way?

B: It was … that came up with this. He is the Head, so I just took it. He was thinking that they must have uniformity. The subject advisor advised said that we do almost the same things. We use the same … also if we need to free up the person if there is a practical that needs to be sorted out. When the other guy is teaching, then the other will be setting up the other things and making the arrangement. We don't have lab assistants.

GK: So how do you decide who is going to introduce the topic?

B: Most of the time Tokyo does the chemistry and I do the Physics.

GK: So it is just by arrangement. Do you do the same thing with Grade 11?

B: No, I am the only one teaching Grade 11. I am just teaching it myself.

GK: So do you take all the Grade 11's?

B: Yes. There are only two classes. Then in Grade 10, I have only one class in Grade 10.

GK: Do you think the combining of the Grade 12's is working? Is it something you would want to do next year?

B: It can only work if we have small numbers, like what we do now. But, long term - we will revisit it and see. We will evaluate it and see next year whether we go for that.

GK: So when you combine, how many students is that?

B: We have 58 or 59. There are almost 60.

GK: So do you have a venue that is big enough to accommodate all of them?

B: They use 11A. They somehow fit but it is not a comfortable fit.

GK: I am thinking if there is anything else that I want to ask you. Is there anything else that you want to tell me generally about teaching Science here at the school?

B: It is fine. I don't like the Grade 9's that I am teaching. If that was a very good class that would motivate you as well as you teach. But, those guys – I am thinking that we are forcing them into Science. I think that if there was an option they would be doing other subjects. It is a bit heavy for them. I notice also with Maths, it is a bit heavy for them.

GK: Coming back to the Grade 9's, you indicated that very few of them will probably go onto to do Science next year.

B: There are very few. But we do have some other classes where we can get more of the Grade 9's.

GK: You said you were looking at reducing the number of Physics students.

B: Ja, the number of Physics students we reduced a little bit this year because the caliber of learners that we have got. Not all of them can do Physics. Physics is a subject that requires quite a lot from the individual. Someone that is committed. Not anyone just going in there.

GK: So of the Grade 9 Classes, you have one?

B: I have got one.

GK: Mr … has got one.

B: One.

GK: Mr ….– has got one?

B: Mr … teaches about two.

GK: OK

B: There is another one teaching Grade 9 - Miss …

GK: OK. So has got the top Grade 9 class?

B: I will need to ask from them. I think it is Miss … who sits by the corner. She is not there now.

GK: Do the Grade 9 teachers regularly meet informally?

B: We do meet, informally. Especially this Grade 9E. It is a problematic class. One time there was a kid that was problematic in 9F. The teachers wanted to take him to 9E because they said that other kids were problematic in 9E.

GK: Oh my word.

B: So, it is a problem.

GK: Remember you said that you looked at the old curriculum and then you looked at the new syllabus that they gave you and you decided amongst yourselves how you were going to change it.

B: It was the resources actually that forced us to do that. We didn't have the oxygen tank with pure oxygen, so we thought that if they could see some other experiments with water which are clear, then we look at the reactivity in a particular group. I think it works well when we look at the metal group with oxygen.

GK: So next year are you going to…..?

B: We will try to get the oxygen tank. I think this time around we should be able to. The Governing body has changed. The guys that are there they seem to be more positive about the school.

GK: So if you do get the oxygen tank, are you then going to follow the new curriculum?

B: Yes, if it is not changed. They are also reviewing it because they think that it is a lot of information. That is what most schools are saying. They want next year to have a common exam. This year schools are going to write their own common exams.

GK: If you feel for instance, that there is too much work, who do you pass that information on to?

B: The subject advisor, we just tell him - not by email. Some other schools may be advising with email. They will then look at the whole thing and email National with the different comments.

GK: Do you meet with your curriculum advisor often or do you have cluster meetings for Grade 9?

B: We do have some cluster meetings. We had one at the beginning of first term. It was a standard testing to say what it is that they require for this year. They then did visit all of the schools so they came here also to look at some of the things.

GK: Then, I mentioned to you that I would like to interview some of the Grade 9 learners. What I need to do on Friday is I will bring a letter, because I have to ask the parents for permission. I will give about 10 of them a letter. Those who bring the letter back, obviously those one I am going to interview. I am going to choose. It will just be voluntary. They can decide. Maybe on Friday, if you could give them the letter - or, I can just ask one of the other teachers.

B: You can give it to me and then I can give it to them. Do you have the letter here?

GK: No. Do you think giving them the letter on a Friday then they can bring it back on Monday.

B: Maybe give it on a Monday and then they bring it back on a Tuesday. With a weekend, they might forget it.

GK: Once I have the replies, because some of them may forget it. Once I have sufficient replies then I can decide on the date. It will be during an interval.

B: OK

GK: Right any questions for me? Anything you would like to say?

B: No, I think that is fine.

GK: When I go through these things again, maybe there are a few more things that I might want to ask you. If you don't mind? One thing that just comes to mind now - you know all the worksheets that you did for this topic now. Is that the first time that you used all of those this year? Or is it something you used before?

B: The questions for balancing. I have used some questions there. I did add some to those. Then, the nutrition particle, we have used it before. Not all of them. Like the magnesium one, I used it this year only. We started to do it this year. Because of the new thing that they sent us. They never looked at the low conservation of mass in the manner that they asked us to do it. That made me to think to do it in that direction.

GK: I will pop in on Friday to drop off the letter and then you can give it to them on Monday. Thank you very much.

Transcription file name: Batandwa practical work interview

Interviewer: GK

Interviewee: MM

GK: OK Mr …, thanks again for allowing me to interview you

B: OK …

GK: What is the date today, the …

B: the 6th

GK: the 5th, 6th, the 7th December … I want to ask you some questions related mainly to practical work and the reason for that is that, in the series of lessons that you did, a lot of the time was spent either on practical work itself or activities related to **...** to the practical work and so, that is one area that I thought I'd like to explore, is the practical work. So, there's just some questions that I'd like to ask you about that.

B: … about that, ja.

GK: so, firstly, general, in general about practical work. You decided to do these activities, these practical activities for, in the series of lessons …

B: ja …

GK: what I want to know is, … how important do you think practical work is and, why do you think practical work should be done …

B: no, practical work it's very important. In fact, most of the demonstrations that I did, if there were a few kids and maybe, enough resources, it would have been nice for each kid to be able to do that on their own, you know, because, at least they can see, first hand experience, you know. Ja, rather than me telling them every time, you know. So, at times, when they see, they believe better, they, they, they, it, it, they tend to remember it better, you know.

GK: OK, … so, so, do you think that practical work is important just, just to improve their recall or whatever it is you are teaching? …

B: … the recall. Also, to make sense, much more sense of what they will be doing. Because at times, when you explain to someone, OK, a car moves this way, and all that, but when they actually see the car being moved, and all that, it's, it's far much better than explaining it, you know.

GK: alright, OK, so, … right, let's leave that there. … What, what are the factors which determine if, when and where you do practical work in your teaching.

B: ja, when it's physical, you say. There are certain lessons when it's not physical. … They say, first of all, what you have in the school, I mean, if you've got enough chemicals, that's fine. Ja, at times, let's say, it's not chemicals that are too dangerous. Sometimes, if, the kids are going to manipulate the chemicals, you know, like, you are in trouble when you get, you give them acids and all that, and you find by mistake one of them has come into contact with that acid and stuff like that, you know,

GK: … so, when you, when you do your planning, say of a particular topic, do you, do you look for sections or concepts that you think may be, may be ….

B: ja, in fact, some, some topics lend themselves to that kind of practical, like chemistry is easy to do practicals. But lets say you are doing earth and beyond, it's very hard to do practical there, you know, the best I can do is a model or something. Otherwise, you can't, you know, it's very, very theoretical to, I mean, to see the moon and all those things and …

GK: … OK, … then, what practical work, besides the two that I saw, what other practical work did you do in all the grades this year?

B: … in all the grades, other practical work … in grade 10, for example, we did some practical on … we're doing refraction and reflection. So, they used a prism. They are trying to determine the refractive index of

GK: oh, yes …

B: … of a particular material, you know? So, that would be physics, then. And we have also done, Boyle's Law in grade 11.

GK: OK, was that a, was that a demonstration or …

B: No, they actually did it themselves, ja

GK: OK, so you've got the Boyle's Law …

B: apparatus … ja

GK: apparatus

B: we've got a Boyle's Law apparatus. So, we do actually buy pumps two years back those big pumps from Shoprite. Because otherwise those small pumps don't work … you know,

GK: oh, oh, also those pumps

B: ja, those ones are better, so much better than the old. Ja, those are the activities that they actually, they were assessed on those activities. They are part …

GK: formal assessment

B: formal assessments.

GK: and in grade 12, what did they do?

B: in … they did some, a bit of titration to determine the concentration of an unknown substance.

GK: OK, so how did you manage to do the titration? Did they all, did they all do it is groups?

B: [over talking] they did some groups, they did some groups. Though, each individual had to do their own report, but they, because the equipment is a bit scarce, so they did it in groups, ja.

GK: OK, so that was grade 12?

B: That's grade 12, ja.

GK: So, how do you man, where do you do, I mean, how many grade 12s did you have?

B: No, I had one myself …

GK: you had one class

B: then Tokyo had one, so it was just two grade 12s.

GK: OK, and how many in a class?

B: mine was a bit fewer, because, they're the science stroke history, so …

GK: oh, yes …

B: … when others going for history, I take the science class. So, there are about 30 something.

GK: OK. So, where did you do it, in the laboratory upstairs?

B: in the lab upstairs, ja

GK: oh, OK. Alright …

B: there were others, also like … this one is a newer one … finding the capacitance of an unknwon capacitor … that's a gra…

GK: a grade 11

B: 11, ja, grade 11. Those are …

GK: and how did that work, OK?

B: ja, it worked OK, though, to be frank, because that topic was not there in the previous syllabus …

GK: yes…?

B: … I couldn't remember how to do it! So, but lucky enough I do research a little bit and, ja, we didn't have the equipment, ja, so I had to go to Goodwood. There's a place there, which is called Progressive Electronics. And then I bought the multi-meters and the capacitors and then I had to … because this capacitors, different colours there they give you certain capacitors all those type of things. So, …

GK: oh, OK

B: … we did all those things, you know

GK: and then it worked well, so [over talking]

B: ja, it worked well, ja, it did go very easily, it did go very easily, ja.

GK: no, that's good. So, all, most of the practicals that you have done, they were all for formal assessment?

B: Especially those that you actually have to … in fact those ones we had no choice, neh.

GK: because they were prescribed …

B: they were prescribed. There are others that we did which we didn't really record, like, you know …

GK: but, what did you do? Like what?

B: No like with the Grade 10s we did the electricity, there's a lot of … to find the brightness of bulbs when they connected in series and parallel and when they've got some parallel, some series and all that type of thing, you know.

GK: so, you did that as a demonstration or …

B: no, that they did …

GK: they also did that …

B: they also did that …

GK: basically doing [indistinct]

B: ja, ja, ja,

GK: OK,

B: and also, we did something with lenses, you know

GK: with lenses in grade 10

B: with the grade 10s, ja, where you put a, let's say, a source of light of some sort and then you put the lens in between. And they had to describe the image, and all that, those type of things, ja …

GK: and how did you manage that in the, do you have a room where you have a room where you have blinds?

B: that room upstairs, there, there are some blinds there

GK: is it!

B: you can put the blinds on the side

GK: OK, so that works well … OK, so it looks like you, you don't only do practical work then for formal assessment. That, you actually use it in your teaching as well.

B: ja, ja, we do it for teaching attempt, where it is physical actually, physical.

GK: so, do you, is it only your, are there other teachers or is it mainly you that [indistinct] ?

B: [laughs] you know what, ja, with this type of thing, many people would do it to a different degree, you know, ja. There are, … I do it, some people also do it, let me not comment too much about that [over talking]

GK: OK [over talking] you know, because, I mean, practical work generally, we find that most, well, my perception is, that most people at the moment just do the practicals that are necessary for formal assessment.

B: actually, this is the problem with the new syllabus. Remember the old syllabus there were about 8 practicals per year, that we used to do

GK: that's right

B: but it used to be, also taxing on, on, marking and all that. And then the crew that went to discuss the, the new assessments, the physical science crew they thought they don't know, let's [indistinct] actually expressed the marking that was involved. It actually [indistinct]

GK: yes, no, I know

B: ja, but then it also took away a lot of things that were positive …

GK: that's right

B: that is the problem

GK: because, I mean, you said you do practical work basically, first [indistinct] first hand experience … also for them to make more sense of it. But, besides that, they're also just get it … they, firstly they, they learn how to manipulate the equipment firstly and also, they need to manipulate the information. So, they had to analyse [over talking]. So, all of those, those skills actually …

B: are very, very necessary …

GK: are necessary

B: though, I must say, practical work adds to the work load because if you are going to do a practical work lets say the following day you know, make sure you are staying after school, may be just to make sure everything is there, everything works, like you are trying to, trying to use, you know. If, like something does not work, you try to see, OK, what is an alternative that they can use, there, and all that. So, that's why some people will avoid it, ja… because

GK: no, you are right … because I mean, I believe you should test it beforehand and everything must be ready on the day ….

B: because I've seen cases where someone tries to do the practical and then it doesn't work because they did not really test it, that it works, that it is working first, you know. Ja, ja, that you see quite a lot someone coming to ask you, hey, where's something that this [indistinct] … I mean, how does this work, how does that work, but, where are the kids, they are waiting … so, that's the problem with a practical … it needs a lot of planning, a lot of it, ja.

GK: OK. Now, there were two, there were two practical activities that you did. The one was a demonstration …

B: OK .. where …

GK: and the one was the … was the [indistinct]

B: metal … OK

GK: in the water

B: OK, OK,

GK: and the other one was the one up in the lab with the magnesium ribbon. OK? Now, just firstly, some questions on the demonstration. I know, and this may be a bit of repetition but I, you must tell me if you agree with what I am saying. You chose to do a demonstration on that particular topic because you felt that you would have like them to have done it, but you thought a demonstration was better because safety, and because of the chemicals available, and so on, OK?

B: especially with this group. It was 50 more and anything. Because you know, a small thing with them, distracts them. If you, might have seen in the next one that we did upstairs, I think I was, or something leaked, …

GK: that's right …

B: then, tjoeps … all their attention it was that, you know, …

GK: that's right …

B: and then, they are not [indistinct] the focus on what they should be … ja, you see … that is the problem. And in a practical, with kids who are not used to doing it, something like that is almost a 100% chance that is going to happen, you know, ja.

GK: can I ask, why that particular topic you thought it was good to do a demonstration

B: OK, because everything can be seen from where the learners were sitting, you know. I mean, the flame and the sound and everything, you know. And, everyone could actually see it, you know, that was one good thing, you know, ja. In fact it was going to be hectic if they done it in groups, because they say the other groups thing explodes first. Then this other group's attention [indistinct] from the work they are doing, trying to focus on the other's explosion there, you see. So, that is the other thing, there.

GK: I think that was a good idea … why, you said that you that you didn't prefer learners to do it themselves, like a hands-on activity why do you think, do you, firstly, do you think that hands on activities are always better than demonstrations or … was it just that particular one or do you think sometimes demonstrations are actually better than …

B: Ja, sometimes demonstrations can get better … like in that particular one I think a demonstration was better there. Ja, there are cases where you find, you know, this one is too dangerous for them, you know, and stuff.

GK: what would make, what would make a hand … what are the benefits of the hands-on experiments.

B: No, the hands-on one, they can see … OK, in fact when you do something, the way you capture the whole thing, it's better than when you are told about something … let's say, about kicking the ball, you know, something, or dribbling, let's say, OK, when you are drbbling someone, you do this. I mean, they cannot [indistinct] watch [indistinct] … but then, it's different when you say, OK, go in there dribble, [indistinct] that person there. You see. It might not be [indistinct], it get's very easy when someone is doing it. But, when they are doing it, it might be something else, you know. Ja, it takes more time, actually for them to do it, because, they might make little mistakes, because they, it's the first time, then they try again, you know, but then, the fact that they are making a mistake and think about it and try to do it right …

GK: but actually [over talking]

B: ja, it makes them that to register and stay there in their minds, you know, than to help something as perfect then, then all of a sudden it's done, ja.

GK: no, I think you are right. So, I mean there are, obviously what I am hearing you say and you must correct me, is that there are certain topics, that would be better for a demonstration and other topics which [indistinct] and activities that are obviously better for hands-on?

B: yes, yes, yes, that's right

GK: … hands-on experience? … alright, looking at the demonstration, what was the main sort of learning objectives? Do you remember?

B: no, it was the … first of all, it was the, to, for them to understand how the chemical reaction is taking place. I think I did also the model in there

GK: that's right …

B: to say that, OK, during chemical reaction actually there is a breaking of bonds and formation of new bonds

GK: right

B: … that was the key thing there

GK: but in terms of the actual demonstration

B: also for practice

GK: … ja, the actual demonstration …

B: … the actual demonstration …

GK: … how did that sort of [indistinct] you know?

B: OK, the other thing in the demonstration they could see that, when you start something solid there and you end up with something completely different. The properties of the reactants being totally different from the properties of the products, you know … that is what, that was one other thing. Because we could also prove the properties the product. They could see the gas coming out … they could also see a litmus paper, I mean, becoming acidic and all those things, ja. Although that was quite a lot of information for them … [laughs] … but they have done acids and bases in grade 8, so, those who are up to scratch, they know exactly what is going on.

GK: So, the demonstration itself was useful to show the difference in properties of the reactants …

B: … and the products

GK: … and the products. It was also useful to show the, the pH change …?

B: ja, the pH change.

GK: right, anything else that the demonstration itself, sort of, that kids could have learnt from the demonstration itself?

B: ja, the energy. Because, there was a lot of like sound and all that, you know, so, energy changes, that's, that's some energy changes also during a chemical reaction, ja. That was the other thing …

GK: and then, obviously, the thing they got most excited about was the sound given off [laughs]

B: yes, ja, that was the thing, that was the thing [laughs] … and something like that is hard for them to forget, you know, ja, because they remember it

GK: so, it was a test for hydrogen

B: hm, hm, oh, yes, the pop sound, yeah, ja, ja, ja

GK: OK … and …

B: the other thing, you noticed, I did not use the conventional apparatus. I used …

GK: yes … [over talking]

B: the bottles and things like that. Just to show that it is not always that you actually need a beaker and other things to do an experiment.

GK: So why do you think it is important for them to know that.

B: So they can actucally do experiments on their own as well. They can actually at home experiment lets they want to see whether tomatoes will grow faster in sandy soil they can actually experiment there without having to b in the lab or the classroom

GK: so, you obviously want to encourage them to do …

B: more experiments.

GK: themselves …

B: experiments themselves …

GK: so you obviously think then, that experiments are important?

B: ja, important … ja, that the thing, that the thing

GK: so, why in science, do you generally do you, do you think it's impor … what, besides those other factors, why do think [over talking]

B: … it's important. I think science is, I mean, most of the things have refined and become better because of experimentation, you know, ja. If you look at the music systems some years ago, or even with, with videos, eh, and scientist experimented, and say, now what is it that can be better. They went to DVDs, you know, and then into high definition and all that because of experimentation that they managed to improve from one to the next, you know.

GK: obviously, it also then seems that, sounds like you enjoy practical work?

B: ja, no, I do.

GK: because, I mean, you are wanting them to, you seem to be, get excited about it and then they will get excited about doing it. So, do you think that one of the reasons, may be, that people should do more practical that it actually does motivate them and

B: ja, ja

GK: … you know, keep them more interested in [over talking] and so on

B: and under normal circumstances, that's why they should have their [indistinct] … ja, I wonder what kids that are very keen to learn, they get motivated. I cannot, I cannot.

GK: because if I just think about it, I mean, if you have a class where a lot of the children went home and went to experiment themselves with all kinds of different things, it could be very exciting to [over talking]

B: ja, it is, it could be, ja. I remember when I was at … High one time, I had a learner who actually made a lift, you know? Ja, they designed it but I was helped actually by the father, because the father used to work in a …, so the father supplied the material, but they managed to make a small lift that could, … that worked on a battery, you see, 12v battery. And it's still there in …., [indistinct] ja

GK: OK, OK, so those were the things that you were hoping that they, the kids were going to learn? Right? Do you think they actually learnt all of that [over talking]

B: not, not all of that, not all of that …

GK: or some of that?

B: no, some of the kids, yes, I mean, they still remember a lot of things from that but in that type of class, [sighs] it is a bit of a problem, ja.

GK: … OK …

B: if we had keen kids, they could have grasped most of that, you know.

GK: so, did, just as a matter of interest, did any of the other grade 9 teachers do any of these activities?

B: ja, especially the one, we actually used it later on, …

GK: … the magnesium one …?

B: ja, the magnesium one!

GK: so did all the all the grade 9 [over talking] one

B: they did it, ja …

GK: so and they used that for assessment purposes

B: for assessment purposes, ja

GK: OK

B: that particular one, ja

GK: alright …

B: but I'm not sure about the demonstrations …

GK: oh, OK … because just on, on the demonstration, … and linked to that was the scientific report, remember …?

B: ja, ja, ja, the scientific report, yes.

GK: now, what's, what you did while I was here was you, they handed in … the scientific report and … I know you gave them some feedback and then in class you gave them sort of the ideal …

B: the ideal one, ja

GK: now, what you said was that you would later on, sometime later on you were going to give them another …

B: scientific report

GK: opportunity to write a scientific report. Did you

B: ja, they did, did a scientific report

GK: I mean, it was for the, for the life sciences, was it, or …

B: oh, OK, they, they, oh, the one that we did later on was … you see, when we went to reflection and refraction there, we used a glass prism and then I said, OK, they must use 30 degrees as angle of incidence …

GK: was this grade 9?

B: … grade 9, ja, and change it to and see what the refract … the angle of refraction …

GK: right

B: … they measure, right. And then they change the angle of incidence to 40 and then, it was like that, you know.

GK: OK

B: and then to see the relationship between … an increase in the angle of ref, of incidence, and what would happen to the angle of refraction …

GK: OK

B: [indistinct] it was just, I made it up [indistinct]

GK: no, that's nice, so, so then they handed in a scientific report on that?

B: yes, they, they handed in a scientific report on that

GK: and how did, did you find that they were better at writing a scientific report, or not really?

B: no, they were a little bit better. They were a little bit better. Some kids, who, unless those were really, who are really not good in anything really but otherwise, kids who are keen managed to do …

GK: so, did you have to give them, did you go through the same process where you gave them the sort of headings and they just had to fill in why …

B: no, they, they remembered from the other one. I said they must refer to the other one

GK: OK. Have you got any copies of that that I could see, or …?

B: OK, I think I will try to get you some, ja. I will try to get you some …

GK: because it will just be interesting to see if there was any sort of progress … because remember, I took some copies of some of them, of that first scientific report …?

B: ja, ja, ja

GK: … and, may be, do, have you got them all saved here, or have they taken them home

B: no, the, the, the other one they've taken, but the ones that I am talking about, the refraction index and stuff, I think it's there somewhere.

GK: because what I could do, is I, if I may be gave you the names of the kids that I had, then we can compare to see …

B: OK, if you'd told me [laughs] before, I could have checked …

GK: OK, [over talking]

B: because that's why there was no [indistinct] for assessment [indistinct]…

GK: that was just …

B: for them to [over talking] for practice, ja

GK: ah, that's great … do you obviously do a lot of practical work, so that's really great …

B: ja, I know, we try to do as much as we can, ja … one [indistinct]

GK: so, do, did all the grade 9s do that as well?

B: ja, they did that … that one they did, ja.

GK: so, but you didn't mark, did you mark [over talking]

B: I did mark, I marked. Actually it was recorded part of the …

GK: part of the …

B: CASS mark

GK: and you also said you were going to do something on nutrition, or something?

B: yes, yes, yes, we did … we did, yes, something on nutrition, ja, where we were comparing nutritional information for, it was for what [indistinct], it was Pro Nutro compared to Kellogg's and Wheatbix, something like that. So, they were looking at carbohydrates and … proteins and … there was three things we were looking at. And then they actually had to draw a bar graph that compared those three things and those three different [indistinct] and they had to, ja, record it put it in a bar graph, you know, …

GK: and how did they do with that?

B: no, they relatively well … ja, because the, but what I found is that … some of them, to bring the, because I had asked them to go find and the …

GK: the boxes or whatever …

B: the boxes and stuff like that, it was a problem, so I had to actually give them the boxes next time and then, in class for them to actually take the information from the boxes and then from that, draw the bar graph and stuff like that, ja

GK: no, those are good activities. OK, … right, then we are coming to the hands-on practical …

B: oh, the one … ja

GK: the magnesium, the magnesium one. Why did you decide to do that particular activity … as a hands-on activity?

B: it was easy, I think, I thought it, it's easy to handle for them, you see. Ja, and also, just to prove, I mean, practically and also for them to know how to use different types of things there. There was the scales that they were using, ja, … ja, those are the, the two main things, like, do you know how to use some equipment, ja and just to be careful, you know, when using equipment. That was the other thing that I wanted them to know.

GK: [indistinct] OK, … so, what was your main learning objective …

B: oh, for them to see that the mass is not lost] in any case when there is a chemical reaction, when the total amount of mass, that you start off with, is the same as the total amount of mass that they end up with. That is what I wanted them to see there.

GK: and do you think that, that they actually saw that?

B: from, from, because they, they wrote those things and then they actually handed it in. Ja, mostly they did … a few didn't see it, but mostly they did see

GK: they did see that

B: ja

GK: you see, because what I, what I …

B: what you thought, yes …

GK: what I was thinking, really, was they, they found a mass … they took the mass of the magnesium right

B: oh, there was something, ja, they couldn't actually measure the mass of the oxygen, is it?

GK: that's the thing, so

B: I know, I know,

GK: I think it's a, I think it's a good idea, but you know, afterwards when I thought about it seriously because what happened afterwards is,

B: they [indistinct] subtract

GK: yes, yes, they just needed to subtract

B: yes, I know what you mean, ja

GK: so, I, … I was just thinking how else it could have been done … to show, to show that?

B: I think, with that one, you can't measure the mass of the gas, that's the problem …

GK: so, basically, what you are doing is, you are saying to them they must equal and then they just need to subtract to find the other one … because that's in essence what happens

B: ja, ja, that's what ended up happening ja, I know, I also thought about that later, but, ja, ja,

GK: so, I actually mean, you must think about how …

B: oh, OK, an alternative to that, neh?

GK: if you actually want to demonstrate the, so, it will be, it will have to be obviously one where the reactants and products are all solids

B: or, if you collect a gas, then you attempt to collect that gas, all that gas, which is very hard …

GK: very hard …

B: is very hard, ja and then, if you know the volume of the gas, …

GK: then you can calculate

B: calculate the mass, which is for them …

GK: but for them at grade 9 level is a bit too much

B: is too much, ja

GK: but I think they probably got the idea, I mean, just from the subtraction and that, that

B: hm, they got the idea …

GK: they got the idea that the products and the reactants should be th same (sound of siren) … does that mean you need to go somewhere?

B: no, no, actually, this bell is programmed for lessons, but then the lessons are over, neh?

GK: oh, I see, they just leave it on … OK, … I think I have asked you that already

B: hm, hm, OK

Recording ends

Transcription filename: Batandwa pre-lesson interview

Interviewer: GK
Interviewee: B

GK: Good afternoon Batandwa. Thanks very much for agreeing to this interview. I would just like to ask you a few questions about your planning of the section on reactions of metals to oxygen, so I am going to ask a few questions, but if you want to add anything else, ask any other questions, please feel free.

B: OK

GK: So firstly we are looking at topic: Reactions of metals to oxygen. What do you think the main ideas are that you need to tackle in that section?OK. One of the things is to reinforce the idea of the chemical reaction, because it is not – I mean they are not so familiar with it. They have done it but they are not so familiar with it. Also the other issue is the balancing of the equations will be reinforced in that topic as well. The other thing is we look at the products and then we check whether it is basic or acidic. The use of the litmus paper and all that, so that is what we are going to do. It must dissolve that in water and see how it is like. Those are the main ideas. The other idea is the whole idea of the scientific investigation. We have done a section on reactions of metals with water, so I think from there they will get an idea of how to get data and report the data and then later on to write a scientific report based on that. So, when they come to this one, they start to look at the quantitative aspects. They can measure. We are going to do it with magnesium metal. We measure the strip of magnesium metal and then we try and see how it reacts and then at the same time, we are going to see the products and analyzing those products.

GK: So if I can just check if I am correct. You are firstly going to do an investigation on the reactions of metals with water?

B: Yes, in fact we have done that. Ja.

GK: So is that what you did in the lesson yesterday?

B: Yes the reactions of metals with water. So, that then gives them an idea of how to report and all that. Then after that they will do something of this nature.

GK: So you are referring to a worksheet?

B: Yes a worksheet, sort of on that.

GK: So will you be giving them that in the next lesson?

B: No tomorrow. Today we will try to look at yesterday's lesson and see how they can take that information and present it in a scientific report.

GK: Right, so one of the first ideas you mentioned was the whole concept of a chemical reaction. Now what do you intend learners to learn about the chemical reaction?

B: The properties of the reactants they will be different from the properties of the products. That they must get clear there. Also that during the chemical reaction, chemical bonds get broken and new bonds get formed. That is what I was trying to do yesterday with the models. Somehow. So that is the main idea about the chemical reaction. The other thing is about the balancing, which I was also trying to put across yesterday. Some of them might have picked it up, but some of them still need to learn more about that. So we will touch it again today.

GK: So have you covered balancing of equations before at all, or not?

B: Not really. We haven't covered it at all. According to the schedule we should have covered it sometime last term, but we didn't get chance as the other topics took longer.

GK: OK, that is fine. Why do you think it is important for learners to learn about breaking of bonds, making of bonds that you spoke about?

B: It is important because as it is the whole idea of chemical change really. In a chemical change they need to know that some bonds get broken and some get formed and also the properties. They need to know that now you form a gas from a solid and a liquid and all those type of things.

GK: What else do you know about chemical change that you don't intend your learners to know?

B: There is the idea of exothermic and endothermic and spontaneous and non-spontaneous, which in reality at this stage I think it will be hard for them. Maybe later on they will get to learn about that.

GK: What difficulties do you foresee when teaching this whole idea of chemical reactions?

B: The problem is that you cannot see the atom. That is one of the biggest problems. There is a lot of imagination involved. So that is why we end trying the models as it gives them an idea. It is not exactly perfect, but it gives them idea of what happens.

GK: What do you know about the learners that will influence your way of teaching chemical change?

B: These particular learners are a bit of a slow learners. It is a hassle. That is why I land up using models. It is a hassle. With bright kids, it might not have been necessary to use those models. Showing them how to balance and all that. Yesterday they could actually see if for every two atoms of lithium combining with two molecules of water and forming lithium hydroxide and one of hydrogen, so they could actually visualize it somehow.

GK: You say that in this class that you are teaching – that they are a difficult class.

B: It is. Most of them have been promoted not because they passed but because of age-wise. From grade 8.

GK: How come you got to be teaching that class? How did the time table work that you are teaching that class.

B: Normally I teach Grade 10, 11 and 12, but because we are two there and from the experience of last year, they reduced the numbers doing Physical Science. So most of them moved to other subjects. Because we noticed last year that the Physics paper in Matric, it was a difficult paper. So the objective over time is to reduce Physical Science and then maybe increase History as it was a 100% last year.

GK: Is that not a problem if you are a Dinaledi school though?

B: It is, but the problem on the other hand, is we have been saying to them that if we are going to focus on Mathematics and Science only, then we need to do some screening if we are going to take those kids. But then they seem to refuse us going out to look for kids who are able to do Maths and Science. There are some kids who come here and maybe they have failed natural science in Grade 7, but they have passed the other things. Their reports say they have actually passed. So we take them. To expect them to do Physical Science at times is a bit too much.

GK: Sorry, coming back to the idea of chemical change and chemical reactions. What teaching procedures will you use to teach the idea and why you choose that?

B: It is a combination of things. The best would have been to have them to do more practicals and all that. But the issues there are too many of them. There are about 50 something of them and sitting with those and trying to conduct a practical with them. Previous experience has shown it is a bit tricky. One could actually maneuver that with a relatively good class, let us say of a selection of bright learners who are focused. Most of them are not and will try to steal some chemicals and try to do some naughty child things on the side. That is the challenge with a class of that nature.

GK: But listening to you what you said earlier you decided to use the models to show them the whole idea of chemical change and you used the experiment yesterday with the reactions of metals with water as part of it. What other ways are you thinking of doing the rest of the section then?

B: The other part is for me to see how they will do the other two. Because I gave the example of lithium and I actually balanced it. I did the chemical formulas and all that. But I didn't give them the example for sodium and how it reacts with water to form sodium hydroxide and hydrogen. Also I didn't give them potassium. Depending on how the outcomes of that are like, it will inform my teaching.

GK: You also spoke earlier about the idea of the scientific investigation –

B: Yes, yes. I don't want them to do it in class. I will give them it to go and do it at home and then I will get it and I will have a look at how they have presented the information. So, for that scientific investigation, I am hoping that they will put it into five categories, the **<u>aim</u>**. I am interested in the aim. I am also interested in **<u>the apparatus that we used,</u>** the things that we used. So they must be able to remember some of those. If possible, they can draw some diagrams to express that. Also I am interested in the **<u>procedure</u>**. Whether they can explain really what the procedure and method is. Then I am interested in the **<u>results</u>** and the interpretation of those results. The results are what they were reporting yesterday. They must maybe make tabulated in a table or put it in whatever way they can think is best and then come with a **<u>conclusion</u>** of some sort. If you react and put one metal with water, what happens? They must be able to say a metal hydroxide comes and hydrogen always comes. That is the type of conclusion I am expecting from them.

GK: How will you check learners understanding of that and whether they have understood what you have tried to teach them or whether they have some misconceptions? How will you actually access that?

B: A small test you know. So whether a home test or actually a test in class. But with the time constraints, I think I might tomorrow give them a home test and then collect it on Monday. Just to check how is there understanding is. It is not a perfect way because they can actually ask from others. It is a compromise at the moment.

GK: Coming back to one of the other big ideas that you mentioned and that is the whole idea of balancing the equations. How do you think you are going to go about teaching that?

B: The equations. I am going to give them more problems. They must practice that. Because that is a skill that you don't get to understand in one day. So, they will have to practice that. There are more sessions where they will actually have to practice balancing of equations. Up to a point, I will be going around checking that until I am satisfied that they know balance.

GK: Why do you think balancing of equations is important?

B: It is important because if you look at the law of conservation of mass, it is actually based on that the equation must be balanced.

GK: What was the other big idea you said? It was chemical reactions and balancing of equations. What was the third one?

B: The other one I was saying is for them to be able to check the product on whether it is acidic. They have done acids and bases in grade 8. It is good for them to apply what they know in another scenario. I think that this will be nice for them to do.

GK: Right anything else you want to tell me about how you have gone ahead? How have you gone about planning the section and what else you intend doing?

B: I think we have discussed roughly, like today I want them to use data they collected yesterday and present it in a scientific report. Before that we analyze how they have they have actually completed the other two reactions. Then they must write that scientific report and then I think that is fine. After this they must do another experiment on metals with oxygen. Specifically, I want it to be a little bit more quantitative now. For them to be able to measure the mass of either that magnesium ribbon and then measure the ash that comes out and stuff like that and then they will see what happens with the mass and all that and interpret it. Because they will have done this fact and it will be a little bit easier to apply then.

GK: Thank very much. Is there anything else you want to add?

B: Nothing

GK: I will probably have to do another interview after the teaching of a few lessons, if you don't mind?

B: No, that is fine.

………………………………………………………………………………………………………Continued……………………………………………..

B: Because we are going to set our own exams, we thought to just rush into this reaction of oxygen with metals without them knowing the period table; it was going to be a little bit problematic. So in our first meeting we decided no, we are going to give them the period table in order for them to know the first 20 elements. We are looking at them understanding for the grade 10 going forwards. Also for them to understand the concept of an atom, an element, molecules, compounds. So that is what we have done so far. From there we have gone into the reactions of metals with water.

GK: OK. After that you are going into the reactions of metals with oxygen. So in your planning, you are not following the prescribed Grade 9 work scheme for this year. It seems as if you have adapted it to suit your own needs.

B: Yes, we have adapted it to suit our own needs. They actually said so, because this is a lot. It is very hard for everyone to finish everything that is prescribed here. Next year they will also look at it. That is why they couldn't set a common exam on this. They sent a circular to say that schools can set their own exams this year. But at least one thing that is different from last year is that the CTA's are no longer there. The CTA's have been substituted by our own exams. Then next year, with some bit of more workshops, so that they can standardize everything, revising this a little bit. It can be standardized to a common purpose.

GK: All those sections that you mentioned before, the periodic table, atoms, elements, reactions with water. Is that part of the Grade 9 syllabus?

B: We used to do it. I don't know when they released that document why they couldn't focus on that. I don't understand how someone does metals without understanding where they are coming from with the prototype. Maybe it is our own bias. That is how we looked at it.

GK: You say we. Do you mean the Grade 9 teachers? Are there two grade 9 teachers?

B: No there are three of us.

GK: So was your head of department there as well?

B: No he was not there. There was just the three of us, but we spoke to him about it.

GK: Thank you very much

B: OK

Transcription file name: Lebona lesson 1

Teacher: **TEA**:

Learner: **LNR**:

Learners: **LNRS**:

[ongoing background noise/bad recording noises]

TEA: [class bell ringing] Please be careful of those burners there. [general class noise of students moving around, talking and getting seated] Right. I really do think [indistinct] it says here, this is the first [indistinct], but the other is… let me just [indistinct] you. I want you to sit down, right, I hope you are [indistinct] [background noises, coughing] for now and I'm [over talking] [indistinct]. Right, [indistinct] first.

LNR: [speaking amongst themselves]

TEA: Okay. Who knows what do we going to do today?

LNR: [speaking amongst themselves]

TEA: Hm?

LNR: [indistinct]

TEA: Yeah, you are going to do an experiment. I gave you the worksheet there. What is the experiment about?

LNR: [indistinct]

TEA: What is it about? Okay, what's, what's our aim, what is the aim? What is the aim of the experiment?

LNR: I would [indistinct] [over talking].

TEA: To find out how the temperature of water changes [class and teacher together] when it is being heated. You understand? So, as we heat ice and water how will the temperature, I mean, how will the temperature change as time goes along? That's what you are you going to see. Do you understand? So, what you going to do on this worksheet, before you start, right? Before you start you are going to group yourselves. You are going to sit in your groups and I said to you groups of four, five or six. And as you can see there are work stations there. There are different points that are going to seat to six people next to each on [indistinct] are going to be there, right? And then, when you are in a group I want you to tell me what you think will happen when we heat the mixture of ice and water, and that is your hypothesis, you can see there, where is it, what page is that?

LNR: [speaking together]

TEA: Yes. Page 1 you've got the aim there, then under the aim you've got what? Hypothesis. Now, how does the temperature change as we heat ice ? What do you think will happen? Is the temperature going to go up or is it going to be constant, if it doesn't, I mean, wouldn't change or is it going to go down, right? That's what you're going to tell us because remember the hypothesis is what? What is the hypothesis rule whatever [over talking by class] hypothesis is?

LNR: [speaking together].

TEA: Sorry?

LNR: [indistinct]

TEA: It's the answer to the question, but what?.... Your guess right? At the moment you're not doing the experiment. You are just guessing that, okay, when I heat ice the temperature is going to go down or when I heat ice the temperature will go up or will remain as it is, we don't know, right? [sounds of learner accent] So, we are going to test that for this value [indistinct]. You understand?

LNR: [sounds of assent]

TEA: Right. So, that is what we are going to be doing and now, very important, when you get to your work stations there you have already there a thermometer inside the beaker with ice, right?

LNR: [group yes]

TEA: You read, you read off the temperature on the thermometer there. Okay, now, how do you read this thermometer? On the thermometer you've got zero there and then you've got one, two, there, four, five, six, seven, eight, nine, and 10. It's 10 there. 10 degrees celcius, and then another 10 lines, small lines, and then 20, you see? So what would be this small line here? Give me a zero, what is this line?

LNR: [class together] One.

TEA: One, right. So, don't make mistakes when you read off the temperature of the thermometer there. You understand me?

LNR: [class together] Yes.

TEA: And the other thing is, and when you read off the temperature of the thermometer make sure that you don't make any error, right? If you are reading, if you are taking the measurement, do not look at the thermometer from the top like this. Do you think you are going to get the correct measurement?

LNR: [class together] No.

TEA: No. Or you hold it like this. Are you going to get the correct measurements?

LNR: [class together] No.

TEA: How are you going to hold, how do you hold this so that we can see, you can get the correct measurement?

LNR: [class together] Straight.

TEA: Straight to your eye, yes. It must be straight to your eye like this. You see you hold it like this. It must be straight to your eye,so that you aree able to see, the correct measurement there, you understand?

LNR: [class together] Yes.

TEA: Yes. So, those are the things you must take into consideration. And… right, then you've got the table there on page number two. You've got a table on page number two, where now you're going to write your results. So what will be your results. The temperature that you're going to measure on the thermometer, after every minute, you see here, on the first column that's the time in. So you are going to time your work. And means , at zero, it is before start, at zero, when the time is zero before you start, what is the, what is the temperature, which is when you get here, the first number up here, you must take the thing you must do , you must take the readings on the thermometer, right? And now, after that you put it on there on the hot plate here, on the electric burner and now you switch off, you switch on your… stop. How many of you have got cell phones? I forgot to tell you to bring in cell phones, hm? How many people?

LNR: [indistinct]

TEA: Okay. So, if you can make sure that at least in each group you've got one person with a cell phone, right? Then you can be able to send it through the [indistinct] right?

LNR: [class together] Yes.

TEA: Yes. And then after every minute you'll take the reading on the thermometer. If you don't have the cell phone, there's a clock there, see that clock?

LNR: Yes

TEA: Yes, there it is. So, what you can do… well, you don't have somebody [indistinct] but you can wait until, you see that, that minute hand, the second hand, the one that is moving, you see?

LNR: [class together] Yes.

TEA: Now, when it, when it, when it's at 12, then you know that it is going to start a minute, right, and then you take the reading there, you see it's at 12 now. Take the reading and then wait until it goes, it turns around until it gets to 12 again, then you take another reading you see? That will be a minute if you don't have the …

LNR: [class together] Cell phone.

TEA: The cell phone. So you're going to take about 15 readings there, because it says here [indistinct] from zero up to 15 minutes.

LNR: Yes.

TEA: That's maybe the time when you're doing the work will be [indistinct], right. So, that is what [indistinct]. Then afterwards with your results, and those are going to be your results then, you are going to plot here a graph, a line graph. You know a line graph right?

LNR: [class together] Yes.

TEA: Yes. So, that will be your, y axis, and then… okay, you know where to put the temperature and you know where to put the, the what, the, the time? You see, you have dependent and independent variable here, right, and you know on the graph, where you are supposed to put the dependent and independent? What is the dependent variable? What did we say the dependent variable is? We did this a long time ago [children's voices outside]. What is the dependent variable? Who still remembers? Yes? What is the dependent variable? Let us not waste time. That is what we started, we still have [indistinct] okay. What is it? Yes?

LNR: [indistinct]

TEA: The one that you measure, good boy. The dependent variable is the one that you measure and then the dependent variable is always, on which axis. a long y or a long x? [children's voices outside the classroom], hm?

LNR: [indistinct]

TEA: Along the y axis, yes. So, what you are going to measure, what you are going to measure now, will be put along the the y axis.

LNR: [class together] Axis.

TEA: And the dependent variable is already given to you there, so we put it along the x axis is simple, you understand? And then afterwwards I am going use the rubric there to mark your work and now listen [indistinct] um, analysis. [indistinct segment]. Number one says, what happened to the temperature of the water as the ice was melting? So, you are going to note this down as you are doing the experiment that's very, very good, right. So, as the ice was melting how did the temperature change? And number two, what happened to the temperature of water as the ice, I mean, as the water was boiling? So, you are going to, we are going to take measurements up until the water boils, right, and then, at that moment also note how the temperature changes. And number three, what do you think at the heat energy supplied was used for? Both during melting and during boiling. Remember you are applying the heat, that's why you've got, you've got the electric burners there, right? So, you are supplying heat energy to ice so, where do you think that energy was going? So, you must think about that. And number four. What type of energy is increasing when ice melts? So, when you heat the ice, what type of energy was being increased there? And when you conclude there you are going to say, when the energy supplied is mixed up with water and ice initially that is at the beginning. At the beginning what was happening? At the beginning the temperature was increasing or it decreases or it didn't change, right, so you circle the correct letter there, I mean, the correct word. Okay, now, the heat energy supply is used to increase the ?. What type of energy using must increase the air of the particles as we were heating, and this process of ice changing into liquid is called? Do you know what it is called? If ice changes into liquid, into ordinary water. What is that, what do we call that. And then the last thing is, you are now going back to what you said, your hypothesis. So, what have you found with your results? You see? Is your hypothesis right or is it wrong? Remember, I always said, I did say to you it doesn't matter whether your hypothesis is right or wrong, because the hypothesis is what, is a guess, right? So, after carrying out the experiment then you are going to see whether your guess was right or wrong…

LNR: [indistinct]

TEA: Was wrong. Right. [noise outside the classroom]. Okay, so [indistinct], so you are going to conclude by drawing the graph as we [background noise] it talks about these [indistinct] to see what's, what kind of a graph you are going to have. Right. Then, let's go to our work stations. So, you are going to group yourselves, right? Just go to the work stations there, go to the different places. [background noises of furniture moving]. You've got the drawing space. [general noise of the class moving and talking] There's one here. [general noise of the class moving and talking] And we take the readings. And take [indistinct], when you take the readings please don't take the thermometer out of the water, or you will get the wrong one, you will get the wrong readings [general noise of the class moving and talking] Right people, you should be taking your readings now, it [indistinct] minute. The time is zero. [general noise of the class talking amongst themselves] And if you [indistinct segment]… [general noise of the class talking amongst themselves]. Mamele, Mamele Who doesn't know how to take the reading from the thermometer? [indistinct] [general noise of the class talking amongst themselves] You should have taken your first measurements at zero. At zero and [over talking]

LNR: Yes, teacher, I'm going to start now

TEA: What is the best reading Lebo?

LNR: What?

LNR: I don't know what.

LNR: [indistinct]

[general noise of the class talking amongst themselves]

LNR: [several pupils talking amongst themselves close to the recording apparatus] we are working with groups

TEA: [indistinct]

LNR: [several pupils talking amongst themselves close to the recording apparatus]

TEA: We said, we said [indistinct]. Can you pay attention please. This is the thermometer. What he has here, what is this?

LNR: [class talking]

TEA: Hm?

LNR: [indistinct]

TEA: It is an?

LNR: Blood.

TEA: What?

LNR: [several pupils] Blood.

TEA: Blood? [sounds of laughter] Okay, this is the bulb, mamele this is the bulb from the, [indistinct] this is the bulb, the bulb of the thermometer, right?

LNR: [Whole class together] Yes.

TEA: And inside it we've got this red liquid substance, and that's mercury. You understand? That's mecury. So now, when you put this bulb or when you heat it, when you put it in the water, in the water or you heat it, you are going to see, you are going to need to see this red thing there; that looks like blood, like life, its mercury, right? It's mercury that's in there. It looks like [indistinct] [over talking], so you've got to go up when you heat this part, you understand?

LNR: [Whole class together] Yes.

TEA: And where do you get this, where do you take the reading? Do you take the readings here, up there?

LNR: [Whole class together] No.

TEA: Where you [over talking]?

LNR: No. [0:19:52.0 someone talking in the foreground in Xhosa] no give me

TEA: Until you get the reading from. I don't think you are going to be [indistinct]. Okay. So, the first reading you should have taken it by now. [class members talking in foreground]. Did you take the first reading?

LNR: [0:20:13.3 several pupils speaking in Xhosa] move away[general talking in room]

TEA: [indistinct] [unable to hear several comments by the teacher due to the pupils all talking] Now, has everybody taken the first reading?

LNR: [Whole class together] Yes.

TEA: Now hase evrybody taken their first reading? Which will be [indistinct]. [class all talking] Okay, then if you all have your first reading the moment you put that beaker on the electric burner there, you'll switch your stop watch on. You'll start to… then [indistinct segment] [general talking in room] [siren] [general talking in room] Okay then mamele, mamele, mamele, look Stop wasting time. Then, when you have taken your first [indistinct] you put this on that thing.

LNR: Oh.

TEA: Put it here [indistinct] [over talking]. [general talking in room]

LNR: it is wrong

TEA: [indistinct] less noise please noise, noise, noise, less noise.

LNR: stop talking class, please

TEA: Right, so mamela it's a bulb [indistinct] [over talking segment] but it would take a [indistinct]. [general talking in room] 10 minutes right. Who is giving this, who is [indistinct] given time? Hold it like this, right? Make sure that it doesn't touch the bottom. [indistinct] after a minute then you going to read there , after one week, [indistinct]. That'll be fine. Yes, now after, after you stir it then you are going to read that [indistinct], do you understand? [indistinct]

LNR: [indistinct]

TEA: [indistinct] that. Yes, yes, forget about it. Put the thermometer inside the beaker please. Never mind the clamp. Leave the clamo alone. [general talking in room] [indistinct segment] make sure it doesn't touch the bottom here yes. [general talking in room] make sure [indistinct segment] Yes, if you start [indistinct segment]. Must start again now.

LNR: [indistinct] [general talking in room]

TEA: [indistinct] [general talking in room] The small one, the small one [indistinct], you see? [general talking in room] [indistinct] but I did [indistinct] starting [indistinct]

LNR: [indistinct]

TEA: See that, because I think you [indistinct] results there. [indistinct segment], yes. [general talking in room] No, you must [indistinct] the read out [indistinct], because the water's not boiling. [general talking in room] [indistinct]

LNR: [indistinct] the ice? [general talking in room]

LNR: look, those 2 ladies

LNR: what, after one minutes. I'm going to start again

LNR: Uh-ah. No, wait, uh-ah.

LNR: you can take this one

LNR: [indistinct] [general talking in room]

TEA: [indistinct] [general talking in room] [indistinct]. [indistinct segment] nine.

LNR: Nine.

TEA: Can you remember what I tell you, what I said about your eye? Where is your eye be? say [indistinct] lines. Where should your eye be? Nine should be somewhere here. You see this is ten there. This is ten, so nine is [indistinct], so that can only be nine there.

LNR: [indistinct]

TEA: [indistinct] but look, it is zero there, 10, 20, 30, 40, 50, 60, 70

LNR: [teacher and pupil together] 50, 60, 70, 80.

TEA: 80, 90, 100 there.

LNR: Okay [indistinct].

LNR: my number is wrong

LNR: you are lying

LNR: give me now

LNR: It's a [indistinct] of the, it's [general talking in room].

TEA: Where were you when I was showing you how to use the thermometer there?

LNR: [indistinct]

LNR: [over talking] no, no, no [several pupils talking together]

TEA: [indistinct] Sure, what has it?

LNR: Nine.

LNR: Two, two. [general talking in room]

TEA: [indistinct]

LNR: [indistinct]

TEA: But [indistinct segment] right there. [indistinct] You take the first reading. [indistinct] before you move there you must take the reading, point [indistinct]. [general talking in room] [indistinct] you can just use your hands, because I mean that's water now, but it's not a [indistinct]. Oh, you take more ice, you can just get more ices and put it in and take the reading.

LNR: [indistinct] OK, you can start again [general talking in room]

LNR: [several pupils talking together]

TEA: [indistinct] but I showed you there. Where were you when I was showing you there? Hm? 10 small lines [indistinct] and this is small line [over talking] [general talking in room]. Are you going to start?

LNR: Yes.

TEA: There's ice there. [general talking in room] [indistinct] just put a little bit of water [indistinct]. [general talking in room] [indistinct] can you tell me what is [indistinct]? 1, two, three readings. [general talking in room]

LNR: Sibusiso, what do you want?

TEA: [indistinct] that ice there. [general talking in room] [indistinct] water [indistinct] cold water. Cold water. No you started there [indistinct] You did. No, you have [indistinct] where did you think [indistinct] there's [indistinct]

LNR: [several pupils talking at once]

LNR: Put this away

LNR: [laughter] Now I'm going off [indistinct]

LNR: [several pupils talking at once]

TEA: Okay, just write there you've got 90.

LNR: 90?

LNR: don't smile

TEA: And then I think you are done.

LNR: [several pupils talking at once] you finish now?

LNR: No, it's not.

TEA: [indistinct]

LNR: [indistinct] it's two bars

TEA: Careful. Right.

LNR: [indistinct]

LNR: I'm going home

LNR: [indistinct] please

LNR: It's hot

LNR: [several pupils talking at once]

TEA: That’s really important. Okay, mamela, mamela, mamela please finish up, and when you’ve got those results [indistinct] [sounds of sh’ing]. When you’ve got those results, then you can go, then we’ll see when we are going to draw the graph. Can draw the graph, you can draw the graph tomorrow…

LNR: It’s going to get [indistinct].

TEA: Not today.

LNR: [indistinct]

TEA: Oh, yes, on Friday.

LNR: [indistinct] we are a charity.

TEA: [indistinct]

END RECORDING

Transcription file name: Luvo post lesson interview

Interviewer: GK

Interviewee: LN

GK: Hi good afternoon Mr Nkhahle, Lebona thanks for allowing me to interview you. Today is the 28th of July. Thanks very much. I just like to ask you some questions concerning the lesson that I video- taped. Actually there were two lessons. In the first lesson the learners did the practical and in the second lesson they continued manipulating the data in class.

Mmmmm, just to start off with, just as a general overview of the lesson what did you think worked well what did you think did not, just what your sense was of those two lessons.

LN: Ok hmm. I think what went well was the fact that you know in the end learners were able to collect the data that was expected of them to collect. And even drawing the graph and interpreting it. Hmm so the fact that they were able to do the experiment, I think I would say that is what worked well. And even when they were working as a group you could see that they were working together I would say maybe even helping each other out which is what I was also expecting them to do, even when it comes to drawing the graph you see, so they were still working together helping each other doing that.

GK: Ok. Anything that you think didn't work well?

LN: Ja, I think the time that I had thought they would finish these … it took them you know a longer time than I had expected and the other thing is you know, during the experiment some of them thought the results that they got were strange and then they ended up changing, manipulating the results somehow like some groups when the temperature was constant, when the water was boiling you know, then I was expecting them to notice that the temperature won't change but then they thought that was wrong in terms of it keep on increasing and then ended up adding more ice to that and then ja they had to start all over again. I think there was one group which repeated the experiment I think three times but then and they ended up you know getting better results.

GK: Ok. With this experiment, with the practical, what were you expecting the learners to learn by doing this activity? What were the main objectives?

LN: Ja, I'll say they to be able to notice that when there is a phase change you know the temperature is not you know increasing or decreasing, it remains constant. That's what I wanted them to see and then also to think also as to what was going to happen why was that the case. I have not taught them before about the latent heat of fusion, but I just wanted to see this is what is happening and I and them to start thinking about why this is happening that way, using the knowledge they got, when we were discussing the structure of matter. Because at that moment I was expecting them to say. OK, they could, they knew that when, when, when they were looking at the particles of (indistinct)…there was something that I was showing them the model I was showing them of how particles are arranged and they could see how they were moving but very slowly in solids but in the case of a liquid the movement was faster which means now in the case of a liquid now they have more kinetic energy than in the case of the solid. And where would they have got that kinetic energy from. From the heat you see. Ja, so that is what I wanted them to understand. And also to , to have practical skills to improve their practical skills you know. Like how to handle the equipment, how they should behave when they are in the lab and also they how they are conducting themselves when they are working in the lab and also how the conduct themselves when they are working with other people. There are so many skills. Also graphing skills, how to put the data in the form of a graph and after how to interpret that. So I was expecting them to gain even the knowledge you know.

GK: Right so there was the scientific knowledge as well as a number of different skills.

LN: Ja

GK: Right, mmmm why did you decide, and maybe you've answered the questions, you can tell me if you did. Why did you decide to do a practical activity to achieve these particular learning objectives. Could it have been done differently without doing a practical.

LN: Ja, it was to make learners experience, you know, these, or to see it rather than just talking and telling them in class that OK this is what should happen if you heat ice then the temperature will increase for some time then start decreasing because of one, two three ………. so I wanted them to do it themselves and then to see that.

GK: What was the advantage of them seeing it for themselves ?

LN: I think they are able to appreciate it you know more than when one tells them and with that, what they see is able to stick into their minds for a longer period than when they are just told because they see that the experience and they work on it. It's a hands-on activity so it. helps them to know it better.

GK: Ok. I noticed that at the start of the lesson that you actually read through the whole worksheet with them before allowing them to start. Ok, now why did you decide to do this?

LN: Ja, to make them understand clearly how they should go about … this practical. For some might not understand when it comes to reading what they should do, that is why I had time to explain everything to them. So that they could understand and know what to do.

GK: Ok. Then, one of the, in terms of manipulating equipment and so on, one of the, one of the problems I picked up was the reading of the thermometers. And you obviously picked it up yourself. Do you maybe want to just elaborate on that?

LN: Ja, I think that there were many challenges when it comes to reading the thermometers because some learners were reading it from, you know, from the top or from the bottom you see , their eyes were not perpendicular, straight to … reading, that is what I wanted to stress that is why I explained before that they should make sure that their eyes are straight to the mercury so they can get the correct reading. I think this is, that is one of the common mistakes that eh, normally people make. Also when it comes to the scale on the thermometer, just to show them how it is scaled to that they don't make mistakes, because there were some who were thinking ok there are commas, one comma something and I had to explain (indistinct) … they can be able to use hmm to use it you know to use it properly.

GK: because you obviously anticipated that problem because you explained beforehand the scale on the board but obviously some of them didn't quite pick that up.

LN: Ja

GK: An I think one of the other problems that you picked up with the reading of the temperature was that the bulb was on the surface ..

LN: Yes, the bulb was touching the side of the beaker or somewhere they were letting it touch the bottom of the beaker. You know and that was wrong.

GK: Ok. Now just a comment about time. And here I referring to a couple of different things. Firstly in terms of just planning the practical, setting it up, clearing up from your side the time it took for that and then also you already mentioned some of it, but the time it took for the learners to do the practical. So firstly tell me how much time it took for you to prepare and clean up and so on before and after the practical.

LN: So terms of exactly …

GK: In terms more or less Did it take long or

LN: It took me a long time because even beforehand I had to do the experiment myself so that I could see what problems learners would encounter and roughly how long it might take. Then the settings on the electric stoves, ja what settings should be on the stoves. Things like those. And then even you know setting up the apparatus and after doing the experiment I had to clean up the lab so that whoever comes after me will be able to find things in good set up. So it really took me some time. And the fact that I even did it with three classes. It was really time consuming I would say.

GK: But worth the effort do you think? Do you think it was worth the effort.

LN: Ja, it was worth it really because what I wanted my learners to experience, to know and to see, ja I think I achieved the goals.

GK: That's great. Then just on the time it took the learners. When I looked at your lesson plan, you said you expected it to take about two hours. Now, we, you did the lesson in the prac and then the follow-up lesson that must have been maybe 1 ½ hours, how long? Or maybe two? Because that Is that what you expected or did you expect them to do it quicker?

LN: Ja, roughly, that was what I expected.

GK: Because in the second lesson, towards the end of the second lesson, at the end of the second lsson you said to them, they hadn't quite finished right, and you then said to them they had to complete it at home and hand it back. So did they in fact hand it back when you saw them next?

LN: When I saw them next. In fact I had three lessons.

GK: Ok you actually had another one.

LN: So which means this time was not enough.

GK: Now I was present in the first two, what happened in the third lesson?

LN: They were just completing, just completing you know the task of drawing the graph and answering some of the questions. Because it was a group work, so sometimes it was difficult for them to do it at home because they are staying at different places so the only time that they would do this was either during my class or maybe when they are school during lunch hour or after school which is difficult because sometimes students always want to rush home. During lunch time they want to be outside, so I had to give another lesson for them to finish up the activity.

GK: And then that third lesson, and did you have a discussion about the results at all or not?

LN: No not yet. You see what I was just doing, just like in the previous lessons, I was just walking around you know and then try to see how they were answering the questions and how they were drawing the graph you know. Asking them about their results, ja and trying to help them out.

GK: Right. Then just on the group work. You said earlier that, you know that they work quite well in a group although during the lesson you needed to talk to them about, one of the groups I remember, you actually had to talk to them about how they are supposed to be working together in a group. So generally in terms of group work do you think that, that they know how, what is expected of them when working as a group?

LN: Ja, in a group, you know its, sometimes better because amongst them there will be one of the learners in the group would understood what the teacher had said and could explain to the rest of the members. Well you do know that people have different characters you know there would be those that pull the group back, but there will be some people that are serious about the work, but in the end the groups effort, they will take part. And finish the task.

GK: And while doing that actual practical did you find that they assigned roles to different people or do you think that needs to be addressed or do you think it worked quite well?

LN: Ja, you know they, the fact that it is a group work and people have got different skills. I remember I was even telling them that since there was only one paper , they must choose someone with a very good hand writing to write down the results and when it comes to drawing, someone that can draw well, and I am sure that amongst them there might have been somebody who was able to answer the questions quite well and so I would say they came up with different skills to contribute to the groups effort at the end.

GK: So generally the group work worked quite well.

LN: Ja, I think I like group work, I like it. Most of the time I give them group activities. Even if it is an assignment. So most of the time I will give them group work assignments.

GK: So have you given them group work assignments before this?

LN: Ja

GK: So do you think they are improving in the way in which they actually work together.

LN: Ja, I would say they are they improve because the results or the marks that they get you will see they are better and those at the end they are not always in the groups there would be some who may be absent on that day and end up being the only ones who were not in the group and if you compare their work you will find that its poorer not as good as the ones that are in the group.

GK: Ok, right. Then as far as the graphs are concerned, in that second lesson and in the first lesson you guided them in terms of drawing the graph. The dependent variable, independent variable. Have they done activities where they had to draw graphs before?

LN: Ja.I think with, talking about the natural science before they would do the scientific investigation because they had to draw a graph there so I gave them homework, then I marked it, then I discussed it with them, showing them what they should have done. And then after that I gave them the practical investigations. In fact I was saying even before that, they went to classwork activities that were involving the graphs. One they had to draw it and the other one they had to interpret. I gave them the data that was portrayed in the form of a graph and they had to interpret that.

GK: That's great.

LN: That one now the scientific investigation. Even in the March test, I always put a graph in the tests.

GK: That's good. I will come back to the assessment later. This is, you mentioned this one before. The fact that one of the groups added the ice when they saw the temperature did not change. And you have commented on that. So what does that tell you? Ja, what does it tell you, what could you or should you do to avoid that situation?

LN: Ja, I think it's the matter of telling them to be as honest as is possible when they are carrying out the practical they shouldn't think that the results will be you know like this which you know, if they don't get the results they expecting now they start manipulating the experiment and changing it. Ja, I remember even if , I forgot to mention this. The fact that they know or it is always been said that water boils at a 100 degrees Celsius. So some were just writing 100 there but when I got to the group and looked at the thermometer, you would see that it was it was still, I mean the thermometer was showing 98 or 99, somewhere there. But the fact that they know this story of water boiling at 100 , they put 100 there. So they were kind of expecting that change in the results .. so what they thought happened. Ja, but some were getting results like 100 and something. So those were the one that the bulb thermometer, the glass . But still they couldn't even think about the fact that it is always said that water boils at 100 degrees and just writing that. But I think they were being honest they didn't know why the thermometer was showing that temperature But then I told them that they were holding the thermometer wrongly.

GK: Ok, then in that second lesson you picked up that some of the learners had been absent and had not done the practical and you said to them they needed to come back and do it after school. Did they in fact come and do it after school or not?

LN: Ja, they did come. Although not all of them. There were some that came. Even those that were making mistakes, so those that put ice in the water, I asked them to repeat the experiment. Those who put the bulb of the thermometer against the side or bottom of the beaker, they repeated.

GK: And they were quite happy to come back ?

LN: Ja they were happy and there was one group of girls who got I would say average results, but then they wanted to come and repeat the experiment because they wanted better results and in the end they ended up being the top in the class as they got the highest mark in the class because of the fact that they kept repeating it.

GK: That's great. That's really nice to know that they are so keen.

LN: In fact I told them that is how scientists work you see in order to make their results better they keep on repeating the experiment.

GK: That's exactly what I was going to say. And that is in fact a very good learning experience for them and you know for them to realise that that's how science actually works. Any way lets continue. I already asked you this. When I asked you if you did this with another class you said you did. So when you did this with the other classes did you change anything in any way compared to the first lesson?

LN: I will say not quite so you because I remember in the first experiment I used the, a clamp .. so that they do not move the thermometer around but I sensed that that might be a problem you know when it comes to reading the temperature. Because I might have put it too high for them or too low for them and then I ended saying to them they must hold it by their hands so that they would be able to ja put it at the level. That is the kind of thing.

GK: So otherwise everything else was fine it worked well with the other classes as well?

LN: Ja

GK: Did you take more or less the same time with them?

LN: Ja, more less the same time.

GK: Alright, then I was going to ask you whether you marked the work yet. If you did what it actually revealed about what they learnt.

LN: Ja I have marked it. Ja I could see when I was marking but they did understand what it was expected of them. Even the graph, which was the main thing they drew it well. Most of the class drew it well.

GK: And the questions, they answered quite well?

LN: Not all. Because I think … the third question says 'what do you think the heat energy supplied was used for?" both during melting and boiling. So they, I think quite a few talked about the increase in the kinetic energy and I thought it would be difficult for them because [indistinct]

GK: But did any one get it right?

LN: Ja, one did.

GK: So that's good so you can actually differentiate between the really good ones and those who are not. That's great.

Ok so based on what you said it seems that this. Was it the first time that you did this activity.

LN: Ja

GK: Ok, and so it seems that it worked well and is it something you would repeat next year if you are teaching Grade 8.

LN: Ja, I will.

GK: Alright then. Just the actual worksheet, that you gave them. Is that something you developed yourself or is it something you got from somewhere else.

LN: Well I think most of the work here is mine, you know like the rubric, the graph but the idea of melting of ice came from the work schedule

GK: But structuring of te … that you did yourself.

LN: Ja

GK: That's great. Anything else that you may want add about the activity?

LN: I think it went well just like I have said and opened the eyes to many of my learners . I think I mentioned that point of the boiling point of water but its not always that water will boil at 100 degrees it will depend on the surrounding conditions and I was able to stress that to them. They understand now why they were not getting 10 , because all of them thought it was going to be 100 so the ended up changing their results. I think the other problem that I experienced which I did not mention there was when it was coming to thermometers are not … it had to do with the calibration of even when I was doing it you see it wasn't really giving me in the zero degrees that I was expecting .

GK: So was it slightly above zero?

LN: Ja, slightly above zero.

GK: Ok

LN: But then they could pick up, they could pick it up there that the temperature was not changing. The temperature was one degree and remained one degree for sometime.

GK: So they could see the trend anyway.

LN: Ja, what I wanted was that they just that curve for them to come up with it but I was quite impressed with the exercise.

GK: No that's great. Ok I think that that activity was … there are actually lots of learning opportunities there. Even as you say all those like the nature of science all of those kinds of lessons and about the boiling points and so on , I think those are nice learning opportunities for them. So I think that's a really nice activity to do.

LN: Thank you.

GK: Thanks very much Lebona and I have asked you if I could get copies of those maybe once you have finished your marking, you could me me a few scripts so I I could just photocopy.

LN: Your welcome.

Transcription file name: Luvo pre-lesson interview

Interviewer: GK

Interviewee: LN

GK: Good afternoon, …. , it is today the 24th June and thanks very much for allowing me to interview you. The purpose of the interview is just to get your views on the practical work and also to get an idea of some of your … some of the practical work you have done before … ja … so, I am just going to ask you a few questions and if you have anything else to add feel free to do so.

OK, firstly, in school science, what do you think the main, the purposes are for doing practical work?

LN: OK, … you know, there are so many things that you deal with in science which are abstract, you know, to the learners, so I think the purpose, one of the reasons why we do practical work is to make, you know, things that learners need to learn in the class more real, you know …

GK: OK

LN: because they can be able to see, touch you know experience, those things that we normally talk about in class. And, also to stimulate their interests, because I think, like I said, seeing how science works, it's kinds of, it's kinds of it, it kind of stimulates their interest to learn science and … also … it's to really train them, you know, for practical exams in the future, you know. Well, I'm dealing with Grade 8's now who don't have practical exams but in the higher grades they need to develop those skills which are going to help them one day to deal with that … also to improve their skills because, you know, when they are doing practical work they have to observe, they have to communicate their findings, they have to interpret … sometimes they have to draw the graphs … they are thinking also because they have to think critically about, you know, what happens or what has happened or why it has this happened this way …

GK: Is that about it in terms of reasons for doing practical

LN: … the reasons, ja … some might, I might have forgotten some

GK: right

LN: [indistinct] in terms of how it goes

GK: OK

LN: … and I think, OK, and encouraging them to work together, also …

GK: OK

LN: what we call cooperative learning you normally find that in a practical you group them so that they are able to work together and also to improve their social skills, you know, they learn how, how each member of the group, you know, associates with each other, with the whole group

GK: OK, when, when I say practical work, right, what types of activities come to mind or when you think of practical work, what types of activities do you see as practical work?

LN: … I can think of it as, you know, a hands on activity, you know, in which a you know, a learner does something and practical work can not only be based in a science laboratory as most of us think. Because when you think of even the field work it could be practical work when learners go out, observe things, take measurements … take for instance, for instance they can go out and do that practical on photosynthesis which is outside the lab …

GK: right

LN: … or they can go out and study about something which is it needs natural environment, also regard that as practical work. … I think I talked about different [indistinct]

GK: … no, you said field work

LN: … OK, ja, …

GK: which is something …

LN: even the field trips that, you know, we can take learners … out. Is also type of practical activity.

GK: right … anything else? So, when you talk about hands-on activities are you talking about generally groups of students working together …

LN: ja, I mean, doing something, something, something that they do … they doing physically

GK: OK

LN: ja, something that they do physically, because … well, I might come to class and tell them that, OK, … if you combine sodium with water you are going to get this and this and that's a lot of …

GK: right, OK

LN: but at the moment that I put them together, you know, give them the pieces of … the things that I am talking about and then let them do that, that will be a practical

GK: OK

LN: it should be based maybe in a science laboratory. But, if, say, I want them to test soil acidity, you know, outside we would have to go outside …

GK: ja

LN: … which, may be, indicators, we do that outside. That's what I say is a hands-on activity, even though, well, you know, nowadays we also have simulations

GK: OK

LN: ja, we can regard it as a practical work even though we are not using, you know, real materials but the fact that they are being simulated, ja.

GK: OK, I'll come back to simulations. OK, so, it's generally hands-on activities when the learners themselves are involved and you spoke about simulations. Are there any other types of activities which you would consider, from your point of view, practical work?

LN: … so, other than the field trips that I talked about …

GK: and the field trips, ja, besides that. OK, maybe I must ask more specific questions … when, would you consider a teacher demonstration as practical?

LN: Oh, yeah, ja, it's obviously a type of practical work …

GK: OK … right … and then also, when you look at the hands-on practicals, I think there are probably different types of hands-on practicals that … that learners could do or that you can ask learners to do. Right? Maybe there, I don't know, maybe … can you think of different types of hands-on activities that you … that learners could possibly to?

LN: Maybe I don't understand …

GK: OK, maybe you don't understand … if, for instance, and maybe you can just tell me what you have done in the past. A hands-on activity could be where … you give the learner a set of instructions, they follow the instructions, they come up with a conclusion … right. Or it could be an open ended hands-on investigation where, where they could decide for themselves what exactly what it is they wanted to investigate, they come up with an inve … so like a scientific investigation, an open ended scientific investigation. So, I am talking about that different type of hands-on activity. Do you see, have you done different types of hands-on activity activities, have you focussed on any particular type, or, …

LN: … other than those that are guided by, you know, our working class, I wouldn't say yes … because even for scientific investigation I, you see, I guide them … you see, OK this is what we want us to investigate … OK, these are, you know, these are the steps that you would have to follow … OK, I would say, I would normally work with close ended, you know, because of the time that we normally have, because if we leave it open ended, people would have come with different, you know, ideas and then in the end … there are even different ways of assessments … and in that way, that's where the tricky part is … because if I am to assess this one you know using this type of assessment and these ones with a different type of assessment and now, in the end, I might appear as being

GK: right

LN: … [indistinct] normally, I normally, you know, give them, you know, a type of and activity, which would say, it's closed and that, [indistinct] …

GK: now, I know that you teach Grade 8, right, and you may have taught Grade 9, I'm not sure, but do you, would you imagine that in the higher grades that a different type of activity would be more suitable? If you think of the learners at the school, for instance? Or, would they be able to cope with the more open ended scientific type of investigation.

LN: Ja, ja, I think even the level of responsibility, and thinking that's increasing as one progresses from grade to grade. Ja, would think it would be more suitable for the higher grades than on the lower level …

GK: OK, … now, you listed a number of different purposes for practical work, right? Now, and then we also listed different types of practical activities. Do you, do you think there are certain activities that are more suited to particular purposes. Let's takes some simulations as an example, right? Do you think that simulation, you can, you can address all the different, a number of the different purposes that you listed by using a simulation or does it lend itself more to particular learning objectives?

LN: ja, I don't think it covers all the aspects of … ja … the practical work.

[Learner shouts in background]

LN: … because if simulation, you know, is where they can see what's happening. But, in terms of, you know, like, being involved, physically touching, or mixing, you know, it doesn't serve the purpose, I think it serves the purpose of making the learners, you know, know that, OK, this is what's gonna happen, you know.

GK: right

LN: … and [indistinct] OK, then, not that maybe they can get some skills out of it, because, like I am saying, there are no physical, you know, materials or [indistinct] that they can use. Ja, you mentioned about the skills, that one you get from the practical activity. You know, if you take them to the lab, if they do, like if you take them out [indistinct] or into the field or on a field trip, there are so many skills that are involved, you know, like, OK, they have to think, you know, but they also have to touch, see how they can work with materials. So, I would say, yes, different practicals would also, you know, serve different purposes.

GK: OK, so, if you, if you compare the simulation to a teacher demonstration, for instance, right? When, do you think there are certain situations where the one, you would prefer to use the one rather than the other?

LN: Ja, I think … I mean simulation is faster. I mean, something that has been programmed that happens, you know, in this way. So, and I think with it, one of the … it is highly unlikely that you might come up with wrong results …

GK: alright …

LN: … they always appear as it has been set in the book but then if I do something physically I might get, you know, unexpected results [laughs] … you see, just like, when they were doing this practical on heating curve, they were expecting water to boil at 100 degrees Celsius. Then there was, no, this water does not boil at 100 degree Celsius, it's staying at 98 or at 99, you see. But they were not aware that because of the conditions that we that we applied that you had to have standard conditions for the water to boil at that temperature. But, if you, if that was being done, you know, using simulation, you would show the temperature to 100 degrees … which is the case, and, you know, then I would say, well, like I said, both ways have got their own advantages and disadvantages. Advantage I would do a simulation in that it is faster and it always going to, you know, it is always going to coincide with what the book says but then with, you know the practical, there are certain things that appear that also make you, as a teacher, to sensitise learners that you see, this water doesn't boil at a 100 degrees, so, what do you think that the reasons are …

GK: right

LN: … and start explaining from there.

GK: OK, … then, … if you think of, of doing practical work, alright, yourself, at the school, what are the kinds of difficulties that you anticipate … when you are thinking of doing practical work?

LN: I think the time factor …

GK: OK

LN: … it takes much of one's time really to prepare … materials, go to the lab, see that everything is there, setting up and … you know, bringing the learners, they do the experiment. After that you still have to see that everything, you know, is back where it was supposed to be and cleaning. Especially the situation where, I mean, in a situation where we are. Because we do not have an assistant, a laboratory assistant, so we have to do things on our own. It's really, really time consuming. I find that even if you plan for one period, but it goes for two periods, because now we have to clean and other things also. Other than that it's … I think the bigger classes that we have here, the number of learners in the class, we have quite big numbers, and it's really difficult. You see that, you'll find that even one practical which can be completed maybe in one period, but for one class, because we may have to divide maybe take 25 learners per class, half the class at a time, it's gonna be taking one longer period to complete. And, lack of resources also. Sometimes you'd want to do something but when you get into the lab then you'll find that they don't have … the material. Ja, we do have the budget in school but I don't think it caters, can cater for all our demands … [indistinct] the space, [indistinct] I think it's more, that's when one has to like, to take a smaller group at a time.

GK: Just talking about, you spoke about budgets and so on. How does it work at your school? If you, do you have to decide in advance for the year's budget and that's fixed, or could you, if you discovered that you needed something, could you go to the head of department and say, look, I need this tomorrow? Or is it fairly rigid the budget?

LN: I'm not quite sure, but I think, I once spoke to the head of department and he said the departments are given a certain amount of money per year I think its about 10,000. In our school. So that's fixed. So, if we can use it …

GK: in what ever way you want, you need to … OK

LN: but now is we managed to use all of it maybe within the first term or then first two terms, there none left

GK: right, alright, OK. Now, just talking about the learners here at your school. What is it about the learners themselves that you know, that influences the way you do practical work, if you do it, if you don't.

LN: Can you repeat the question …

GK: OK, your knowledge of the learners at this school may, or may not, influence your decisions you make about practical work. Firstly, whether you are going to do it or not. Or the type of practical work you are going to do. … So, my question is, does it or doesn't it influence what you do and if so, what are those factors.

LN: I would say it does, because when I develop or I want to give them any practical activity I have to think of their level of understanding, whether they will be able to grasp what, you know, what I would tell them to do. And, also it has to do, I would say with … you know, their background. I mean, what is the level of, you know, [indistinct] what's the background, like the family background, you know, because, I mean at school, most, most of our learners you know, come from, you know, families that, say, are, they are struggling in terms of you know, financial background. Those are the things that one would consider. I might say to them, OK, tomorrow we are going to test acids and bases. Go and find out about the properties of acids and bases. And I know, that what they have to do, some of these things they don't have in the books, or maybe two, the Internet, but here very few of them have access to that. Even if maybe I would like them to come to the lab here, if the Internet is working, very few have got skills on how to use the computer. You see, those are some of the things that, you know, hamper our problems in terms of practical work.

GK: and again, you are teaching grade 8, right? So, obviously, especially when they first come in, obviously that could be a bit problematic.

LN: eh, eh, considering also where the schools, where they come from. Because most, in fact all of them come from the, the townships. Even the, some of the basic things, the basic knowledge that you would expect that kid to know, most of them would know, but we find that that's it's only a few. I think, you know, at the feeder schools also they play a major role … ja … especially at grade 11, as I say, I mean at grade 8, because that's when our people come from all over. But, at least when one is at grade 9, ja, I think, ja, that grade is better. Because you know they would have gone through grade 8.

GK: OK, … just in terms of, of, assessment then. Again, if you think of the purposes of doing practical work, what different types of assessment would you, would you actually use to check, that they, that they have learnt what you intended them to learn? …

LN: in terms of formal or informal?

GK: it doesn't matter.

LN: ja, because I mean in could be informal in a sense maybe to test their knowledge, you know,, what's their knowledge on this. It could be formal, in which case now, whatever they are going to do, ja, they are going to be recorded for formal purposes. But I think, ja, I can use informal assessment to let me know what kind of informal practical tests I can set for them. Because that one might serve as a, you know, baseline study, [indistinct] OK, they are at this level, OK, then, then next when I prepare these, the next practical for assessment I'll have to set it at this level, ja.

GK: OK. In your experience as a teacher for the last three year, say, right? If you take a particular class, on average how many practicals, and that includes any of the activities which you [indistinct] as practical activities. How many of those activities with a particular class per year on average over the last three years, say.

LN: You mean per year?

GK: yes

LN: I would say maybe three, four per term

GK: OK, right. OK and then if you maybe can describe one or two practical activities that you have done, that worked well and maybe, you can tell me why you thought it worked well?

LN: ja, the, there was one in which they were to test the acids and the bases that are at home. And I gave them the indicator papers and, but then I mentioned which ones they have to, they have to test. Ja, it was very interesting to them to find that, you know, that the chemicals the we call acids and bases they are not only the things that we deal with in the laboratory. Even at home there are such … things. Ja, I think it was very interesting, you know, task to them. And there was one also in which they were investigating the, the effect, the effect of running, on their pulse rate, it was also interesting. They carried it as also a scientific investigation task.

GK: OK. So, the acids and bases one, did you give them litmus paper?

LN: Ja, I gave them the litmus paper and then I said [indistinct] different things like the soap, the … vinegar .. and then the toothpaste, there were 4, oh, the dish, the dishwashing liquid, 4 or 5 of them

GK: and so, and, and in terms of, of, was that used for formal assessment?

LN: no, it was just class work

GK: OK, and so how did they, how did they report back on the results? Was it individual, did they have to write it up or did they just report back in class, or what …

LN: ja in class, because they were doing that individually and now, during the report session when it wasn't the whole class I just picked some learners/students tell us their experiences …

GK: OK, … OK, what I want to ask you now is related to your own experience as a student at school and at university, or at college or wherever else you studied. Your own experience of practical work? So, at school did you do practical work, what kinds of practical work did you do and then also at further studies?

LN: ja, we were doing them at school. I remember we used to have field trips with our biology teacher. … [indistinct] well, the experiment had to do with the, the growth rate, I can't remember, but I remember that ja we were looking at, what, the young plants, ja, then with marks, we were marking the stem. I think we were comparing the rate of growth of certain plants, ja. And then the one we usually used, we were dealing with almost [indistinct] germination, germination of seeds. Also rust, ja, the factors that bring about … rust and photosynthesis [indistinct] and I think with testing of ions …

GK: OK … flame tests and …

LN: ja, the flame tests and …

GK: and the carbonates and that kind of stuff

LN: ja, carbonates, the sulphates, ja, and [indistinct]

GK: what school were you at?

LN: No, I was in Lesotho

GK: in Lesotho?

LN: ja, it was a very nice school

GK: was it a public school? Or a private school?

LN: it was a church school. In fact, it is a church school even now it is private, but then … it was funded, all the schools were funded by the government in Lesotho, ja. Ja, I remember, we, we, really every, the most every week I think there was a practical that we were doing

GK: so, if you, I don't know anything about Lesotho, if that was a church school, there obviously were state schools, public schools, funded only by the government? And it was it also, was the type of education very different between the two or not really?

LN: you mean, between the …

GK: the church school compared to the public school

LN: oh, no, no, no, the type of education was, it was …

GK: similar

LN: similar, yeah. It was uniform. In fact, the private schools were very, very few

GK: is it?

LN: very, very few, ja, Most, … I think, most schools were owned by churches but they were funded by the government. They were controlled by the government schools, you see. I think the church was just controlling us in terms of … the … what do you call, the rules, like … if it's catholic church I mean, [indistinct] of church, [indistinct] behaving this learners

GK: OK, but those teachers and that would generally be paid by the state and so on?

LN: yes, yes … [indistinct]

GK: OK, and then, at, in further studies, did you do lot's of practical work?

LN: ja, ja, I did a lot. We also have laboratory sessions most every week at the university

GK: did you where did you do your undergraduate [over talking]

LN: post graduate [over talking], I did my BSc in Lesotho. Ja, every week. 2 or more because, I mean, because of [indistinct] courses. I remember I was spending most of my Fridays and Saturdays in the lab [indistinct] because I know that the next week when I go and do another practical I have to submit the …

GK: write-up, ja …

LN: the write-up, ja.

GK: so, what were your majors again … for your BSc?

LN: it's chemistry, and physical geographic

GK: OK

LN: but, I mean, at first year that's where, you know, I did a lot of practical work in the three science disciplines,biology, chemistry, physics, …

GK: OK

LN: but I think also, thinking about the high school … we were doing a lot of practicals, because of the amount in the syllabus [indistinct] because, … we know that at the end of the year there was a practical test that was set [indistinct] kids

GK: OK, so they were physically had to do a practical. It wasn't a written practical test, it was a physical practical test?

LN: ja, it was physical practical test.

GK: OK, … just for my information, but, when you do, when you did the practical tests, were those generally different workstations where you had to do different kinds, small little tests, or was it one practical where everyone had to do the same thing, or was it? … You know, with the actual exam that you did, like the prac exam at the end of the year?

LN: OK, … no, it was just one thing, just one thing. Sometimes it would be an [indistinct] solutions that we have to test the ion [indistinct] so that we know [indistinct] we then had to [indistinct]

GK: samples …

LN: samples, or the tests … the test indicators that we have to use, because, I mean, when you test for sulphates it is different, then you are going to use a different …

GK: reagent …

LN: reagent … [indistinct]

GK: so you had to know that beforehand, OK. Do you think prac exams are a good idea?

LN: I think if … [indistinct] learners have been prepared well, if they have been used to you know, doing practicals [indistinct] … it's OK to have them. But, I think if they … if the learners will enjoy them. But, I mean, if they are not exposed to practical work every day and they are given an exam of that, I think it is going to be unfair to them [indistinct]

GK: right. So, you do think, you, as a teacher now, the practical work that you do at school, do you think that your experience at school or maybe your experience at university, has influenced that to some extent.

LN: uhm … in fact, if it wasn't because of the problems that I have mentioned, you know, I would love to do more practicals. But, you know, due to the limitations that one has got, really, it is very difficult … it is very difficult. But I do enjoy, you know, practicals. And I know they are interesting to the learners to do them. Especially, when one thinks of the olden days, schooling days I remember how I enjoyed them.

GK: ja … so, you … in your case, at school now, how many practicals do you need to do for, for formal assessment purposes?

LN: it's one per term

GK: one per term, OK. But generally do you do more than that or, or do you stick to one per term? … and I now talking about the broader, the broader definition of practical work, hey. I am not talking about formal assessment.

LN: I mean, for formal assessment …

GK: ja, so, if you take, if you think of all the practical work including all the different activities we spoke about, do you do, do you do just one formal activity per term or do you do others as well?

LN: I think two or … two, three, yes, not one, it's not one

GK: And you were saying when you were at school the curriculum actually determined that you do more than, that you do more practical work.

LN: ja, I think, you know, thinking back when I was in Lesotho, you know, the curriculum, I think it's different from here, was even there, we know that there was one day where we spent the whole afternoon in the laboratory.

GK: OK

LN: so I think, that was also putting the pressure on the teacher to have something for that day …

GK: so the teacher knew that day is practical work, OK

LN: we're knocking off at … 4 and then we were eating our lunch at half past 12 to half past 1. Then we knew that from half past 1 to 4 that's …

GK: that's practical work

LN: practical work on a Thursday

GK: OK so, [indistinct] classes have it, had it on different, different grades had it on different days or something. So, that's it … you think it worked well?

LN: ja, I think it worked well, really, you know, … for some of us, I think that's where we developed this interest of … I want to become a scientist, form that, you know, age. And, indeed, even at the varsity level, it was difficult, but we still had the passion with that …

GK: So, how do you think, what is the best way of encouraging teachers at … let's say this school, right, to actually do more practical work. What do you think would be the best way to do that, or one way of doing that? Within your context.

LN: I think, ja, taking, taking our situation here, you know, those problems that I talked about, you go to the lab, you want to do something, you go to the lab. There's nothing. You , it kind of de-motivates one . Sometimes you go to the principal, you asking for money [indistinct] to go and buy these, then you are sent back to the head of department, but again, head of department is now busy, the you start walking up and down. But, I think, if things are available, I think, teachers won't have that excuse why they cannot do the practicals. And, I know it's impossible, but if … you know, we could have people that helping us in the lab, the lab assistants, knowing that, you know, if I want to [indistinct] lab then I talk to this person, then I will give him what I will make and then when I go to the lab everything's sorted out and then mine is to, you know, move around, supervise learners and watch them and then afterwards I took another class. You see, it's a load, it's a heavy load that we have in terms of teaching and also, when you think of now, when you now, going to prepare. But, obviously, I want to [indistinct] budget I have next year. I have to prepare today, I have to go and see in the lab that OK, everything is sorted out. OK, where is that, today's, you know, things like those. So, it's stuff that I do, you know, after work, which is what, I think, most people would do. Not like to do. But I think, it's in your system that we are having now. It's in your document, [indistinct] which stipulates that, OK, learners must do at least one practical per term. Ja, I think, it can also encourage [over talking] I, like if, you know, if it's left to a teacher to decide whether he or she would like to do the practical work, [indistinct]

GK: But, if you, if you, I mean, if you now really think about this school, and realistically think about what can be done to encourage it. I mean, the possibility of a lab assistant is probably very, very low, right? Obviously, the curriculum demands, as you said, will encourage certain people to do it. And I think with the CAPS document, I'm not sure how they are going to enforce it. I mean, they prescribe, I think 1 per term in grade 10-12 as well. No, two for the year, I think. But they have some, what they call recommended practicals as well. And I'm not sure how they want, they going to enforce those recommended practicals. Whether they're going to say, look, you have to do this or not. So, … the curriculum, you're right, it does, to a large extent determine what teachers do. … But, other than that, how do you encourage teachers to do it, especially if they themselves have not been exposed to it and haven't benefitted from, you know, from that experience themselves. Because, I think that is one of the big problems in many schools.

LN: I don't know all the trainings, you know, if, teacher can do workshops, you know, or … the importance of practical work. I think that might also play a major role towards changing attitude of [indistinct]

GK: OK, thanks very much, for your time

End recording

Transcription filename: Michelle lesson

Teacher: M
Learner: L

1 M: So what we are going to do today is we are going to – are we focused?

2 L: Shsss

3 M: We are gong to be conducting an experiment in groups of four of your choice. A group of three is also fine but not les than three and not more than four. OK
If you can mact I will match you up – you don't need to talk about that now. So if you've got three or four that's fine and your aim is to investigate the effects of exercise on heart rate. I think you should take out a piece of paper and a pen .

{noise}

4 M: Right on your paper please write 'aim' – to investigate the effects of exercise on heart rates. Now part of your job in your groups of three or four is to decide how you are going to set up a correct method to investigate that so you are going have to think about things like your independent variable, your dependent variable your fixed variables – what's your control going to be what's your experiment going to be. You have some notes on that – but just to help us a little bit – what sort of things do you think you might need to do this experiment?

5 L: take your heart rate before

6 M: before what?

7 L: before the exercise and then your heart rate again after.

8 M: perfect – so you are going to need a before and after heart rate – how you going to measure your heart rate?

9 L: Take your pulse

10 M: take your pulse – does everybody know how to take their pulse?

11 L: No

12 M: OK so just that we can be sure. There are two places you can take your pulse either in your neck or your palm – you have a bone that runs down over here probably a ligament don't use your thumb because your thumb has its own pulse your results. So we are going to use these three fingers there. Can you fell something beating? If you cant you can try in your neck next to your trachea easier to feel If you do not feel a pulse in their body they are not dead if you are unsure you are very much alive – I will come and help you. So you will have to

measure a before pulse rate a before heart rate and an after one and then obviously you will have to do some exercise in between. To make sure your results are accurate – to make sure fully rested so maybe even be fore you move when you are nice and still take our pulse rates generally you cant vey accurate find your pulse.

13 L:

14 M: the average of a teenagers your age a woman is about 60 but sometimes its much slower it depends on your got to start counting in four seconds and start

(4 s elapses in silence)
stop. We timed it for 30 seconds so times it by two My heart rate is so 65 beats per minute whatever

15 L:

16 M: If its more than 90

Chatting indistinct – about heart rates

17 M: quiet. What do we have to do to make sure our results are valid and accurate you must do it three times whatever you doing – three times so that you can get accurate answer

18 L: an average

19 M: an average . Ok I suggest that you use the first half of the lesson to actually do the experiment and get your results. You can discuss maybe how you going to all the variables.. When you are ready you can come and sit down and I can give you tour paper you will get 40 minutes or more if you finish your experiment sooner but by the end of the lesson it must be done. You can choose to go out of the classroom because otherwise it will be too noisy please don't choose to run up and down these stairs here you can do running on the spot you can do walking around the field whatever you choose to do but you are allowed to leave make make sure you are back . Question?

20 L:

21 M: Ant other question?

22 L: If you are

23 M: I can't hear

24L:

25 M: generally less but it depends on the person and their body build Any other questions . oi.

26 L: When does your heart rate become actually dangerous- beats per minute

27 M: I am not sure of the actual cut off I will have to google that

28 L: Ok ladies off you go

[Noise as learners leave.]

29 L: The heart rate will increase when the body does exercise.

30 L: Oh ok so now we going to go outside.

31 M:

32 L: So we just supposed to go and do exercise.

All learners leave

So we just ready to do exercise now.

I realy think its too fast

Let me take it now

Ok are we taling it – how many are we doing

(all learners in group do star jumps)

OK was that 30 seconds

So we double it

What did you get
So it does increase
Are going to take an average
We also have to have a control
Hypothesis
So the hypothesis can be – the heart rate will increase
The independent variable the amount of exercise – just exercise
Dependent is heart rate in beats per minute
Fixed variable – the number of start jumps the amount of time
Are taking average of everyone
Has to be the same person

Learners return to class in groups – teacher is marking at table – learners get on with writing up their prac.

33 M: be quiet now here are your pracs – there is a rubric at the back and you cant talk to another person.

[learners all come in and quietly get on with their work. – complete silence in class]

Some learners put up their hands and asks teacher a question.

For those who just walked in individually, you are allowed to use any notes not allowed to talk to anyone.

Gives learners 20 minute time check.

Transcription filename: Michelle post-lesson interview

Interviewer: I
Interviewee: M

1 I: Thanks again ... for allowing me to do this interview.

The purpose of the interview today is to just look at the prac that you did, he one that I observed the last time and to discuss that and then there are some general questions about practical work that I would like to ask you.

2 M: Sure

3 I: So firstly what do you think worked well in the prac that you did, that I observed.

4 M: I think, so the girls quite enjoy doing practical work so they are quite enthusiastic so I think it gets them to think about the planning in a better way because they actually have to do it because they are having to perform it its less likely to have gaps they think through it little bit more carefully umm and also they get to practices using the terms what is an independent variable, a dependent variable and how are you going to make sure that the experiment is fair.

5 I: Alright – was there anything that you felt didn't work as well as you expected it to.

6 M: Umm well the understanding of the whole process wasn't as thorough as I would have like but I did think it worked in that they got to do it – possibly it would have worked better if I had got around sort of twice to each group rather than just once – umm so I found when I got to some of the groups they did not quite understand exactly what they should be doing or how to do it accurately. So possibly if there had been two teachers or an assistant or something like that it would have been ideal.

7 I: Right, umm – then I noticed that you gave them the instruction sheet only after they had done their exercise – was there any particular reason why you decided to give it to them afterwards and not before?

8 M: Probably just because I forgot to. So ideally they should have got it beforehand with the rubric. Oh no sorry because it was an assessment that's why. It was supposed to be that they do it in groups and assess in groups – sorry I had a bit of a blank there. So I gave it to them afterwards so that they would have to think about it individually. They could discuss it but obviously it was to test their understanding - so I do find that if you give it to them beforehand thy know its for assessment they will focus so much on writing and comparing answers rather doing the actual practical work. Sorry I just forgot.

9 I: That's fine. Then you mentioned that you sort of wanted them to focus on planning an investigation and so on. Were there any other aspects you were expecting them to learn in the process of doing that particular activity?

10 M: Ya I think the mean thing was s I say about the different variables, I was hoping they would discuss that a bit more and just how to make sure that the experiment is in fact reliable and repeatable. They didn't actually quite get that at the end but the fact that it should have been everybody in the group doing the experiment at least three times – sorry so just repeat the question

11 I: What were you expecting them to learn?

12 M: to learn. So basically how to make sure that the method was repeatable and reliable mainly.

13 I: then you said that they did not quite get certain things. What exactly did they not get?

14 M: they struggle with the variables – what are they – so what is in this experiment what is the independent variable, dependent variable, fixed variables etc. its quite difficult to pick that up but we started doing the experiments now at a much younger age so in Grade 8 and Grade 9 so that by Grade 10 they have a better understanding. Because we used to sort of really only start talking about these when they were in Grade 10 then we had the crash then – so I just think they find it extremely difficult. So I am always surprised because you go over it and they seem to understand it and then we you actually do the experiment then they don't.

15 I: Right umm - then the worksheet that you gave them – I see there was an examiners name a moderator's name and I think you mentioned to me that the activity you got from a textbook .

16 M: It was based on a textbook ya.

17 I: The examiner is the person who decides what the final assessment is got to be?

18 M: yes.

19 I: and the moderator – is the moderator the moderator of the actual paper or the moderator of the scripts afterwards?

20 M: Both – what we do – so there is the examiner who sets it up, decides what it is and how it will be assessed etc. and then the moderator would check to see if its fair or any suggested changes or if its not clear so they moderate the actual setting of the paper then afterwards mainly we just do it for the portfolio pieces to be honest – but the moderator would – we actually moderate each other's work so the examiner can also be a moderator. So specifically here it's the moderating of the setting of the paper.

21 I: So if you were the examiner for instance would the other teacher be able to make input into what is in that assessment.

22 M: yes so generally the examiner would set it and the moderators would make various comments then the examiner would adjust the paper.

23 I: Right – this particular task was it prescribed in the curriculum?

24 M: No – according to CAPS we do far more assessments than is required but one of the things that is suggested is a practical but we try to do two practicals – one assessed one every term. Sometimes we write up two formally but one of them may not be marked as such by us – it will be marked learners. They mark their own work or it will be marked by a peer. But we do many more pracs than that. This specific is not necessarily prescribed.

25 I: Ok but this one will be used for portfolio purposes?

26 M: yes

27 I: Right then I know that – ok maybe – as an independent school what is your relationship with the WCED in terms of assessments and so on. Do you follow the curriculum, do they give you input.

28 M: We do. We go to the meetings, we follow what they say so we do the prescribed syllabus, we do the prescribed assessment however we normally add additional work and we add in extra assessments – you know we do have the time and the standard is quite high. So we normally do more than what is prescribed.

29 I: Now I know that in some districts teachers have indicated that the CA's no longer want rubrics, they want them to go back to a sort of memorandum. Have you had that discussion.

30 M: No I haven't heard that we do find that the rubric are very airy fairly for a better word – a lot of thumb sucking but obviously quite a convenient method to convey to learners what we are expecting of them. So normally we've got a rubric like we did for this one but then we have specific criteria that basically makes a memo – so meet standard one or two three or as high as it goes – we have a specific list of things .

31 I: So it's a combination basically of the memo and the rubric.

32 M: ya

33 I: Alright then – during the , during my observation I know the learners called you and asked you questions but I could not pick up sort of what they were asking. Can you remember what any of those questions were? That's when they came back

34 M: Ya afterwards – some of them would have asked for verification - must we do the method in point form. Some of them also asked must it be in the third person. So they were just sort of recapping the rules some of them or people were just asking to borrow things – asking for a pencil or ruler or whatever it was. So I think most of it was clarifying things I had said – so must we list the independent and dependent variable etc. Ya clarifying really.

35 I: For this particular topic of circulation and respiration you decided to do this particular practical was there any particular you decided to do a practical for this particular topic?

36 M: As I said for most topics we actually do a prac – so we also will do another one – where we will dissect the heart and the lung. So this specific prac lended itself to the learners practicing the scientific method which we find them very weak in . The dissection we find that if we assess that ,that they actually do better at it come Grade 11. So that they do it later anyway so we rather not assess that now and there you are more assessing dissecting skills and drawing skills. We did that previously we did an onion cell prac. In that one we sort of assessed their drawing skills .

37 I: Sorry the onion cell prac at what level did they do that?

38 M: It was also the grade 9's so we did that this term for a second assessment. So that was more assessing whether they could make a slide correctly then their drawing skills. So it was nice to practice the actual scientific method you know it was in their textbook, they pay for the textbook so we like to make use of it so although it wasn't quite as it was laid out in the textbook it was based on that so they could read up about it beforehand .

39 I: Alright umm – now that you have marked some of them was there anything you picked up while you were assessing the pracs?

40 M: The methods were particularly poorly written, many are still forgetting to do it in point form and not talking about I must do this or Candice did this or whatever it might be. They also struggled to specify directly or indirectly about the control and the experiment so they leave that out or they forgot that they have to repeat it using different people. Method was quite poor – the results were alright but obviously that was quite poor based on their method sometimes – if they hadn't repeated it then they obviously did not do that in their results but the results were good and the discussion was quite poor as well. They not quite sure how to talk about the hypothesis about accepting or rejecting it they just say our experiment was a success because it proved our hypothesis correct - so they not quite getting that part. And quite weak on suggesting improvements – they always just say we did wonderfully and so the improvements are generally quite vague or they repeat what I suggest – we must do it three times.

41 I: So the feedback you give them – do you just have a discussion in class or do you just give it back ..

42 M: For this one specifically – we don't go over all of the pracs as in detail but because we specifically trying to practice the scientific method and the standard wasn't as good as I would like. It was as I expected but not what I would have liked so yes we will go through it in a lot of detail . So I will say a) this is how you should have done your method, this is how you what you should have included there – this is how could improve.

43 I: Did most of them manage to complete the task in the given time?

44 M: Ya – what we actually found was that we weren't really assessing them for time so most of them in the lesson that you observed did not finish they got quite far because they are relatively good at sticking to the time limits but I did actually give them a bit more time in the following lesson simply because the emphasis was not on time management.

45 I: You have mentioned in this interview and the previous one some of the other kinds of pracs that you do can you maybe describe any other types of pracs that you have done?

46 M: Ya we try and do a variation. 8's or 9's do you mean?

47 I: 8's or 9's or up to grade 12 ?

48 M: Ya so we try and do – obviously when its chemistry we get them to actually do those experiments – so all the chemical reactions whatever is in the syllabus we try and get them to actual perform those . we don't always assess those. That's just for handling generally sometime we do get to assess it , dissections where relevant and obviously our garden is really beautiful so we might go and draw different things or draw different things looking for specific features, microscopes we use where relevant – we've got quite a few slides – prepared slides and unprepared slides. Generally we try and prepare our own or get them to prepare them. I can't remember the other topics. But specifically for chemistry we get them to mixed the various chemicals so they can observe and smell or whatever they are supposed to do .

49 I: So those chemistry one are they mainly the ones where you give them the method and they just follow instructions.

50 M: yes so rather than just saying if you mixed an acid or a base this is what it should be – we actually get them to mix an acid and a base in equal quantities to make it neutral and then they test it with the litmus paper or whatever so they can just physically see it and hopefully get a better understanding and remember it better.

51 I: And then are there any activities which you can think of off hand that instead of getting them to do a hands-on prac that you do as a demonstration.

52 M: yes definitely. Sometimes its if we are time pressured and we want to do three prac we will have all three prepared and show them. Sometimes if its something we feel is too dangerous like with the reactions of the group one metals we obviously demonstrate that one possibly one one of the things you need is quite expensive we will demonstrate that or if we just happen to be short of that chemical but we do have the facilities for them to do it so whenever possible we do get them rather to do it.

53 I: Then some general questions. What do you think the purpose is for doing practical work in school science.

54 M: I think just to – mainly to encourage them to be enthusiastic about science otherwise it is a bit of a dead subject – so I think they a lot of them enjoy it a lot because they know they are going to be able to experiment and get hands-on experience so yes just to encourage them to be enthusiastic and to encourage them to follow that line of work hopefully and also definitely to get a better understanding. So if they can see the structure of the heart they will remember cutting something open or running it under the tap or whatever they had to do – umm and as I said the scientific method basically they do it they do get a better understanding because they can see the steps they have to follow to complete it or why did it not work out or we know it was supposed to be like that, why was it not like that.

55 I: Then what are the factors that influence your decisions about whether you do practical work or not or what type of practical work you do.

56 M: I think its just about the topic – so as I said for this one we will do the dissection and also we did the scientific method write up. I think it just depends upon the topic and also variation. But you know next term when its basically a chemistry term they will be doing a lot of chemistry experiments but again we will do in between we will get them to draw what they did rather than write up what they did just to sometimes we will just assess a specific aspect of the scientific process rather just write up the method or draw the apparatus that you use so I think its just to encourage a variation. As I say we don't do a lot of too much formal assessment maybe only twice a term we will assess something that they did but it really is just for the fun aspect of it and actually doing it.

57 I: So those assessments that you do informally I think you mentioned that you sometimes use peer marking for that – so every assessment that they do or task that they do – it is marked in some way or other?

58 M: Ya you no in some way so it might just mean that we are walking around having a look at whet they are doing and commenting on that
. There are a couple of instances where they don't have to do anything – they can just enjoy the prac. So even so I still will walk around and say be careful of this or I have to remind them how to light the Bunsen burner so they may just get verbal input and observation basically it does not necessarily have to be written work .

59 I: Umm- then group work how do they manage with group work – do you find that they - do you have to teach them how to work together as a group effectively initially or –

60 M: Not really – they quite good at that just because the curriculum since they were young lends itself to that they have been encouraged from little. There are a couple of kids who struggle with more social aspects so they – so if it's a problem I will help to get them into a group or if it's a regular problem I will randomly assign them to groups but he actual functioning of the group normally is quite good.

61 I: First tell me about your own experience as a student of practical work. When you were at school.

62 M: We really did not do all that much. I can remember a few observation I do remember doing the (indistinct) I remember doing many pracs I also remember feeling really threatened random it had to be assessed it was very pressured and it was just a scary very unpleasant experience but I knew I wasn't … what I was doing .

63 I: And at university?

64 M: Well obviously that was different, we for chemistry we did a lot of titrations but also because I was not used to doing it at school I did find it very threatening as well as we did lots of dissections and that I enjoyed very much but because I was very interested so I suppose I made an effort to it in my own time so I was more comfortable with that. But the chemistry and physics things I wasn't prepared and confident so I have it quite frightening actually.

65 I: Do you hve anything else you want to share about practical work

66 M; I do find that some of the girls are reluctant to participate they are sort of more hangers back they not really interested in what they are doing but those are general y the ones who may not continue with it and they are really just not interested. I do encourage them to participate but I do think they are well prepared. They haven't done as well as they should have in this prac but its – it does prepare them well for later so by the time they get to the higher grades they might be much more confident .They do get a lot of enjoyment out of the pracs.

67 I: And just as a matter of interest – what is your uptake of science of physical science in grade 10?

68 M: I am not actually sure off hand – I know that life science is very well subscribed to so about 60 of the 90 girls we have take life sciences quite a fair number I would say about 2/3 of so about 40 I would say about half or just under half carry on

69 M: So basically in Grade 8 is to set them up for what to expect in the lab we introduce the to the rules of the lab so no running no eating don't wear loose clothing, wear your lab coat or if they don't have a lab coat they just bring their dad's shirt so that they don't mess on their things always using the safety goggles which we have a full set for each class so basically reminding them what they are supposed to do and we also do just introduce them to the process what are the definitions of everything they have a note that they can refer back to of we can remind them again but also when it is a specific prac when a specific rule is important like when you smell something you don't actually smell it, you waft it and this prac is very important that you have your safety goggles because this is very corrosive or whatever – so we do recap the relevant .

70 I: And introducing them to different equipment or do you find that they are quite familiar with that by the time they get to grade 8?

71 M: Some things they are and some things they are not. So we do also at the beginning of the year because they come also from different schools so we ill show them all the different things. We don't really do it because it is quite boring just the theory here this is a test tube, this is a conical flask and this is what ever what you might use it for. So they get a whole table of all the equipment and their basic functions so ya we do recap so again when its relevant – this is a conical flask and we use it instead of a beaker because.

72 I: And I have been in schools where kids arrive in grade 8 I have seen them in Grade 10 where kids actually did not know how to use a thermometer.

73 M: We do actually have a problem with thermometers they do need reminders of how to use the. Because often in some experiments where you are needing to stir it and to measure the temperature. So they use the thermometer as a stirring stick and they bash it or break it so we actually need to replace many of them we just lucky that we can but once its happened two times we have to remind them this is not a glass rod it is a thermometer so even though they are exposed to them they are not always sure how to use them .

74 I: But do you get the sense that most of the girls that come to the school have had some kind of hands-on experience

75 M: ya they quite maybe they haven't used a specific type of equipment before – but they are quite willing to try because they have handled possibly different equipment somebody in the group would have done it so they would want to try so they are not scared of using the equipment

76 I: … Thanks for your time.

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End of interview.

Transcription filename: Michelle pre-lesson interview

Interviewer: I
Interviewee: M

1 I: So firstly just tell me very briefly about your science teaching experience.

2 M: I taught at … for about four years from 2000 . I've overseas as well a couple of times just relief teaching so experienced quite a few schools there and this is my 10th year of teaching at …. . So I am currently teaching natural sciences and life sciences ya basically I have been doing that for the duration of my time here.

3 I: Alright I will be give you a biographical details form next time I come to just to record your qualifications and so on if you don't mind.

4 M: OK

5 I: So the purpose of the interview today is basically out find out what you are going to be teaching when I come and observe – just some idea of what you intend doing, what you have done on the topic thus far that kind of thing.

6 M: OK

7 I: So the first question is . What topic will you be teaching and what grade?

8 M: Its Grade 9 and we are going to be doing the circulatory system in conjunction with the circulatory system. They work together so basically respiration and then gaseous exchange and how that will transport the gases around the body. So ya they are sort of two separate sections as laid out in the syllabus but we will be teaching it at the same time.

9 I: I will be observing you doing the prac – so up to that point what would you have covered by the time I observe?

10 M: We would have done basically the whole of the respiratory system so what organs are in the system and the differences between breathing, respiration and gaseous exchange and then we would have also introduced the circulatory system so how the blood is involved in taking the gases around the body – so gaseous exchange.

11 I: Alright and then when teaching that particular section what do you consider the main ideas that need to be taught .

12 M: Well obviously with the respiratory system it's the structure of that system and why more complex organism need have a system so we explain bacteria are fairly simple so can just by diffusion and why need to have a more complicated system and then the various functions of it – but first we emphasis the difference between breathing and respiration because they get very confused with that so basically it will be the system and why it is important and then the process of

breathing – how you breathe and what it is and respiration and that process that we did last year a bit but we refresh that and then gaseous exchange. And then circulatory system – again what the various organs are in the system . To be quite honest I haven't looked at that section thoroughly because we are going to be doing that a bit later but basically the importance of it and how it is involved in the transport of gases.

13 I: Alright and then are there any aspect on the topic that because they are at Grade 9 level you would deliberately not be teaching them on that particular topic.

14 M: Well not specifically obviously what we do is at a relatively superficial level so for example we won't , I won't explain to them in what form oxygen or carbon dioxide are transported around the body in because I know it will be completely over their heads. But really what I do is I teach the basic content as it is stipulated by the curriculum basically and what's in their textbook but generally the girls here are quite inquisitive so they ask lots and lots of questions so basically I will answer their questions so if it does go into next year's work or a something that's at a higher level unless I see that the class is losing interest I wont explain it to everybody but I still will answer all of the questions so I never deliberately leave anything out but for example I know that they are not going to ask me how is oxygen transported around the body and it is not relevant for now.

15 I: OK I am sure you have taught this section at Grade 9 level before what are the difficulties you foresee learners to have with this particular topic. Are there any difficulties?

16 M: Mmmm Ya there always are - with every topic I suppose. I think its quite abstract in a way they are very interested because it is the human body buts its quite abstract you know these gases getting around your body and cellular respiration you know I think they sort of forget the importance of the fact that it is making energy so ya constant reminders of that kind of thing. And then another thing but a little more light hearted we do dissections of the heart and the lungs and some of them are a bit squeamish ya also some of them have a morbid curiosity so they all join in.

17 I: I can imagine. And then your knowledge of the girls that you teach – does it influence especially the practical work you do in any way?

18 M: Not really you know we sort of do the same thing from year to year unless obviously the syllabus changes so much that we that it is not relevant anymore but that's not really the case but if we found that something does not work or that they were not interested or that it just didn't work then we would change it but we don't but we wont not do a prac because they are not going to cope. We'll probably just give them some extra preparation or help at the time – so we try and choose things that fit the syllabus requirements and what we need to assess but also we do a lot more assessments than what is needed anyway – so if we

think something is interesting and they would enjoyed it in the past we make a point of incorporating it any way.

19 I: So you say you do many more assessments – those assessments are they used for summative purposes – do you use them for marks?

20 M: Yes we use them for school marks and then for the end of the year – just for term four when we fill out the CEMIS form then we picked specific assessment through the year so only for that term their report and CEMIS are the same I far as I can remember. But ya we do use all the marks.

21 I: So for June results will include all of those assessments .

22 M: yes

23 I: Alright and then just tell me a little bit about the labs that you have at the school.

24 M: We have very beautiful labs new ones. So firstly the two main labs are fully equipped so they've got benches with gas outlets and little cupboards underneath with the equipment they will need - we also have a work room at the back where stuff that are not as commonly used and obviously the chemicals and stuff that is not as commonly used is kept and then we have a lab technician who helps us to set everything out we are spoilt and then this year my classroom which is more a standard classroom as well as the one next to me for the – another science teacher for the senior science – physics those have been converted almost into mini-labs – they've got kind of counters like this around the edge but each has also got a gas outlet and a little cupboard underneath but it is not as spacious because it has all the table in the centre so ya I can do demonstrations and simple pracs there but if I need to I can moved into the main labs.

25 I: So you the main labs are only used for organized practicals – they are not used as normal teaching venues?

26 M: No they are – just like other schools we are short of class rooms so I do share my room with another teacher – it happens to be with a science teacher but could also be an RE teacher just if its open because very everything is safe so does not need to be attended to by a science teacher. So in the classrooms or the labs is safe stuff and then in the workroom we pack everything away in there.

27 I: Alright just coming to the lesson I'll be observing if you could just run through quickly what it entails.

28 M: So basically it's a prac to investigate the effects of exercise on heart rate. We haven't tried this one before but it was one we found in the textbook so we just type it up to facilitate them writing it up. So in the textbook they had instructions and various questions but we just find it is good practice if we introduce them to the proper scientific layout of the process so that is why we

presented it like this – so they can choose how they are going to investigate it and obviously we coach them from grade 8 about independent and dependent variables and fixed variables so that's fair test and repeating it at least three times so ideally they should think about having somebody who isn't doing any exercise and others racing up and down the stairs and then record their results . So we don't – we'll obviously give them some clues and maybe discuss how do you think you are going to go about doing this as a class just to some ideas but then they have to think carefully about what they going to use how they are going to do it the method and then we suggested that they write it up as a table and a bar graph but we don't specify exactly how they have to do it so for example they might choose in the table to work on every person's average because each person will have to do it three times so they might work out the average in the table or they might choose not to do that but obviously their bar graph will be more complicated then. But it can be correct and then the discussion – we – they struggle a lot with that still so we just give them some clues there so the results that they got – what could you have improved, did you get what you expected if so or if not why not that kind of thing and then obviously a conclusion and then we just attach the rubric at the back as well– lots of clues as to what to do.

29 I: And how long – oh it says here 80 minutes.

30 M: Ya so ideally we would say it will be done over a double lesson. I have two classes actually so the one class will do it in the double where they will do the prac and then write it up immediately afterwards individually – so they do the prac together and they discuss and take notes and then in the second half the other 40 minutes they will need to write it up but as they do the prac they will have more writing up time they must just manage that themselves. The other class I see them for their double too late in the week so will do it over on a Monday and a Tuesday so they will do the prac on the Monday and write up on Tuesday. If they wanted to they could start writing up I will just take it in on the Monday .

31 I: Just coming back to two things quickly. Firstly what textbook do you use?

32 M: I don't have a copy here but it is called Platinum.

33 I: You spoke about sort of inducting them into the scientific methods from Grade 8 onwards can you just tell me more or less what you do in that process from Grade 8

34 M: So we have everything that we teach them we've got Powerpoints to. They have a textbook which we supplement with notes just to sort of so that they've got something to do to fill in that matches their textbook and then its we also have Powerpoints with the memo's with additional diagrams or what ever just to support what we are doing. So what we do with that is we will just basically go through definitions – what is an aim how is it different from a hypothesis and then all the variables and then obviously we would think of a scenario – so what is the aim here what would a possible hypothesis be and we will discuss it and

then we have various worksheets that we give them that tests so very simple scientific scenarios so they will say what would the hypothesis be then given another one whats the independent variable etc. and then we do drawing of graphs you know they would draw it but we will always ask them which is the independent variable, where you going to put it, why you going to put it there so ya we try and drill that right from the beginning because otherwise but even in matric they still seem to struggle but it is getting better and better because we start it so early now.

35 I: Yes I have noticed that even at grade 7 level learners can now talk about dependent and independent variables whereas 10, 15 years ago we did not discuss those things at that level.

And so do you do quite a bit of practical work in grade 8 as well?

36 M: Yes – the syllabus really lends itself to that. Because we've got everything so accessible and they ended up time – ya for many of them it is their favourite subject because they get to do so much stuff and its not very threatening because they do not have to do it on their own and probably four out of five times it is not for assessment it is just for having experience of working in the lab.

37 I: And just on practical work – do the grades 8's & 9's participate in the science expo?

38 M: We used to do that quite extensively, not the grade 8's, but the grade 9's it used to be their annual project – so they used to be given that round about now or even earlier in the year and then we used to have a mini science expo at school – so we would set it all up and every child could do one or in pairs if they wanted to and we would invite the parents have some wine and we would give prizes you know we would obviously be much more generous with our prizes but we would also do the gold and silver and bronze and then various other prizes for most creative idea that kind of thing. We did that for five maybe six – ya quite a number of years and then last year we decided not to do it because there were just two grade 9 teachers we had three classes but just two teachers so we've taken a break from doing that and also they get a bit stale doing it year after year and also for use we just taking a bit of a break but so not really we do tell them about it but they don't choose to do it because it's a lot of extra work but maybe next year or the year after may become a school thing again and then sorry from there we pick the best ones if you got a silver or a gold – we used to get about between five and 10 entries .

39 I: and at a senior level? Do they do expo at all?

40 M: I don't think so – I don't know of anybody who has entered. Again they are told but I think its just a lot of extra work so they choose not to do it unfortunately.

41 I: I know at another school I went to they were saying that in Grade 8 & 9 they do quite a bit of practical work but as the go up to grade 12 the number of pracs they do actually decreases. Do you find the same here?

42 M: Definitely – its just the time _ I think we are probably supposed to be doing much more whereas now we could be doing a lot less but it is just we are able to do lot more because we just have time for experimenting and playing with things – whereas at the senior level – unless it has to be done for assessment or portfolio we generally don't .

43 I: And then just one last question – in grade 9 I see you have 80 minutes so that's a double period. So are your periods 40 minutes and how many periods do you have per week?

44 M: We have six for the grade 9's per week – so there is one double lesson and then four single lessons then for the grade 8's they just have five single lessons. So we see them everyday for 40 minutes at least.

45 I: Sorry I thought it was the last question – coming back to the lab technician – you say she does all the preparation – how does the logistics work?

46 M: She is not qualified so initially there was a lot of training for her so basically we for this type of prac I would take it to her and write a list of everything I needed _ I need 8 sets of stop watches, this that and the next thing and then she would put it on to the various benches for us. The girls are responsible for cleaning anything up so if they dirty their beakers or they whatever they have to wash it themselves but if it's a test tube and they can't get it dry they can leave it to drip dry and then … she is the technician, she packs everything away.

47 I: So you basically trained her?

48 M: Yes – trained and are still training. She's been here now – I think this is her third year.

49 I: So does she have any sort of experience in science ?

50 M: Not at all – I think she's got a matric and that is all. So its quick tricky but she is very willing to learn and we have encouraged her to watch the pracs . It's a massive help – it was a big problem before we just found we did not do quite as much because it was just something else we had to prepare – ok we did do but it is just much better having her .

51 I: Does she assist the life sciences, natural sciences and physical sciences?

52 M: yes.

End of interview.

Transcription filename: Nadjwa post-lesson interview

Interviewer: I
Interviewee: N

1 I: Right thanks Nadjwa for agreeing to this interview again. The first few questions just relate to the lesson itself and then afterwards I am just going to ask you some general questions about the practical work.

So firstly in the prac that I observed - what do you think worked well?

2 N: It wasn't one of the best pracs I've done. So I mean it started off ok it seemed to have worked well em the kids the interaction of kids seemed … the kids liked that obviously but generally when you do a demonstration its especially noisy while you setting things up so I think the interaction of the kids , they got excited the rest got a little bit ….?

3 I: Then .. what did not, obviously in terms of the actual prac itself there were things …

4 N: There were things that did not go well and going hand in hand with that is obviously the kids behaviour. So while you are trying to sort things out the kids are running a racket that's what irritates me. That's why I like to be prepared and have things sorted but I mean as you said the best laid plans - its just one of those things. So that what's that what's normally I would say irritates me most if things don't go well you lose control of your class because you are trying to figure out what's going on and they just going crazy.

5 I: OK

6 N: So that's basically it. I think you lose control of the class if .. because it is hard to keep them focused if you are trying to trying to sort out issues.

7 I: That's quite understandable. So, you probably have mentioned this to me before but I need you just to say to me again. What were you expecting the learners to learn from the actual practical?

8 N: I was expecting them to basically what we covered – because we covered density – so I wanted to show them the density of carbon dioxide, oxygen and all those things and show them actually how from the prac you actually can prepare oxygen and hydrogen in the lab its not just the notes I have given them as you know science things it not one of those theories you can't really prove it. Its one of those things that you actually can show them that works. So I wanted them to take away just to have fun a little bit instead of just being taught. And to observe and to use those skills of observation and to come up with their own conclusions, summarise what they've been taught and what they've seen .

9 I: So it is consolidating the theory, it is about some skills and

10 N: That is basically it.

11 I: and some excitement. Alright why did you decide to do practical work to achieve these objectives you had in mind – or why did you decide to do this prac to achieve those objectives?

12 N: It is something that I can show them. Like I said I can't show them – it is not easy to show … let me think of something – for instances teaching them different states of matter and phases and the particles and energy – I mean you can show them the effects of that but you cant really show them that there are gaps between particles in a solid are much more bigger than .. you can show them things like compression and so on this is the nice thing are you can do a physical thing to a theory and its not always possible in science so and at a junior level it is also nice to keep them interested at a senior level its much more theory and there are very few practicals - so the more practicals we can get in at the junior level you can keep them interested keeps them wanting to do the subject so it promotes the subject a little bit

13 I: I did notice that some learners were excited while other were completely disengaged. Is this normal in the school.

14 N: It is normal in the school in any class I think, especially you must remember they all have to do physical science , they all have to do bio. Whether they like it or not they need to do it . When you get to senior phase, Grade 10 they decide want to do science they don't want to do science. So those that don't really want to do science are not really interested. Also certain kids are just kids you know no matter what you do they will never be happy. Its hard to get them all interactive.

15 I: OK. Then the worksheet that you gave them, was that a worksheet that you yourself prepared?

16 N: No it was something that was prepared by a previous teacher that worked here, she's left now

17 I: So all the resources you used were used before.

18 N: Yes it was used before– so I know that it works you know … things that work well we don't really change for instance now there are certain things we are going to change in Grade 9 to accommodate CAPS but em but most of the stuff that we have is working well so we will leave it as it is and just make it accommodate the kids you know. So get them more involved, give them some more research get them to computer labs so it relates a little bit instead of just giving them notes .

19 I: Right and then you said you may repeat the prac. Did you end up repeating the prac?

20 N: I haven't I haven't yet because we running the test in two weeks time so I wanted to finish the notes – but I will tell them I will do it as a fun thing at the end – before the exams .

21 I: And then – the worksheet that you gave them were you going to assess the worksheet in any way?

22 N: No I didn't – I to paste it in then we answered it together and I gave them model answers and explained why certain things worked well and why other things didn't and what we expect to see.

23 I: How would you do it differently if you wanted to or do you think generally it works.

24 N: Ag you know I just think I felt a lack of preparation, probably not on my side but I should have done it but as I said we have a lab assistant who preps everything so I got them the hour before break so I checked that everything was there and the things that wasn't there I asked him to bring. He only brought half the stuff so I am a little bit more – I expected him to have everything prepared because I taught so that threw me a bit but I otherwise I would have been better prepared. If I prepared it myself I would have .

25 I: But the activity itself, do you think it works?

26 N: Yes because you try and get some kids involved some other at a later stage I would give those kids one this was just to get them involved . But you always get the kids who are eager, jumping up first, you know but as the prac goes on you get the ones that are quieter to get involved as well.

27 I: Alright just a few general questions then. Firstly in terms of science education – what do you think the purposes are of practical work?

28 N: Well – I am thinking we are preparing kids to tertiary education and so I know from my experience that they are going give you some practicals so you have to have some hands on experience and as you said it not prescribed as it was 20 odd years that we had to do 20 odd practicals we do 2 if we are lucky you know what I mean. The more we can get the kids exposure to that, the more we can give them hands on the better for them you know. So that they are not completely lost when they do tertiary education. And then for those kids who are not going to, who are not interested in science who are not probably going to do science – it is nice for them to get them interactive with the subject instead of just learning notes calculations the physical part to physical science

29 I: Alright and how does your knowledge of the learners, not necessarily that class but generally, how does that influence what practical work you do and how you do it?

30 N: It will influence that maybe the degree of what I am going to do a little biting for a little bit of advancement then you can say if I add a this look what happens you know that kind of thing. And then you have the kids that just follow to the t do steps 1 to 10 and you not going to because you know they are going to disrupt the class or they not interested or so the dynamics of the class definitely sets the tone you know in teaching anyway even carrying out the prac it depends what you are going to do but I mean you try to do everything , the basics with everyone and depending on what kind of class you have, you going to do … or not.

31 I: So what you saying is you do the prac with everyone but its just

32 N: but there are a few tricks here and there. If the kids mame will you do it again, I'll do it again others lets pack up, then we pack up so it depends on .

33 I: Ok. And then besides your knowledge of the learners are there any other factors that influence your decisions about whether you do practical work or not.

34 N: Yes – it would be time allocation – whether we have the time available to show them is it a luxury? and sometimes we feel you know, even though it is not prescribed by the education department it nice for the kids to actually see something – they don't require you to do these practicals but you've done it before from your knowledge and the kids get excited or its just nice for them to see so we'll show them . Not on everything but where we possibly can we will. If we have the available resources then as far as possible we will try and show them something. Not maybe as practical a hands on but as a demo. Bring in show if we teach electricity next year so will bring an electrolytic cell or show them this is electrodes … this is what your battery looks like. Just to give them an idea of what's going on. As much as possible.

35 I: And then your assessment of practicals formal or informal – will you just comment on that?

36 N: It would be .. we would it depends on again what we doing, with which grade, who we doing it with. The senior phase its definitely an assessment . So if we do give them a practical as a worksheet that we going to mark . The junior phase, not too much. There is one or two practicals that they have to carry out that we will mark but as I say for junior phase its more a fun thing .. get them interested but in senior phase …. There's one or two things that we give them, one or two practicals that they just do for fun. Like for the grade 10's we are going to give them a forensic test kind of thing where they have to identify the soluble salts. It does not count for anything but just for them to kinda figure out what's going on you know . It depends on the time and so on.

37 I: So you actually mark those?

38 N: No we don't mark them . I give them an instruction – no actually if the anion process we taught them how to identify so we'll give them unlabeled containers and we'll I think X is this or this is the iodide or . And other things where we would mark it as a – its actually we don't actually mark it if it doesn't count. We tell them everything counts or else they will get disinterested

39 I: And then if you don't mark it as in yourself mark it and allocate a mark – do you in class just check the work and so on

40 N: Ya so I mean they would definitely, you can't just leave it. the type of kids we have here they wont allow you not to go back. They feel they need to consolidate everything. So no homework is never marked, nothing is ever left empty so even if you forget they will remind you. Just the type of kids that you have here you know there is no ways you can just do something for fun and just leave it. They will want to know but why, how come which is kinda good you know, which could also be a bad thing of course– not at westerford – you wont they wont allow you just to leave something out. It will bother them.

41 I: And then just – you spoke about hands on pracs em, I obviously only saw a demonstration but your hands on pracs, lets say Grade 8 – how many would you do in a year.

42 N: Grade 8 thus far we had about three already and then we doing electricity now so we created little electricity box – ice cream boxes with batteries and simple thing so we take that out every time we teach a lesson. We spend lots of time on electricity . We spend something like the entire 4 th term before the exams. We start at the end of this term. We start off completely basic, what is a battery what is energy they make their own little circuits and connect things in series, ok we don't do parallel in grade 8 yet and then what happens when you put a non-conductor in there. So we introduce all those terms and so about three kids get a box and then there's questions about that. So today we talk about conductor then tomorrow we talk about insulators and then we talk about cell in series, how it affects the voltage, or what is voltage - you we take it very, very slowly.

43 I: And so a lot of that is hands- on.

44 N: Is hands on. So we start with questions and they need to answer it using the boxes then we summarise what have they concluded then we can consolidate, then they copy a note down on what they just did. So in grade 8 lots and lots of hands on work.

45 I: And you mentioned that as they progress through grade 10,11 & 12 you don't do as much .

46 N: No because of all the changes of syllabus and CAPS now it is so so laden with so much theory you know we don't get time to do much with them. There are only 2 prescribed pracs one chemistry, one physics that's possibly we can try and get into that .We will do one or two as I said forensic tests and we don't really have much time and we don't even, all the work that set we don't finish and grade 11 you know so there isn't much time even though we would love to and sometime we have to do we have the time ag lets just sacrifice the time and do it other times we cant you know – we just need to finish this before an exam or a test or something. And the dynamics of the school. If there is a function on so the periods are shortened or .So that all plays a role and at that point in time you decide whether you are going to do something or not

47 I: Alright – just to give me an idea of – you've done a teacher demonstration, you do lots of hands on – are there any other types of things you do in sort of practical work.

48 N: We do presentations, so we take them to the computers or the library so that they can do some research, they come and they give there presentations on so you get some IT involved, some presentation they need to collate a mind map so present it to the class and we mark them on their mind map you know. Too much information , is it user friendly that kind of thing .So there is other form of prac activities , its not just sitting there and listening to the teacher so.

49 I: And field trips and that?

50 N: We don't do . They always moan about the science department its so awkward for us cause we are so many we have to take and teachers time tables are so scarce so I mean so scattered. It would be nice if all the science teacher free say between 10 and 12 then we could go but now you have 2 in the morning and 3 teachers teaching in the afternoon and others don't even see there classes today so it will disrupt the other teachers as well. So we try not to do any. We sometimes get talkers in. We had the

mobile planetarium coming in – I don't know if you know about it this we had a play come in last year on Einstein so we do get that kind of production as well . Its always We want to but after a long discussion we it just the disruption to the school. Other subjects do it but then they are not maybe see their kids everyday or they time table it during an exam session you know . So ya we try doing it – its not that we don't so we don't look into it so we always try but sometimes its just the cons that outweigh the pros . Before we always used to take the grade 10,11's and 12's somewhere . So we start off the year with let us take someone out this year but

51 I: The other thing I wanted to ask you is . In your own experience as a student at school how much practical work did you do.

52 N: Oh I was at time where we did 20 pracs or something. So we did all of those .

53 I: And were those hands-on pracs.

54 N: I think they were. Some were and some weren't . I think half of them were and half of them weren't. But I don't remember much I don't remember doing much practicals. I think I was looking for earthworms and things like that maybe one or two titration pracs that I can remember. But I cant remember much practicals I don't think we much. I think we only did prescribed pracs you know so I think you made me think now actually. We also did always have the resources – I mean I did not go to a school as fortunate as Westerford so that was one of the other issues as well.

55 I: Did you? Cause I remember when I was teaching I used to take my learners to UWC.

56 N: We did not go there.

57 I: What they then did was – they did all the pracs with the Grade 12's so- 5 chemistry in the morning 5 physics in the afternoon.

58 N: And then they just worksheets and they given it back or

59 I: Remember those days it wasn't the whole thing about scientific investigations it was just filling in the answers. Look it had its pros and its cons so one last question – when they do hands on pracs do they often work in groups.

60 N: Often they work in groups. we don't have the facilities to allow them we have 32, 33 kids in a class and we have 10 groups max in a class . So we have 2 proper science labs with taps going all the way round so if you think of the juniors there are 6 classes of 32 you can only set it up in one venue and the teacher has to move out when someone else comes in . so that's a disruption . Try and imagine one kid doing it on its on we wont be able to finish in hours. So they most times we do it in – although sometime we do it – what happens often with the seniors is that they do it as a group and then we'll come back the next day. So they will only do the practical we give them the instruction so the next day we let them write down their data – whatever and the next day they will come into class and answer the questions under test conditions so we give them back their data and each one so they still get an opportunity to

61 I: So they actually completing themselves. They doing the practical as a group but answering the questions themselves. And generally when they are working in groups – do they work well generally?

62 N: It depends you know. With seniors they mature enough or maybe not sometimes to choose their own groups and they probably most likely choose their friends and people they get along with. But then again it is a disadvantage because they are playing around sometimes other times it works well. At this school it seems to work well . juniors it depends on the class., the dynamics of the class. If I find that they are mature enough I will let them choose their own groups otherwise I will choose groups for them and it has its cons as well they don't work well together you know that kind of thing or they work well together. as I said again it's the dynamics of the class. With seniors I will just let them choose their own groups and I will check whose not in a group and that kind of thing.

63 I: And generally when you do group work do they just decide amongst themselves how they are going to organize themselves or are there definite roles that they play .

64 N: Again it depends on the grades. Its grade specific. The matrics I leave it entirely up to them. This is the instruction, this is what you need to do – you come back with a report. In Grade 11 we give them a little more instructions now this is what you need – this how you carry it out you need this that you need to find a person to do this person and – juniors you have to spoon-feed them. So you say this is what you need this is how you go about it What was the question now again?

65 I: we are talking about group work and if they have specific roles

66 N: Ya each one has specific role.

67 I: So is that identified by you?

68 N: in junior grades I - but sometimes not. We do Grade 9 expo with them We tell them exactly what they need and they will then identify who is doing what you know. OK that depends on the activity you know. Like this mind map I told them this is what you going to do you have to do a presentation on the mind map – so you just tell them but you can decide who is doing what I would like each one to present something – say something. But again it depends on what they are doing.

69 I: And you spoke about expo – do you normally send your learners.

70 N: We don't – yes we do . All the Grade 9 we do an expo at the start of year.

71 I: So is that an internal expo?

72 N: Internal expo yes – so we go through from A to Z how you do an expo because in Grade 8 we teach them what is an hypothesis, what is an aim and all those things, dependents independents – all the knowledge we are going to use now. So what you do is decide on a topic that interests you and you need to come up with an hypothesis and you have to carry it out . So in Grade 8 we tell them how to do a method, how to do write up practical, how to do your recording. So in Grade 9 this is your topic this is what you need to do, this is how you display it. So we spend maybe about 2 hours going through

how to choose a topic what is a scientific we do that in Grade 8. How to choose a topic, how to write up a topic what you need for the report what you need for poster and then they do it on their own. And then we have weekly checks on how far you are we will let them do a timetable until due date. Due date is the end of term one. And then we book one or two venues and they set up an internal expo and everyone is invited and then we actually have the presentations so the kids would actually present like they would at expo. We don't give them as much time and then kids ask questions of them they have an opportunity. And then now we look who wants to – or I think you should present or ask them who would like to then one or two .So this year we only have one group entering. They were the only group that were interested you know. So they are in thee process because expo is next week so they are busy and that it

73 I: And the seniors?

74 N: the seniors – we offer it to them but they normally – because they have so many projects of their own in grade 10 11, and 12 same for bio you know. The idea just creating something at an expo level is just so much work I think they just decide they not going to.

75 I: So what science projects

76 N: In Grade 10 this year – let me see – what project did they do this year? In Grade 10 they did batteries – o they did some research on batteries and write a report on it and do a poster same at a grade 12 level because we just taught the chemical cell now so it links to what they are doing . The battery thing after mocks. Grade 11 ok we haven't created one yet.

77 I: So are those mainly research projects not

78 N: Research projects - and then we have investigations and so we have one research project then we give them 2 investigations – so we tell them you have to look at the effects of rainbows . Then you have to create your own rainbow. Why is it like this = so they looking at . So we don't tell them anything. So they have to figure out how some do it in a dark room, others do with water, other do it with the glass you know so they need to figure out research carry it out and then come up with their reports. Grades 12 we do a sugar investigation – so they have to burn sugar you know – look at the chemical reaction – you get carbon they do they make an apparatus from recycled material they use tins and tealights and candles and thing and they put sugar and they have to figure out one teaspoon to – but all we give in the outline is this is what you need in your report – its an investigation hypothesis, investigation question, results conclusion. There might be pictures, proof of that you have done it this is the topic you go and get it done. How you carry that out – that is entirely up to you. So its amazing – so you get some kids come up with the same, some come up with ingenious things so last year I had someone with came with a lever thing and a little … bottle and the candle lifts off and you could change the level of the height to the flame and so they seem to enjoy it . So I think in Grade 12 we introduce it just after mocks to we give it to then the week before the September holidays so they all tired and so it is something fun for them to do you know so that so they first say oh no mame how can you give this – bt afterwards its best it of the entire grade 12. It depends also It seems to be working well.

79 I: Ans so times you know when you give learners projects , you find that their parents end up doing the work. Do you find that quite a lot here.

80 N: In junior science they do – not so much in senior science. We do have a problem of plagiarism copying pracs from year to year but we are trying to prevent that as much as possible. So my kid maybe from last year and their project is maybe from another teacher . When we have time we compare projects especially with the first year teachers. What we would do is organize those teacher and sit down as a group with them and mark it collectively each one a good one they think they have a a bad one and we all mark it and we analyse it until we fell confident and they feel confident but we try to prevent cheating and plagiarism but its not always possible

81 I: Ok Thanks so much for your time.

Transcription filename: Nadjwa Lesson

Teacher: N
Learner: L

30 learners in lab with demonstration desk at the front and sinks, and gas along three walls . there is an adjacent store room.

There are double tables (two per table) arranged in rows.

Teacher is wearing a white coat all equipment and chemicals are on the demonstration table

1 N: So we going to show our visitor how well behaved and what ACE students westerfords are obviously I am expecting too much of this Grade 8 class.

…. Did you touch anything?

2 L: No mame!

(Puts up a diagram showing the preparation of O_2 on an overhead.)

3 N: So what we are going to do initially grade 8's – we are going to do oxygen first. Will you just read through our notes on what oxygen looks like. Who can without looking at the notes – what are the two chemicals we use to create oxygen? Do you have the answer to the question? You going to try Ingrid? Oxygen?

4 L: You can't make oxygen

5 N: gas

6 L: Its an element you cant use something else to make it.

7 N: We making oxygen. Yes you can. You make oxygen you breathe out carbon dioxide. Class makes oxygen. Right. ….?

8 L: Potassium chlorate

9 N: Its potassium chlorate and ?

10 L: magnesium sulfate

11. N: And magnesium?

12 L: dioxide

13 N: Dioxide. Right. Shh. Settle down. Grade 8's I need you to settle down please. So again remember we going to take some potassium chlorate. Now you

going to stop cutting and pasting because you have to watch me now ok. And we take manganese dioxide, put it on the bunser burner and we going to heat it and we going to collect again. …. whats the method? how do we collect oxygen?

14 L: Collect oxygen mame?

15 N: Yes the method. What is it called? … Can't you help … ?

16 L: downward (unclear)

17 N: Yes … ? Downward displacement of ? …. what is the method?

18 L: (softly) water

19 L: Downward displacement of water.

20 N: of water. Thank you. Right so what I'm going to do . Come now quiet.

21 L: (learners chatting) its funny how they took so long … on the board

22 N: on the board too yes. …

23 L: … is terrible

24 N: No, no. … . Same can be said about you? …. We going to take some manganese dioxide and potassium chlorate (chatting) . Shhh. ….. I am going to try to fill two gas jars so there's quite a few things that we have to carry out but I don't think we will be able to do all but I just want to at least make two of each Shhh.

25 L: Will we be able to smell it?

26 L: Its odourless.

27 N: Its odourless

(chatting)

28 N: Shh Grade 8's

29 L: (chatting)

30 N: OK. Lets have a look. Right lets have a look, we have our chemicals, lets light our Bunsen. Lets get the matches. Who wants to be my assistant? James.

31 L: mame I want to be your assistant.

32 L: mame …. is unreliable

(Lots of noise he takes off his tie and puts on safety glasses)

(a few learners surround the desk)

33 N: What …. is going to do. If you can't see properly stand on the side … is going to fill our gas jar? Remember that. So what we have is test tubes we have our chemicals in there, potassium … ! I'm going to put in a stopper. No, no ? taking anything. A lot of people ask what does the beehive look like. This is what it actually what it look like guys. So what's going to happen is, we going to put the rubber tubing through here, through this hole over here and a gas jar on top of it . Ok so
[does not allow gas in tube to escape]
(a few more learners come to the front while other remain in their seat – some continuing to do other work)

34 L: Why is it shaped like that?

35 N: Sorry?

36 L: Why is it shaped like that?

37 N: So this can go in there.

38 L: Why does it have those ridges?

{ learners ask a number questions and other learners answer some of them. Teacher often does not answer the questions}

39 N: Right. So you need to invert that … no no and invert it . No, no take your hand invert it remove your hand once, only once it is in the water. Then close. Got it? tubing …. Ok … so James you can get out of the way so that we can show everybody. So what we've done is put the tube through the hole in the beehive through the hole at the top and the tube is now in the gas jar with water.

40 L: mame can we move this so that everybody can see?

41 N: Oh

42 L: Mame is there water

43 N: There's water in the tube – in the gas jar as well and you going to try and

44 N: No, no

45 L: mame Whats that black stuff?

46 N: Where's the black stuff?

47 L: in the tube

48 N: One of them are potassium chlorate

49 L: Potassium is the white one.

50 N: potassium is the white one The other one is manganese

51 L: manganese

52 N: manganese– so the black powder is manganese. So the black powder is manganese dioxide and the one is potassium ….. How will we know that a gas is being produced guys? It may take a while. … ?

53 L: Mame bubbles will ..

54 N: Where is the other ….

55 L: He is not here

56 L: The other, other …

57 L: … 3

58 L: Big Mac

59 N: You call him big Mac? Who came up with that?

60 L: I came up with that mame.

61 N: So lets wait a while. There we go. Have a look have a look have a see guys.

62 L: Youooooh

63 N: OK first person who can tell me how do we test for oxygen gas?

64 L: Put glowing splinter in oxygen and it ignites

65 L: Look mame all the water is disappearing.

66 N: Did you guy see what's happening? The water is?

67 L: displacing.

68 N: I want you to hold that

69 L: mame the waters going back out the thing

70 N: Oxygen is pushing the water out – oxygen is pushing the water out of the gas jar.

71 L: Your hands in the way here

72 L: Mame if it is so easy to make oxygen, why can't we just make more so that we don't like die?

73 N: Oops

74 L: … you can't stand there man.

75 L: … we can't see

76 N: What I going going to invert … water in there. Right so … you are going to put your .. bunser burner

77 L: Must I light it again?

78 N: Have a look guys , putting this in and its see oxygen ..

Small explosion

79 L: Yourrrrrrrr

80 L: That so cool.

81 N: OK so that is oxygen OK so now what we need to do is

82 L: Agggg
(Laughter)

83 N: Just fill this with water. Lets collect another gas jar of oxygen. So that's done. So do you believe me that that is oxygen guys?

84 L: yes

85 L: Check those stuff floating in there that so cool.

86 L: Mame when the oxygen is used up, what is in the tube thing.

(indistinct)

87 L: …. Carbon dioxide …

88 N: I just want to take another

89 L: The burning stick thing

90 N: Right I'm filling another gas jar with some over the weekend so on Tuesday when I see you we can look at the level if oxygen is soluble in water compared to carbon dioxide and hydrogen as well. I'm not to sure what we supposed to do for oxygen there guys?

91 L: Mame – when the match uses up all the oxygen is carbon dioxide that is left in the thingy?

92 L: Mame whats all the white stuff that's in it now?

93 L: Smoke

94 N: Smoke, carbon dioxide.

95 L: I can't

96 N: No maybe you should do what I asked you first time. …. taking pictures of babies and

97 L: (laughter)

98 L: Bubbling

99 N: Don't do what I do hey. You guys on the bunser burner …. you don't do what I do

(chatting)

100 N: Shhh Right we going to do carbon dioxide next.

101 L: mame why does this one go slower

102 N: Must be the chemicals that we used now?

103 L: mame I like your (indistinct)

104 N: You like it?

105 L: use the black and white picture

106 L: (chatting)

107 L: I really can't see

(Chatting)

108 L: I thinks it done

(Chatting)

(puts diagram for carbon dioxide on the board)

109 N: Right next. … I want you to … (indistinct)

110 L: Mame you said you going to use a different person.

111 N: Ok a different person

(chatting)

112 N: OK I need a marker

113 L: chatting

114 N: What is happening? ….. I need a marker, who has a marker?

115 L: chatting

116 N: A little patience, a little patience guys, come on - next we going to do carbon dioxide. Who can recall what carbon dioxide is guys?

117 L: chatting

118 N: Right we said. We need basically calcium carbonate and dilute hydrochloric acid. So what I have over here … I need someone to write on here for me please O 2. Get a marker for me

119 L: What a marker – I have a highlighter.

120 N: Ok so carbon dioxide. What are we adding?

121 L: Oxygen

122 N: Nooooo

123 L: Potassium chloride and

124 L: Mame for which one?

125 N: carbon dioxide

126 L: Dilute HCl

127 N: Calcium carbonate

128 N: I am going to do now I going to add calcium carbonate

129 L: mame if I open this tap will the gas go on.

130N: Yes the gas is on.

131 L: he switched it on

132 N: So what I'm adding now Grade 8 is calcium carbonate , Grade 8's settled down. Calcium carbonate . Who can tell me why am I not using the downward displacement method to collect carbon dioxide. Raise your hand and answer. Not because it is a different gas

133 L: because the density is bigger.

134 N: because the density is?

135 L: Bigger

136 N: Bigger . So what we going to do is . The first thing I am going to do is I have lime water over here. Remember the test for carbon dioxide? what what happens?

137 L: Mame isn't it just normal water?

138 N: … whats wrong? Why you sitting … don't you want to open the window because I think its becoming a bit stuffy?

139 L: Mame isn't it just normal water?

140N: No its lime water.

141 L: What the ..

142 N: When you get to Grade 10 I will explain to you more . For now just remember its lime water is I will explain to you on Tuesday. So I have calcium carbonate in here I am going to add dilute HCl …. So we can add that . (silence) Whats wrong – its not going through

143 L: Not funny

144 L: Put on your glasses

chatting

145 N: So he is holding the lime water …. hold that as well (silence)

146 L: One bubble

147 N: One bubble…. There we go there we go. Can you see the bubble?

148 L: Bubbles

149 N: can you see the bubbles guys?

150 L: mame there so many bubbles.

(Chatting)

151 N: Lets add some calcium carbonate

(chatting)

152 L: mame what is that?

153 N: Its calcium carbonate …..

154 L: Wow

155 N: Still not doing anything?

156 L: laughter & chatting

157 N: You know what . Lime water . Put that in there , hold the tube Hold it here please – thank you. that's better ….. I didn't make the lime water I don't know why it is not . Anyway let us just and fill this gas jar now. I really don't know . I think Mr … didn't mix me a fresh concoction of lime water. There we go . I am going to take this straw and blow through it and then it should go

158 L: Are we making – mame?

159 N: we are making carbon dioxide

160 N: OK lets have a look we will try the lime water again what I am going to do remember I said carbon dioxide does not support combustion

161 N: So if I take my candle … this is not going to work because there is no carbon dioxide in here

162 L: So mame its denser than air

(it does not work)

163 N: I don’t know what is going on.

164 L: so its denser than air so it will be at the bottom

cahtting

165 N: Now lets see if its going work?
(it does not work)

166 N: But anyway we can always redo it on Tuesday.

167 N: Ok we will leave the carbon dioxide there.
(puts diagram for hydrogen on the board)

168 N: Right next person

169 L: me

170 N: We are going to do hydrogen now.

171 L: mame can I be the next volunteer?

(chatting)

172 N: We have to choose a girl

173 N: OK we just going to take the test tube … Right for hydrogen – hydrogen is what? We’ll try carbon dioxide carbon dioxide again.

174 L: zinc granules and

175 N: zinc granules and sulfuric acid

176 L: hydrochloric acid

177 L: and sulfide

178 N: Oh her’s more hydrochloric acid. Lets do hydrogen gas and if not I will try something … OK so what we going to do is basically

179 L: (laughter)

180 N: You have to wear them.

181 N: Ok so all you going to do is just hold this for a while. How do we test guys?

182 L: it makes a squeaky pop?

183 N: What makes a squeaky pop?

184 L: the match

185 N: a lit match
186 L: a lit match
187 N: or a splinter

188 N: So we going to take .Lets put in our acid first …. So you can see the gas being produced . There is hydrogen over there

189 L: You guys missed that. (A popping sound) You missed that – you talking non stop . so that is basically hydrogen being produced. We said there was going to be a squeaky pop so lets just do it again.

190 L: can I do it please?

191 L: (a lound pop) Yourrrrrr

192 N: What can we do now

193 L: Pop goes the weasel

194 N: We going take a balloon and fill the balloon

195 L: And its really light.

196 L: Will it float mame?

197 L: Can I please have the balloon?

198 N: the balloons are old.

199 L: Does anyone have a balloon?

200 N: So what I am going to do

201 L: Mame will it work?

202 N: Right so what we going to do

203 L: mame will it work?

chatting

204 L: mame that stuff will probably burn your skin.

205 N: Yes it will. ……. Right you can see that the balloon is definitely being filled by hydrogen gas. I am going to try carbon dioxide now if we've got time. We have time. ….. Very chatty today hey … . Non-stop.

206 L: Me? I'm sorry mame.

207 N: no sorry

208 N: Ahhh . I'll do it again.

chatting (1 ½ min)

209 N: Ok I am going to hold this and try again … Grade 8's … OK here we go

(balloon fills but removes stopper and deflates tries again but does not work)

210 L: … glasses on. Picture time

211 L: … this is your safety at stake.

212 L: mame is it going to pop? Put your glasses on
(3 min delay)

213 N: We'll try one last one. Third time – third time lucky.

214 L: Mame is this going to blow up?

215 N: No its just going to pop. So what I have over here? …. Ok I have a tiny little balloon filled with hydrogen gas it's the best we can do and what we going to do now is what did we say …

216 L: We can't see …

217 N: Guys are you looking?

218 L: yes mame

219 N: Ahh there's it

220 L: Ahhhh

221 N: We'll try it again …. Grade 8's I asked you at the start of the lesson , I asked you last week as well (afternoon guys) on your patience.

222 N: Grade 8's 4th balloon. Two of them were broken. … listen please. I want you to listen. Tell them what you are observing.

223 L: Its warm.

224 N: Why do you think it is warm?

225 N: releasing energy. I want you to think about . Stop throwing things around now hey … and I want you to think about the word exothermic. When you get to Grade 9 we will teach what endothermic and exothermic is . Remember this experiment . Lets have a look – last five minutes . ……… right this is the last try.

226 L: bubbles

(puts partially filled balloon on board but it does not ignite as expected)

227 N: Its just one of those days guys. … Ok lets leave it. Nothing seems to be working today besides the oxygen. Right thank you. Do you guys see the marks on the board? Previous experiments when it used to work but I don't know what's happening today but

(Small explosion)

228 L: Lets do it again mame.

229 N: No, no we had enough now

230 N: So what you were supposed to – Grade 8's I you have a bad memory I'd like you to on the worksheets otherwise we will do so together on – oh we still have 10 minutes. So you can start now. While I tidy up.

231 L: mame can I have a sandwich?

232 N: No – no

233 N: Grade 8's I gave you work to do while I am tidying up – you should be doing it not chatting

(she checks some learners' work)

234 N: … have you filled in anything on that worksheets? Stop arguing, do the worksheet

235 L: This practical must we fill it in?

236 N: yes

237 N: I am very sorry this did not work out now.

238 I: No that's not the point . So are you intending – they now fill this in

239 N: Then we go through then once we done so that's basically your answers so. I ask for their suggestions what they thought. I wanted to do all the gases – normally what I do normally, normally it works I leave the trough inverted the level and then we decide which is more soluble so I mean I did not get there today – I never do the soap bubbles because it never works. But everything else so we fill this out – basically now the uses and then we going to have a summary of the gases and then thereafter we teach them what mind maps are then the difference between a mind map and a concept map. we copy down some examples stuff they done already topics I will introduce the topics on Monday to them . So ….. indistinct.

Grade 8's you guys are not leaving until you have picked up every single paper on this floor. This floor was tidy because I made my Grade 11's pick it up. I knew we were going to have a visitor so I made them pick it up. look it's dirty full of tiny little papers you all no one is leaving

I will try and make up more carbon dioxide and then they can just blow through and blow out the candle.

Transcription file name: Nadjwa pre-lesson interview

Interviewer: I
Interviewee: N

1 I: Thanks so much for agreeing to this interview. You said you were teaching the section on gases with Grade 8 hey.

2. N: I started this week yes.

3. I: So if I just ask you – looking at that topic in Grade 8 – what do you think the main ideas are in that particular topic.

4. N: Basically I would say one of the main – cause I mean, we started the year with apparatus – we show them how to use some of the apparatus like the thistle funnel and those kind of things. We show them also – we've just taught density, show we can now compare the density of the three gases so that come into play. Before density we did the molecules – the difference between gases liquids and how – you at atomic level what happens in the molecules of a gas compared to when it is a solid – so that they can visualize that all now. Then actually we get to and then the most important thing we want to carry through is how to test for these three gases- because they carry this knowledge– we expect them to know this all the way to grade 12 – how to test for oxygen with the splint, glowing splint, how to test for carbon dioxide- we use that again in Grade 9 – so we do practicals on that again – so those are the main things that we basically want to do.

5. I: OK. Just something I wanted to pick up on. You said that at the beginning you actually teach them how to use certain equipment. Is that what you said?

6. N: Yes we do. We start off our module – our year with basically lab rules then lab equipment so we teach them this is a thistle funnel, this is a conical flask, this is a retort stand you know so it kind of links to what was taught already.

7. I: So is that at the start of the Grade 8 year.

8. N: Yes at the start of Grade 8 and then they do some simple measuring, we do measuring as well you how to measure with a beaker and a burette and a pipette. So we have a simple practical at the start of the year just to get them to use a those little – teach them to light a Bunsen burner as well. We spend actually quite a while- about an hour teaching them. They have to draw it, label it, and then they have to come up the next lesson and actually have to light the bunsen burner because there is a particular way they have to light it. So all those things kind of comes into play.

9. I: So is this their first topic where they are actually going to be using practical work.

10. N: No, no. They have done practical work before. They have also written in June – prac exam on basically identifying apparatus – or we set up a investigation and they have to identify what is the filtrate, what is miscible and why is it miscible and that kind of thing. Its simple little things so they got all the background knowledge so this is the last chemistry prac we do and then we move on to electricity. So gases is the final thing and it just collaborates everything that has been done. We wouldn't we advisable for us to start teaching gases at the start of the year because we have start building up the basics.

11. I: Right. Just in terms of the sequencing of your topics or modules- do you follow the WCED.

12. N: No we don't at all. I've got permission from my principal, we have been doing this for years. We basically rearing our 8's and 9's for the senior phase. So we teach them the basics that we want them know in Grade 10, so we can just build up. For things like – in grade 9 they need to do something like light, then we don't teach them light because we do that in 10. So everything that we expect them to know, starting with the chemical equation, balancing – we do all that in 8 & 9. So we don't have to teach that. We can just start off with basic – what is an element – all those things get taught here so we kind of I would say maybe 80% of the time but we don't follow exactly to the t.

13. I: And with the new CAPS coming in- do you think that may have to change or not really?

14. N: What – again I said grade 8 & 9 we relate to 10 – so we already decided things from Grade 10 things that we've taken small little sections like what is homogenous and heterogenous things like that they they want us to teach in Grade 10 we are going to teach it in grade 9 next year onwards. So ehm that's our main goal you know. We will try and follow CAPS as much as we possibly can but our basic goal is just to prepare them well for grade 10. So what we found in about 5 or 6 years time is that gap between 9 and 10 was so great that the kids would be getting A's in Grade 9 and when they get their first exam in grade 10 then they get 50's then they would be this big – then they can't understand. So we have been for the past two three years the first initial thing we did, we separated out the biology and the physics. So life science teachers teach biology now in Grade 8 & 9 and science teachers now teach grade 8 & 9 . Previously we use to teach bio and physics So we done that and now we kind of rear them so already teach the thing … the way we teach senior science. We didn't before so that gap is getting a little smaller.

15. I: So have you seen some …

16. N: We have. We have seen some improvement in the kids coming through. Cause I mean cause initially what we used to have was what we used to have was the kid coming through to Grade 10 had been taught physical science by a biology teacher and then there were gaps . We know exactly what we they were doing and what we want them to do, so we rear them well and the same thing is happening now in biology. You know they can change their syllabus in 8 & 9 - so we getting there.

17. I: So you have just started teaching this topic so if you can just explain to me what you have done thus far.

18. N: What I've done thus far basically started with , I started oxygen, it's the easiest one so I ask little bit what do you guys know about oxygen, so kind of relevance, so say they we breathe it in, use it in respiration, so they'll say oh Mame we actually doing that in biology now, the respiration, so we just talk about what happens, its diatomic, a little five six points and then they copy that notes down, and then we give them a diagram on the preparation of oxygen and then they label it. that's basically it So this is what we are going to do when we do the practical and then do the same for hydrogen and .. so it takes a bit that took an hour and a half, and you know grade 8 level and so when I get them now the next lesson which is tomorrow I will hand out a worksheet which I'll get them to paste in their books first of all then I say look at the columns it says here each .. column and rows and then they will tell you solubility in water, reaction … I cant remember the questions now but anyway each gas will have its own column and different … so this is what you have to look out for when I do the practical … basically

19. I: So you only did one lesson before so now…

20. N: No, no I did an hour and a half.

21. I: An hour and a half – which is how many lessons?

22. N: One and a half lessons

23. I: One and half lessons, oh ok. And now you are going to do the practical. Are you intending to do all three?

24. N: It depends you know – sometimes I manage – it depends on how smoothly things run. Different classes is different – sometimes you have a class who can do everything and another class can only do two. On average I can normally only fit in two and then I have to do a third one on another day. But our aim is always to finish all because they've got the notes. So what I will try to do is to finish off all three practicals, they must fill in what they see they can then when we get we consolidate you know. What did you actually see, what can you conclude from that, that kind of thing. We got some fun things, we've got things where we basically fill a balloon with hydrogen that the ending off so hydrogen lasts with them put so we put it

on the board and light it a big explosion that's the ending. So as I say I like to try and do it in one hour. So they remember it. Then they going to moan again, do it again, do it again. That's the gist of what we intending to do tomorrow.

25. I: Alright then. Are there any ideas or concepts about gases that because they are in grade 8 you are deliberately not teaching them?

26. N: No … Yea we don't talk about … cause we teach gases again in Grade 11, so we talk about temperature, pressure and volume. Those things we don't touch on at all now its just the basic introduction of …

27. I: So you – am I right in saying the main ideas are really preparation and the tests. And its obviously theory and actually practical.

28. N: Ya.

29. I: Right – just in your experience of teaching this topic – what are the areas that learners have problems with?

30. N: Definitely the reactants that make up – we ask them – we give them – this is what you have to prepare oxygen – so they have six different things they have to remember – so they have to remember is it dilute sulfuric acid is it concentrated – so they get confused between what is what kind of thing and also another difficulty they have – because of the density of oxygen - they collect over the downward displacement of water – they forget what the method is called . Simple things that basically is what – or they forget that oxygen is diatomic or hydrogen is diatomic. You that kind of thing and carbon dioxide is also going be its got two and carbon dioxide is also diatomic so they forget the basics of chemistry . But those who study well – because we test them basically justs what's in their books - they really do well. I try to set, I try when I set exams, I try and set on related to what's being taught, I also set a thought questions but I mean if it's a straight forward Grade 8 paper - whatever is in their book, they should do well.

31. I: And just in terms of the collection of gases – is it going to be the first time they are going to see the collection of gases?

32. N: See – yes.

33. I: What do you – you're knowledge of the learners how will it or how has it influenced your planning teaching this particular topic?

34. N: Like I said it depends – I'm planning, this is a kind of a rowdy Grade né but you know I'm just stern with them so I am intending to finish everything other classes I know there are too many questions there is no way I am going to finish it. So with this class I am intending to finish everything in the hour hoping everything works obviously. There is

always issues with that – but otherwise … so it does play a role yes . How do you say - the ethos of the class, what do you call it the dynamics do play a role,   and if you've got a weak class then you've gotta go really slowly – but I am not gonna go that slow because I've given them the background, we've spoken about it a little bit – so this is it – this is what we use, and this is how we prepare it.

35. I: So do they affect mainly the pace at which you go rather than what you do?

36. N: What you do – we basically teach – every year more or less. We teach the same thing – you set the pace . You can see – you can see some kids who are not really science orientated at this level. As much as they try, they are not getting the basics so there is no ways. And its hard cause I have this girl who is in Grade 9 who can't , she can't seem to – beautiful at art but just cant seem to grasp.

37. I: Science is not her thing.

38. N: Science is not her thing. So no matter what you try – so doing subscripts so put it at the bottom. She says I keep forgetting mame . So things like that . So you can identify at this level already. Hopefully trying to turn them from not doing science. Just – we don't normally chase anybody away but sometimes …

39. I: Ok – the teaching strategies we've touched on – you've – so in tomorrow's lesson the practical and obviously there are worksheets and so on. You mentioned that in previous session you basically gave them the reactions and apparatus and they labeled the diagram. Is that mainly worksheet based?

40. N: They had to copy down the notes, we chatted a bit about each gas, first oxygen you know- a little mind map you know, and then I gave them an actual note on it, they copied down the notes and then I gave them a copied picture of the apparatus, they labelled it and that's it and then we did hydrogen

41. I: Oh and then repeated the same thing. Alright. Just in terms of assessment – how will you check if they understand what you've done?

42. N: Ok – so – we try and have a test after each module so there is going to be a gases test on this module . But before that we doing a little presentation activity. So we have 10 topics – you have things like …. of gases , respiration, baking, carbon dioxide – baking cakes kind of thing and they have to relate one of the three gases to their topics . So they should know that baking cake relates to carbon dioxide. And so we put them in groups of three and we allow them to do some research on it so they come back and each person in the group must present something about baking cake and how it relates to their topic. And then one of the criteria is to make a

mind map of the topic and then presentable and copy down so that the rest of the kids to make the rest of them interested – cause what we found was that they would chat and not be interested so they need to copy down the mind map so the rest of them just listening they have to copy down the mind map as well. And they take turns so they end up having 10 mind maps in their book. But we teach mind maps first once we've done with the prac write up then we are going to do mind maps and I give them the topics so we come back again next in a weeks time. And so we sits through those and listen to them and then each one gets a mark on their presentation and their mind map. And then they write their test soon after that. We always tell them they don't really have to study the mind map but they just read through it and we ask them one question in the exams so why did the Hindenburg explode kind of thing or what is … so we don't force them study the extra information but general information about the topic.

43. I: So it is application

44. N: basically ya

45. I: … of the topic. Ok is there anything else – you – ok so you've now told me about the mind maps that was very interesting. Is there anything else you intend doing besides gases?

46. N: gases ?

47. I: On gases?

48. N: No we move on. Once we've done the mind maps on gases we move on. Mind maps are quite a long time we only see them for two hours – so ten groups of three and they have to listen then they have to copy down so it takes quite a long time . we cant actually allocate anymore time on gases. It also gets them involved you know – not just sitting listening and copying down notes.

49. I: The prac tomorrow is it a teacher demonstration ?

50. N: It's going to be a teacher demonstration ya.

51. I: Ok

52. N: Basically because it includes hydrochloric acid and it also goes a bit quicker also. As I've said they had hands on experience already so . we choose the safer stuff I think they did one on filtering – chalk and salt or something how to light a Bunsen burner, copper sulfate that kind of thing so they've done .We do more practicals in Grade 8 at the start of the year cause as I said we introduce and then as the years move on they do less – because the other modules and it takes more time

53. I: So generally do you have – just in terms of practical work – do you have - how many labs do you have at the school?

54. N: We have three labs with gas taps going all along the class wall – but they are all teaching venues ..

55. I: OK so not designated

56. N: No so once so we use it for teaching and for learning so sometimes we have to swop venues when we have to set up pracs in those particular areas and then we have two classroom we use as demos – with gas taps on the main desk but are not really labs but you could use to do demonstrations on gases in your teaching venue instead of going to another venue.

57. I: And teacher are based in rooms?

58. N: Yes teachers are based in room and kids move around

59. I: And do you have lab assistants?

60. N: Yes we do. Mr … has been here for 20 odd years .

61. I: Ok – and what is his role?

62. N: His role is basically setting up practicals for us. So two weeks ago I will come to him and say we going to do gases so please prepare this by this date in the venue or what ever and then he sets it up for us. We have a booking sheet books so each teachers books in a the date and the time so he must make sure those things are there for that teacher and that is what he does and he does our printing we are fortunate that he does our science printing the rest of the school sort of does their own printing and they have a person who does the general printing and …

63. I: So he is Life sciences and …

64. N: Life sciences, physical sciences .

65. I: And technology as well?

66. N: No he just does the sciences .

67. I: And generally, you said you have quite a few young teachers so they also do quite a bit of practical work?

68. N: They do everything I do basically and so in their first year I would normally demo it to them or we will get Mr … to assists - he's been here so long he knows so he will help them out especially with hydrogen you know –they nervous so he'll actually do it for them or if they are free

they will come and watch you do it so they feel a bit more confident > So we having weekly meetings – so I will sit down next week and so this is exactly how we do it so you can come and watch me do it if you wish or get Mr … in to assist you. In normally in their second they know more or less what they need to do .

69. I: Its nice that they have some kind of support. Ok I think that's all for now and then I will see you tomorrow.

70. N: Tomorrow

71. N: So its 12 to 1.