CONNECTING TOPICS FROM GRADE 10 AND 11 IN GRADE 12 TO IMPROVE CHEMISTRY PERFORMANCE IN MATRIC PHYSICAL SCIENCES

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Declaration

I hereby declare that the dissertation entitled "Connecting topics from Grade 10 and 11 in Grade 12 in order to improve Chemistry performance in Matric Physical Sciences Paper 2" submitted to the Department of Chemistry, North-West University, Mafikeng Campus in the fulfillment of the requirements for the degree Master of Science (MSc) in Chemistry is the original Research work conducted by myself under the supervision of Prof. H. Drummond. None of this Research work has been submitted by any student, at the North West University or any other University.

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Mr I.J Molaakgosi Date

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Prof. H. Drummond Date

Acknowledgements

I dedicate this thesis to my parents, who have sacrificed a lot to see me succeed; I can never thank you enough. To my sisters, my daughter, my nephew and niece, thank you for being my pillar of strength during difficult times. To my supervisor Prof. Helen Drummond, thank you for guidance and patience. Lastly; to everyone who helped me with this research project: the teachers, principals, and learners from Bodibe Secondary, Baitshoki High, Tswelelopele High and Tau-Rapulana High Schools, I couldn't have made it without you, thanks a million.

Abstract

According to the National Diagnostic Reports (NDR) of 2013 and 2014, learners in Grade 12 did not perform well in Physical Sciences Paper 2 (Chemistry) and did not understand the complex Chemistry content taught in Matric. In this research project, it was assumed that this was caused by: lack of mathematical, scientific skills and reasoning needed to understand Physical Sciences; and lack of understanding and recalling of complex Chemistry content taught in Grade 10 and 11 before they entered Grade 12, as the Chemistry syllabuses in Grade 10 and 11, link directly with the one in Grade 12.

To solve this problem, three Chemistry topics (Organic chemistry, Reaction rate and Electrochemical cells), which were reported to be the most challenging to Grade 12 learners (Department of Basic Education, 2014) were selected. The topics in Grade 10 and 11 which link with these topics in Grade 12 were revised before the selected Grade 12 topics were taught.

An IQ test and a Chemistry common test were administered to learners at four schools in the Ditsobotla District of the North West Province before the actual research was conducted. Thereafter the learners in one school were divided randomly into the experimental and control groups. The experimental group was taught revision topics of Grade 10 and 11 before the beginning of Grade 12 topics; while the control group was only taught Grade 12 topics. This was done so that it could be seen if revision of Grade 10 and 11 topics did help learners understand Grade 12 Chemistry better.

Before, for example, Organic chemistry was taught in Grade 12, learners in the experimental group were reminded of chemical bonding, atomic structure, valency, intermolecular forces etc. from the Grade 10 and 11 syllabuses, so that they could link them with structures of organic molecules, reactions between organic molecules and the different boiling and melting points between different homologous groups, which are part of Organic chemistry in Grade 12. This type of revision was also done on the topics Reaction rate and Electrochemical cells.

The IQ test was administered in order to check if learners who are doing Mathematics and Physical Sciences from Grade 10 to 12 had the skills to cope with the content, and the Chemistry common test was administered to check if there was a gradual increase of knowledge of Chemistry content from Grade 10 to 12.

The results of both the IQ and Chemistry common test showedthat the Grade 10 learners in all the schools had challenges with basic concepts of Mathematics and Science, indicating that they enter Grade 10 with limited skills and knowledge to cope with Grade 10 Mathematics and Physical Sciences. The Grade 11s also showed lack of skills and knowledge, indicating that there is little progress of gaining skills of Mathematics and Science when they progress from Grade 10 to 11. The Grade 12s performed better than the Grade 10s and 11s but as not expected, also indicating that many Grade 12 learners had not yet mastered basic Mathematics and Science skills.

Results of the studyshowed that revision of Grade 10 and 11 concepts helped learners in the experimental group perform significantly better than the control group and their main difference was the manner in which the learners in the experimental group responded to high-order questions as compared to the learners in the control group. It was concluded that revision should be done in all grades to allow learners to recall previous knowledge before entering a new grade, and this would help them to understand concepts they did not fully understand in previous grades.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAPS: Curriculum and Assessment Policy Statements

DBE: Department of Basic Education

ELRC: Education Labour Relations Council

Emf: Electromotive Force

FET: Further Education and Training

FOA: Form of Assessment

GET: General Education and Training

IQMS: Integrated Quality Management System

IQ: Intelligence Quotient

LTSM: Learning and Teaching Support Material

NDR: National Diagnostic Report

PCK: Pedagogical Content Knowledge

VSEPR: Valence Shell Electron Pair Repulsion

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Since the introduction of the Curriculum and Assessment Policy (CAPS) in all learning areas offered in the Department of Basic Education (DBE) (2011a), Physical Sciences focuses only on five major topics, being Matter and Materials; Chemical Systems; Chemical Change; Waves, Sound and Light and lastly Mechanics (Department of Basic Education, 2011b). The first three topics are assessed on Paper 2 while the last two topics are written in Paper 1 of the final examinations in all grades of the Further Education and Training (FET) phase (Department of Basic Education, 2011b).

After the release of the 2012 Matric results, the National Diagnostic Report (NDR) stated that in Paper 2 (Chemistry) "the overall performance of candidates was not good." (Department of Basic Education, 2013). Although this question paper was written before the introduction of CAPS was at Grade 12; learners clearly did not have the basics, knowledge and skills of Chemistry that they should have learned from previous grades i.e., Grade 10 and 11, and this affected their overall performance in Grade 12. According to the report, "lack of skills to interpret data and to give reasons/explanations, resulted in the very poor answering of the question paper" (Department of Basic Education, 2013).

The CAPS Physical Sciences Policy suggests that "the best way to ensure that learners study the basics is through frequent informal testing. This should be done on a daily basis, sometimes orally and sometimes as a short test that can be written in homework books and marked by the learners" (Department of Basic Education, 2011b). However, this does not fully solve the problem of learning Chemistry, as most teachers do not have the time to analyse each question from each learner's book and revise it with the learners before they write the formal test or examination (Department of Basic Education, 2011b).

To solve problems related to mastering Chemistry in Grade 12, teachers should try to revise the most important concepts and skills from the Chemistry that the students have learned in Grade 10 and 11, and use this as an introduction to the topics that relate to the ones giving them challenges in Grade 12. Linking concepts from previous grades might be helpful considering the fact that the CAPS Policy document has topics in Grade 10 that link with those in Grade 11 and Grade 12. For example, Atomic structure (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantization and electron configuration) in Grade 10 links with Molecular structure (chemical bond; molecular shape; electronegativity and bond polarity; bond energy and bond length) in Grade 11 which will also link with Organic chemistry (functional groups; saturated and unsaturated structures; isomers; naming and formulae; physical properties; chemical reactions like substitution, addition and elimination) in Grade 12 (Department of Basic Education, 2011b). Topics might not link directly but the concepts required are the same. For example, a learner must learn about the atomic structure of an element and its electron configuration in Grade 10, which will help to understand a chemical bond and bond polarity, introduced in Grade 11, and chemical reactions of organic compounds which are taught in Grade 12. Learners need to link these skills and concepts as they progress through the three grades of the FET phase.

1.2 Rationale

Many learners in Grade 12 do not perform well in the Physical Sciences Paper 2 (Chemistry) examinations. One reason for this may be that the learners did not understand and master the concepts of Chemistry which are taught in previous grades before they reach Grade 12 i.e., the concepts taught in Grade 10 and 11. There is a high number of "progressed" learners in Grade 12; these are learners who have been progressed from primary school and the senior phase of high school (Grades 7, 8 and 9), in spite of not having reached the required achievement levels due to the age-cohort policy (Department of Education, 2008). These learners arrive in Grade 12 knowing very little of the Chemistry content taught in previous grades, and struggle heavily to understand the Grade 12 Chemistry content.

These factors result in learners being confused by the time they reach Grade 12. Because the concepts taught in Grade 10 and 11 link directly with the concepts in Grade 12 (CAPS, Department of Basic Education, 2011), the learners need to understand what was taught in lower grades so that they can understand the Grade 12 concepts. The method used in this study to help learners understand Grade 12 concepts is revision of some important concepts of Grade 10 and 11 content, which serve as an introduction to the content in Grade 12. For example, Redox Reactions in Grade 10 and 11 continue with the topic Electrochemical Cells in Grade 12. Therefore, for learners to have a clear understanding of Electrochemical Cells, they need to first revise Oxidation, Reduction and Oxidation numbers from Grade 10; and Oxidation and Reduction Half-Reactions in Grade 11.

The revision of previous topics does not involve the repetition of the Grade 10 and 11 syllabuses in Grade 12. It is simply reminding learners of concepts which they did not fully understand in previous grades so that they can understand those concepts clearly when they reach Grade 12. This revision can assist all types of learners to: gain a sub-microscopic understanding of complex Chemistry concepts from previous grades as well as Grade 12 concepts which have proven to give challenges in Matric examinations (Department of Basic Education, 2013 and 2014); improve the average and below average learners' ability to answer questions which require explanations and drawings of structures in Chemistry and lastly it can assist learners with serious learning barriers in connecting the information they did not understand in Grade 10 and 11 with the content in Grade 12 so that they can score better marks in Grade 12.

1.3 Aims and Objectives

Aim

It is hypothesised that one of the reasons that learners perform poorly in matric is that they do not sufficiently master the content of Grade 10 and 11, and hence do not have an adequate knowledge and skills base to cope with Grade 12. The main aim of this dissertation is to determine whether Grade 12 Chemistry would be improved if certain topics from the contents of Grade 10 and 11 which are particularly challenging to learners in Matric were revised at the start of Grade 12.

Objectives

The objectives of the study are to:

- Check the gradual increase of knowledge of Chemistry content as the learners progress to different grades;
- Check if the learners in the FET phase have the mathematical and scientific skills to learn Physical Sciences;
- Revise the topics from Grade 10 and 11 which correlate with difficult ones in Grade 12 in order to improve their skills of Chemistry in Matric; and
- Investigate whether revision leads to better performance in Matric.

Research questions

The study is thus intended to answer the following questions:

- Does the knowledge of Chemistry content increase as learners progress to different grades?
- Do learners in the FET phase have the mathematical and scientific skills to learn Physical Science?
- Will revision of topics from Grade 10 and 11 which correlate with difficult ones in Grade 12 improve their skills of Chemistry in Matric?
- Does revision leads to better performance in Matric?

1.4 Outline of thesis

Chapter 1 introduces the dissertation, and outlines the rationale, aim and objectives.

Chapter 2 provides a review of the relevant literature that has been published on difficulties that students experience in learning Chemistry, theories on teaching Chemistry, the role of teachers' pedagogical content knowledge in teaching chemistry, the attitude of high school learners towards learning Chemistry, the importance of previous knowledge, policies of the Department of Education on progression to different grades and pass marks in the FET phase, and the 2013 and 2014 Matric results and National Diagnostic.

Chapter 3 outlines the methodologies used in this study which are the administering of the IQ and Chemistry common tests in four schools, the random selection of the control and experimental groups at Bodibe Secondary School, and how the revision of Grade 10 and 11 Chemistry content was revised with the experimental group before they were taught the Grade 12 Chemistry content and how the control group was also only taught the Grade 12 content with no revision of content of lower grades. This chapter also explains the profiles of the four schools selected and where are they situated and the teachers who assisted with the administration of the IQ and Chemistry common tests.

Chapter 4 summarizes the results of the IQ and Chemistry common tests of all the four schools and the results of revision classworks written by the learners of the experimental group and results of the classworks of Grade 12 Chemistry topics (Organic chemistry, Rate of reactions and Electrochemical cells) written by both the control and experimental group, and the results of the test written by both groups to check whether revision can assist learners pass Chemistry better or not.

Chapter 5 gives the discussion of results of the IQ and Chemistry common tests, revision classwork exercises written by the experimental group and classwork exercises written by both groups and test written by both groups of the three Chemistry topics in Grade 12.

Chapter 6 gives the conclusion of the study based on the results of all classworks and tests, on whether or not revision of Chemistry of Grade 10 and 11 can assist Grade 12 learners understand Grade 12 Chemistry better.

Conclusion

This chapter has introduced the topic of the dissertation, outlined the rationale, the aim and objectives of the research and given an overview of the structure of the dissertation. In the next chapter the literature on the topic will be discussed.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Literature review of this study is based on: difficulties that students experience in learning Chemistry, theories on teaching Chemistry, the role of teachers' pedagogical content knowledge in teaching Chemistry, the attitude of high school learners towards learning Chemistry, policies of the Department of Education on progression to different grades and pass marks in the FET phase, and the 2013 and 2014 Matric results and National Diagnostic Report. This was done to understand what challenges learners have found to be facing when studying Chemistry and writing Chemistry examinations.

2.2 Difficulties in Learning Chemistry

Chemistry is one of the most important branches of science; it enables learners to understand what happens around them. Because chemistry topics are generally based on the structure of matter, chemistry proves a difficult subject for many students. Chemistry curricula commonly incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002).

Chemical knowledge is learned at three levels: "sub-microscopic," "macroscopic (descriptive)"and "symbolic", and the link between these levels should be explicitly taught (Johnstone, 1991; Gabel, 1992; Harrison & Treagust, 2000; Ebenezer, 2001; Ravialo, 2001; Treagust*et al.*, 2003). One of the essential characteristics of chemistry is the constant interplay between the macroscopic and microscopic levels of thought, and it is this aspect of chemistry (and physics) learning that represents a significant challenge to novices (Bradley & Brand,1985).

Chemistry can be seen at least at three levels: "There is the level at which we can see and handle materials, and *describe* their properties in terms of density, flammability, colour and so on. A second level is the *representational* one in which we try to represent chemical substances by formulae and their changes by equations. This is part of the sophisticated language of the subject. The third level is atomic and molecular, a level at which we attempt to *explain* why chemical substances behave the way they do" (Johnstone, 1982).

The abstract nature of Chemistry along with other content learning difficulties, for example the mathematical nature of much of Chemistry means that Chemistry classes require a high-level skill set (Fensham, 1988; Zoller, 1990; Taber, 2002). While students show some evidence of learning and understanding in examination papers, researchers find evidence of misconceptions, rote learning, and of certain areas of basic chemistry which are still not understood even at degree-level (Johnstone, 1984; Bodner, 1991); hence what is taught is not always what is learned (Sirhan, 2007).

Preparing the mind of the learner is one way to help students to focus attention on the new information by linking it to previous knowledge (the knowledge they already know and understand). The concept of "Pre-lectures" is shown to be powerfully effective as a way to prepare the minds of learners, with special emphasis on those whose background knowledge and experience is less than adequate (Sirhan *et al.*, 1999). Students who know more about a topic find it easier to identify and focus on important information. For this reason, carefully choosing the delivered material may greatly facilitate learning (Sirhan & Reid, 2001).

2.3 Theories of Teaching Chemistry

Philosophy begins when students and teachers *slow down* the science lesson and ask what terms mean, what things can be known and how can we know them, and about what things actually exist in the world and the relations possible between them (Matthews, 1998).

For learners to master the content, they must be taught exceptionally well, thus teaching is an important part of learning. "Teaching methods are the means by which the teacher attempts to bring about the desired learning. This includes selecting content and instructional material as well as teaching procedures; it determines to a large extent what students actually learn" (Clark & Starr, 1991, p. 9). "An understanding of how students learn can help teachers to devise effective strategies for teaching. This requires that research into the learning process is made accessible" (Clow, 1998, p17).

Besides textbooks, the most important models in teaching chemistry are chemistry teachers themselves. These models, of course, can be strengthened by providing teachers with an overview of the philosophy of chemistry (Bent, 1984).

After the Matric 2013 Chemistry paper was written and results were issued, students were interviewed on their incorrect responses (Ramnarain & Joseph, 2012). There was substantial evidence to suggest that although they did have an understanding of the concepts at the discrete levels of representation in a transformation, they found it challenging to make connections across the levels. The findings of this study have implications for classroom practice, and raise concerns about the current status of chemistry teaching as well as the preparedness of teachers in supporting students to achieve conceptual understanding in chemistry (Ramnarain & Joseph, 2012).

According to Education Labour Relations Council (ELRC) (ELRC, 2011), teachers should use inclusive strategies and promote respect for individuality and diversity. Teachers must be well prepared, such that "lesson planning should be abundantly clear, logical, sequential and developmental" (ELRC, 2011). In order for students to acquire conceptual understanding in chemistry, the teaching of chemistry should promote the development of ''representation competence'' in students (Kozma & Russell, 1997, p. 949).

2.4 Teachers' content knowledge

Teachers' professional knowledge is widely believed to be one of the most important factors contributing to high quality instruction (Abell, 2007; Peterson, Carpenter, & Fennema, 1989). Shulman's idea for teacher education conceptualizes professional knowledge in three dimensions: Content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK) (Baumert et al., 2010; Shulman, 1987; Shulman, 1986). These are seen as common facets that should be taken into account when considering competencies a good teacher should possess (Baumert et al., 2010; Grossman, 1990).

The first of the three, *content knowledge*, includes knowledge of the subject and its organizing structures (Grossman, Wilson, & Shulman, 1989; Shulman, 1986, 1987; Wilson, Shulman, & Richert, 1987). The second category, *curricular knowledge or pedagogical knowledge*, is "represented by the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances" (Shulman, 1986. p42). The last, and arguably most influential, of the three content-related categories is *pedagogical content knowledge* (PCK).

PCK is the most useful form of representation of ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations; the most useful way of representing and formulating the subject that make it comprehensible to others. PCK includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986).

Shulman presented a strong case of PCK as a specific form of knowledge for teaching which refers to the transformation of subject-matter knowledge in the context of facilitating students' understanding. Teachers need this type of knowledge to structure the content of their lessons, to choose or develop specific representations or analogies to understand and anticipate particular preconceptions or learning difficulties of their students (Van Driel et al, 2010). Shulman asserted, that the more representations and strategies teachers have at their disposal within a certain subject domain, and the better they understand their students' learning processes in the same domain, the more effectively they can teach in that domain (Van Driel, & Berry, 2010).

When teachers' subject matter-knowledge is very limited and contains many misconceptions, preservice secondary teachers hardly develop PCK during their education program (Halim & Meerah, 2002). In case of experienced teachers, it appears that a strong and well-integrated subject-matter knowledge does not guarantee the smooth development of an individual's PCK. In particular, when teaching unfamiliar topics, it appears that experienced teachers drew conclusions from their general pedagogical knowledge, which can constitute a supporting framework for the development of their PCK (Hashweh, 1987).

New, inexperienced teachers possess lack of PCK. Until a teacher has gained sufficient confidence and experience and mastered basic class-room skills, that development of PCK may be delayed. While teaching experience may promote the development of PCK, the provision of structured opportunities for reflection on the relationship between subject-matter knowledge and classroom practice is also important for facilitating the development of new teachers' PCK. Without such opportunities PCK development is at best, haphazard and at worst, barely apparent (Van Driel, & Berry, 2010).

2.5 Attitude of high school learners towards learning Chemistry

Attitude is a hypothetical construct that indicates an individual's likes and dislikes towards an item. It may be positive, negative or neutral. Attitude is an approach, temperament, sensation, situation, etc. with regard to a person or thing: inclination or course, especially of the mind. Attitude is a way of looking at things (Muellerleile, 2005). A positive attitude towards chemistry is essential; it denotes interests or feelings towards studying chemistry. Attitude and academic achievement are important outcomes of science education in secondary schools. Students' attitude and interest could play a substantial role in their decisions to study science (Abulude, 2009). Science teachers bear on their shoulders a huge responsibility of promoting and developing students' positive attitudes regarding science as a school subject (Abulude, 2009).

The important outcomes of secondary school science education are attitude as well as academic achievement. Three major theoretical viewpoints about the important nature of attitudes have been proposed by social psychologists: the tri-component point of view, the separate entities point of view, and the latent process perspective (Oskamp & Schultz, 2005). The tri-component point of view made of three potential parts: affect (the emotional component of an attitude), behaviour (the active elements of attitudes) and cognition (the mental component of an attitude) (Search Psychology 110, 2016). The thoughts and emotions one has towards an attitude object such as chemistry lessons and the chemistry subject are referred to as the affective point of view. The individual's explicit events and reactions to the attitude object is referred to as the behaviour component of attitude, while the cognitive factor is the thinking or belief that someone has about the attitude object (Khan & Ali, 2012).

It is worth mentioning that the development of students' positive attitude is necessary because attitude is linked with academic achievement (Cheung, 2009). A number of factors have been identified as related to students' attitude towards chemistry. Such factors include teaching methods, teacher attitude, influence of parents, gender, age, cognitive style of learners, career interest, and social implications of chemistry and achievement (Adesoji, 2008). Understanding of students' attitude is important in supporting their achievement and interest towards a particular discipline (Dhindsa & Cheung, 2003).

Surveys conducted in Europe (Osborne & Dillon, 2008) among large groups of young students clearly showed that girls and boys differ in their interest in science-related topics.

A study conducted by Chang (2009) indicated that boys showed higher learning interests in sustainability issues and scientific topics than girls. This is in line with previous studies by Morgil, Seçken & Yücel (2004). However, girls recalled more life experiences about science and technology in life than boys (Morgil, Seçken & Yücel, 2004).

Salta and Koulougliotis (2011) identified the factors that could positively influence students' attitude to learning chemistry. These factors could be organized into three main categories:

- Teaching approaches;
- Educational tools; and
- Non-formal educational material and activities.

For enhancing attitudes to learning chemistry, Hofstein and Naaman (2001) suggested three key factors that should be considered : (i) the methods used to present the content (e.g. relevance, and historical approach), (ii) instructional techniques that are implanted, and (iii) gender issues.

2.6 Misconceptions in chemistry topics

The notion of *misconception* was introduced when the scientific community found that students' ideas could be quite different from what they were taught (Fensham, 1972; McCloskey, 1988). Students' conceptions change progressively as they are exposed to additional relevant information in higher grades. Nevertheless, there are still great differences between what is taught by science and what is learned by students (De Posada, 1997). This awareness led to many researches on misconceptions held by elementary and secondary students. The idea of conceptual change was proposed by educational researchers to rectify these misconceptions (Posner & Strike, 1992).

Students' misunderstandings about science concepts have been labelled as several terms interchangeably. These include: naive beliefs, preconceptions, alternative frameworks, children's science, naive theories, naive conceptions, intuitive beliefs, intuitive science, learners' science, and misconceptions. The term alternative conception is used to mean students' ideas, manifested after exposure to formal models or theories, which are still at odds with those currently accepted by the scientific community. Especially, when an alternative conception is used with consistency over more than one context or event, it is referred to as an alternative framework (Boo, 1998).

A significant role of preconceptions in science learning is that they could channel the interpretation of subsequent teaching and affect learners' developing conceptions. Particularly, an alternative conceptual framework often acts as an impediment to effective learning of scientific conceptions (Taber, 2003). Therefore, the most important *pedagogical knowledge* a successful teacher should have is what misconceptions students usually tend to have before and after teaching. In other words, the teacher needs to be familiar with students' conceptual change thoroughly before, during, and after instructional process. He or she also needs to know why certain types of conceptions are acquired, how to challenge them effectively, and how to build usefully on the ideas children bring to lessons (De Posada, 1997; Taber, 2000). Once teachers build the knowledge and skills, they can plan more effective lessons that help students develop scientific ideas (Lee & Foley, 2007).

Moreover, while high school students develop naïve ideas of physics from their daily lives, they seem to attain misconceptions of chemistry from their prior formal education. The main reason for this is that the microscopic world of chemistry is difficult for them to experience, and thus chemistry teachers use a lot of analogies and metaphors to explain chemistry concepts. Therefore, it is particularly important for chemistry teachers to know how to avoid their teaching being misinterpreted and leading to misconceptions (De Posada, 1997; Taber, 2000).

2.7 Children with learning barriers

Many children are not achieving in school, often coping with a chaotic family life, poverty, mental ill health and emotional problems. This presents a challenge for schools which cannot always provide the requisite support. Thus, resources should be more focused in schools while children are young to help them achieve their full potential. At a time of significant cuts in public sector funding, greater priority should be given to targeted early intervention programmes to prevent more costly interventions being needed later (Webb, 2012). Parental unemployment, low family income, low parental educational attainment and family breakdown are associated with high rates of mental disorders amongst children (Green et al, 2005).

A young person's mental health problems can impact on their family, educational and social life (Cooper et al, 2006; Fox & Butler, 2007). Emotional well-being is an important foundation for learning and educational achievement. There is a fundamental inverse relationship between high emotional arousal and thinking-learning capacity (Goleman, 1996). Research in the field of emotional intelligence demonstrates that a person's ability to perceive, identify and manage emotion is the basis for being successful (Cherniss, 2000). This develops early in life and affects how productive children are in school (Goleman, 1996).

Counselling indirectly benefits students' capacities to study and learn. Young people allocated to counselling show significant greater improvements in well-being than those on a waiting list control (McArthur et al., 2011).

2.8 The importance of previous knowledge

Many students lack adequate prior knowledge to extract meaning from instruction. Yet teachers often make assumptions that they come to class possessing the skills and information to learn what is taught. Some research suggests that this assumption is erroneous and that learning is influenced as much by students' prior knowledge as by the new instruction they receive. Attention, then, needs to be paid to this fundamental aspect of the learning process (Campbell, 2008).

Students, of any age, bring beliefs and life and academic experiences to the classroom that influence what and how they learn. At times, such prior knowledge facilitates learning by creating mental hooks that serve to anchor instructional concepts. Conversely, the acquisition of new content can be thwarted if it conflicts with students' pre-existing misinformation. As a result, the role of prior knowledge in learning is paradoxical: it can lead to success and failure in the classroom. Consequently, teachers and students alike can benefit from taking time before instruction to identify what is known or, more accurately, believed to be known about a topic. Many strategies can tap students' prior knowledge (Campbell, 2008).

When preparing for instruction, most of the teachers focus tremendous effort on the content they will teach. Often, less planning and instructional time is dedicated to accessing pre-existing knowledge. This oversight can have significant implications if preconceptions are not engaged, children may fail to correctly grasp new concepts or give up on a subject altogether. One simply needs to consider the prevalence of the notion that some people are good at math while many are not. Such ideas can prevent learning if not addressed. Further, if students' pre-existing knowledge conflicts with the new content, the presented material information risks being distorted. For example, studies at all grade levels have shown students' chronic misunderstanding of basic physics concepts. When they attempt to explain the upward toss of a ball, they describe an initial upward force that is balanced at the top of its trajectory, and pulled by gravity back to the earth (Campbell, 2008).

2.9 Policies by the Department of Education on Progression of learners to different grades

In the South African education system, a learner may only be retained once in the Intermediate Phase (Grade 4-6), in order to prevent the learner being in this phase for longer than four years (Department of Basic Education, 2015). One of the requirements for promotion of learners in the Senior Phase (Grades 7-9) is that the learner will be promoted from grade to grade if they have Moderate Achievement (40% or Level 3) in Mathematics (Department of Basic Education, 2015). Again, a learner may only be retained once in the Senior Phase, in order to prevent the learner being in this phase for longer than four years (Department of Basic Education, 2015).

Learners in the FET phase (Grade 10-12) will be promoted from grade to grade if they have:

- Achieved 40% in three subjects, one of which is an official language at Home Language level; and
- 30% in three subjects provided the School-Based Assessment component is submitted in the subject failed.

A learner may therefore also only be retained once in the Further Education and Training Phase in order to prevent the learner being in this phase for longer than four years (Department of Basic Education, 2015).

2.10 Passing Mark in FET phase

The passing mark in FET is 30% and if a learner has obtained this mark at Grade 10 in Physical Sciences, he or she is assumed to be ready to progress to Grade 11, according to the CAPS Document (Department of Basic Education, 2011a). "You no longer need 50% to pass certain subjects, which means you can be completely ***ignorant of more than half the subject***

matter content and still pass" (Prof Jansen, vice-chancellor at the University of the Free State, City Press, 2013).

The Minister of Higher Education and Training Blade Nzimande, on 9 January 2014, defended the 30% pass requirement for three out of six subjects needed to pass matric, saying young people would miss out on post-school education opportunities if it was raised. Education experts, teacher unions and business leaders strongly criticised the quality of the matric certificate before and after Basic Education Minister, Angie Motshekga announced the 78.2% matric pass rate on 6 January 2014. They said it did not equip matriculants with skills to successfully enter the job market and universities (Mail & Guardian, 2014).

2.11 2013 Matric Results (Physical Science Paper 2) and 2013 National Diagnostic Report (NDR)

The National Diagnostic Report (NDR) committee was initiated in 2010 by the minister of education Angie Motshekga. The NDR on Learner Performance is a report which provides teachers, subject advisors, curriculum planners and other education support officials, with crucial information regarding the performance of learners in the selected subjects. Suggestions for improvements in teaching and learning are made, and include, among others, teaching methodology improvements and use of learning and teaching support materials (LTSM's). It is expected that teachers of these subjects, together with their subject advisors, will interrogate these diagnostic subject reports, and apply the suggested remedial activities where possible or devise their own more appropriate remedial measures (Department of Basic Education, 2013)

The 2013 results for Chemistry were not good, and according to the NDR:

(a) The overall performance of candidates in this paper was not good;

(b) The questions on organic chemistry (Q3, Q4, and Q5) were fairly well answered;

(c) Lack of skills to interpret data and to give reasons/explanations resulted in the very poor answering of the question on reaction rate (Q6);

(d) Stoichiometric calculations (Q6.6 & Q9.3) were poorly answered. Although most candidates could select the correct formula, they often failed to work with correct mole ratio;

(e) Q9 (electrolytic cells) was extremely poorly answered. Many candidates obtained zero for this question. Electrolytic cells remain a poorly understood section of the work;

(f) In general, candidates had a poor understanding of electrochemistry (Q8, Q9, and Q10); and

(g) The inability to answer questions like Q6.4, Q6.6, Q8.3, Q9.3 and Q10, which were somewhat "outside the box", although not difficult, is worrisome, as it points to a serious flaw in the thinking skills of candidates (Department of Basic Education, 2013).

2.12 2014 National Diagnostic Report

2.12.1 Performance Trends (2011-2014)

The general performance of candidates reflected a decline from that of the previous two years. According to table 2.1, in comparison to 2013, it was noted that the number of candidates writing the subject decreased by 16389 in 2014. The number of candidates who passed at the 30% level declined by 5.9 percentage points and those who passed at the 40% level also declined by 5.8 percentage points. Candidates achieving distinctions (over 80%) increased marginally from 3.1% to 3.3% of total candidates.

Table 2.1 Overall achievement in Physical Sciences

Year	Number wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2011	180585	96441	53.4	61109	33.8
2012	179194	109918	61.3	70076	39.1
2013	184383	124206	67.4	78677	42.7
2014	167997	103348	61.5	62032	36.9

2.12.2 Analysis of learner performance: Paper 2

The most difficult topics in the 2014 Paper 2 examination paper, judging from the quality of the answers, were organic chemistry, reaction rate and electrochemical reactions. Therefore, these topics were chosen to be studied in this research project and analysed as follows:

Question 2, 3 and 4 (Organic chemistry)

Question 2 (Nomenclature of Organic Compounds)

- Many candidates did not know what a carbonyl group was.
- The most common incorrect answer to Q2.2.2 (Write down the IUPAC name of the monomer of polyethene) was ethane. At the time of the final examination, all Grade 12 learners should at least know the structure of polyethene and that ethene is the monomer. Some did not read the question and gave the IUPAC name of the polymer instead of the monomer. Others drew the structural formula of ethene without giving the IUPAC name.
- Candidates often spelt words incorrectly, e.g. *pantane,* or used the wrong forms of words, e.g *chloro* instead of *chlorine*.

Question 3 (Physical Properties of Organic Compounds)

- When explaining the increase in boiling point from methane to propane in Q3.3.2, many candidates did not mention either the increase in strength of intermolecular forces or the increase in energy needed to overcome the intermolecular forces and forfeited one mark. A number of candidates referred to stronger intermolecular forces between C-atoms and forfeited a mark. A common misconception was that, learners thought that more energy was needed to break the chains. Common incomplete/incorrect statement regarding the energy involved were:
  - More energy needed to break the bond;
  - More energy needed to break the chains;
  - More energy is needed for propane than for methane;
- Candidates who answered Q3.4 (Why is the boiling point of propan-1-ol higher than that of propane? Explain by referring to the type of intermolecular forces present) incorrectly failed to identify the type of Van der Waals forces/intermolecular forces between propane molecules correctly. They only referred to Van der Waals forces instead of naming the type of Van der Waals forces i.e., London forces. Some also

referred to dipole-dipole forces between alcohol molecules without mentioning hydrogen bonding.

Question 4 (Reactions of organic compounds)

- Drawing the structural formula of the ester propyl-ethanoate in Q4.4.3 was a challenge to many candidates. Common errors were:
    - Drawing the structure of an incorrect functional group;
    - Drawing the structural formula of ethyl propanoate instead of propyl ethanoate;
    - Adding an extra H atom on the carbon of the carbonyl group.
- Candidates omitted bonds between C atoms and between C and H atoms when drawing structural formulae.

Question 5 (Reaction rate)

- Candidates could not answer questions that required *explanations* correctly. These are Q5.1 (Define the term reaction rate) and Q5.3 (Use the collision theory to explain why the reaction rate of experiment 4 [which had larger mass of reactants thus larger surface area] will be higher than that in experiment 3 [which had less mass of reactants])
- In the comparison between experiment 3 and 4 in Q5.3, many candidates failed to identify the larger mass of $CaCO_3$ in experiment 4 as the factor responsible for its higher rate. Most of those who obtained no marks in Q5.3 explained it in terms of temperature. Many of those who identified the higher mass as the factor did not get full marks due to the omission of the words "effective" and per "unit time".
- The interpretation of the graphs and the data in the table in Q5.4 was a challenge for most candidates. The following observations were made from the candidates' answer:
    - Weaker candidates rewrote the data given in the table without comparing reaction conditions and reaction rate of the four experiments and failed to link graph C to experiment 1. They obtained no marks;
    - Some obtained one mark for the answer i.e., *graph C is experiment 1,* but failed to give any explanations. They compared reaction conditions in the four

experiments without mentioning the effect of the conditions on reaction rate. No reference to the graphs was made in such explanations;

- Many candidates, who were able to compare the reaction conditions and link each of the graphs to the correct experiments, forfeited two marks because they did not explain, in terms of the gradient of the graphs, why they linked a graph to a specific experiment, and;
- Candidates struggled to explain themselves. For example, many referred to a *higher graph* instead of a *steeper gradient of the graph* and forfeited the gradient marks.

Question 8 (Electrochemical reactions)

- Candidates did not fully grasp the meaning of reduction potential and how to determine it when one of the half-cells is the hydrogen half-cell.
- Many candidates did not obtain marks for the standard conditions for a galvanic cell in Q8.1. Common errors were:
  - Using standard temperature (273K) instead of 298K (25^0);
  - Omission of the amount of a correct temperature value;
  - Incorrect value for standard pressure e.g. 101kPa and 103.1kPa;
  - Giving temperature and pressure without values, as answer; and
  - Using 1 $mol.dm^{-3}$ as one of the conditions, despite the question stating *besides concentration.*

Conclusion

Some previous studies regarding difficulties that students experience in learning Chemistry, theories on teaching Chemistry, the role of teachers' pedagogical content knowledge in teaching Chemistry, the attitude of high school learners towards learning Chemistry, the importance of long-term memory in the classroom policies of the Department of Education on progression to different grades and pass marks in the FET phase, and the 2013 and 2014 Matric results and National Diagnostic Report have been reviewed in this chapter. In Chapter 3, the methodology employed in the study will be outlined.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The study was conducted to check if revision of certain Chemistry Grade 10 and 11 topics that link with the topics in Grade 12 could help learners understand the Grade 12 Chemistry content better. To check if this was the case, first three of the most challenging topics of Physical Sciences Paper 2 (Chemistry) were selected as part of the study, being: Organic Chemistry, Rate of reaction and Electrochemical cells. Then all the Chemistry chapters of Grade 11 and 10 which linked and continued directly with these three topics were revised before the teaching of Grade 12 topics.

Before revision was done, all four schools had two tests administered to their learners, being the IQ and Chemistry common test. The IQ test, which had majority questions of Grade 8, 9 and 10 Mathematics and minor questions of Grade 9 Natural Sciences, was administered to check if the learners had the mathematical and scientific skills to cope with Physical Sciences before and after they entered the FET phase. The Chemistry common test, which had questions of Grade 8, 9, 10 and 11 Chemistry questions, was done to check if there was a gradual increase of knowledge of Chemistry as they learners were progressing from GET to FET phase.

There are five high schools in Itsoseng township and three in Bodibe village, but only two were chosen in Itsoseng and another two in Bodibe, with a total of four. The schools were chosen for three reasons: first, Bodibe was a new high school having Grade 12 for the first time; second, Baitshoki and Tau-Rapulana are general schools with only one class each doing Mathematics and Physical Sciences; and lastly, Tswelelopele is a science school specialising in Mathematics and Physical Sciences only. Their different backgrounds and profiles would be helpful in understanding whether learners found Physical Sciences challenging because of the type of school they find themselves in or is it because they are not prepared well in Grade 10 and 11 before they enter Grade 12. The learners in the FET phase of all four schools, except the Grade 10 learners in Tau-Rapulana who could not write because of administrative issues, wrote the IQ and Chemistry common tests. Bodibe Secondary was the school that was chosen for the main research because other schools' tight schedules and administrative duties made it challenging for them to avail their Grade 12 learners to continue to be part of the study.

After the IQ and Chemistry common tests, learners from Bodibe Secondary were divided randomly into two groups: control and experimental group. The control group was only taught the Grade 12 content and the experimental group was taught revision of Grade 10 and 11 Chemistry topics which linked with Grade 12 topics before they were taught Grade 12 Chemistry topics to check if revision could help them understand the Grade 12 topics better. Classworks were given to both groups and a common test was given after the two different teaching methods were applied to the two groups and the results of the test and classworks were analyzed. After the research was concluded and all the data was concluded, the learners in the control group were given the same revision as the experimental group to ensure that all the learners had the same opportunity to improve their performance in their final examinations.

3.2 Research methods used

The study involved the following steps and methods:

1. The syllabus was analyzed and the topics which gave learners challenges in Grade 12 Chemistry (Department of Basic Education, 2014) were sampled, and linked with revised content from Grade 11 and 10 content. It must be noted that, due to time constrains and administrative issues in the schools, not all the Grade 12 paper 2 (Chemistry) content was revised. Only the three Grade 12 Chemistry chapters which were found to have been most poorly understood by learners were part of this research project, namely: Organic chemistry, Reaction rate and Electrochemical cells;
2. An IQ Test on learners across all grades in the FET phase in four schools was administered. This was done to test if learners in different grades in different schools could reason, explain and distinguish concepts and also to check their mathematics skills, which is a strong prerequisite to mastering physical science in Grade 12;
3. A common Chemistry test was administered to learners across all grades in the FET phase in four schools; and was used to check if there was a gradual increase in the knowledge of Chemistry from grade 10 to Grade 12. This was done in the form of multiple choice questions, based on general chemistry knowledge;
4. The three sampled Chemistry topics in Grade 12, being Organic chemistry, Reaction rate and Electrochemical cells were then taught to one class of Grade 12 in one school. This class was divided into two groups randomly. The first group, which was the experimental group, was taught revision from Grade 10 and 11 which linked with the three topics in Grade 12. The revision included revision lessons and revision class

work exercises. Each time after revision, a topic from Grade 12 which continues and links with the revision from Grade 10 and 11, was then taught and the concepts were linked. The other group, which was the control group, was not taught revision of Grade 10 and 11 contents, instead only Grade 12 content was taught;

5. During each classwork done in the three content topics in Grade 12, the performance of the two groups were compared to see if revision was assisting the experimental group to perform better than the control group;
6. A test was administered to both groups after the finishing of the different teaching approaches between the two sampled groups to finalize the comparison of results of the experimental group and control group;
7. A statistical test (t-test) was used for the analysis of the results of the IQ test to check if the learners in the experimental and control group were equivalent prior to the study, and on the test written by both groups at the end of study to check if there is a significant difference in the performance of the two groups.
8. After the analysis and comparison of the results was done, the control group was also taught the revision of Grade 10 and 11 work, so that all learners would have the same chance of passing the Chemistry content in Grade 12.

3.3 Topics revised

The topics of the Grade 10 and 11 syllabuses (CAPS) that were revised with the correlating topics in Grade 12 are shown in Table 3.1

Table 3.1: Topics of the Grade 10 and 11 syllabuses revised with the correlating topics in Grade 12

GRADE 12 TOPICS	REVISED TOPICS FROM GRADE 10	REVISED TOPICS FROM GRADE 11
Organic chemistry Functional groups; saturated and unsaturated structures; isomers; naming and formulae; physical properties; chemical reaction (substitution, addition and elimination).	**Atomic structure** (models of the atom; atomic mass and diameter; protons, neutrons and electrons; isotopes; energy quantization and electron configuration). **Chemical bonding** (covalent bonding; ionic bonding; metallic bonding).	**Molecular structure** (a chemical bond; molecular shape; electronegativity and bond polarity; bond energy and bond length). **Intermolecular forces** (chemical bonds; types of intermolecular forces; states of matter; density; kinetic energy; temperature; three phases of water (macroscopic properties related to sub-microscopic structure)).
Reaction rate (factors affecting rate; measuring rate; mechanism of reaction and of catalysis).	**Representing chemical change** (Balanced chemical equations).	**Energy and chemical change** (energy changes related to bond energy; exothermic and endothermic reactions; activation energy).
Electrochemical reactions (electrolytic and galvanic cells; relation of current and potential to rate and equilibrium; standard electrode potentials; oxidation and reduction half reaction and cell reactions; oxidation numbers; application of redox reactions).	**Reactions in aqueous solution** (ions in aqueous solutions; ion interaction; electrodes, electrolytes; electrical conductivity)	**Types of reactions** (acid-base; redox reactions; oxidation numbers, balancing of oxidation and reduction half reactions

3.4 Subjects

Four schools in the Ditsobotla District of the North West Province were chosen for this research. These four schools have very different profiles. One school was previously a middle school, and has only recently begun to offer the FET phase. This school was also chosen for the main revision programme due to the fact that the researcher is employed there. One of the other schools is a science school, while the other two are general schools, but with different levels of achievement in matric.

3.4.1 Profiles of high schools involved in the project

- **Bodibe Secondary School**

This is a school which is situated in Bodibe village, outside Lichtenburg. It was previously a Middle School and introduced FET phase in 2013 after the North West Department of Education decided to introduce rationalization of middle schools and merging some middle schools with established high schools. It is a general school offering subjects such as Mathematics, Mathematics Literacy, Physical Sciences, Geography, Life Sciences, Agriculture and History.

It was in this school where the actual research was done because other schools found it difficult to allow their learners to continue to be part of this research project due to administrative issues. Grade 12 learners in Bodibe Secondary were divided randomly into two groups, being the control group and experimental group so that it could be observed if revision of Grade 10 and 11 topics could assist in the understanding of Grade 12 topics. Before the learners were divided randomly, the Grade 12 learners together with the Grade 11 and 10 learners had previously written the IQ and Chemistry common tests. There were a total of 117 learners, 42 doing Grade 10, 34 doing Grade 11 and 41 doing Grade 12.

- **Tau-Rapulana High School**

A school also situated in Bodibe Village outside Lichtenburg. It is a general school offering subjects such as: Mathematics, Mathematics Literacy, Physical Sciences, Geography, Life Sciences, Agriculture and History. Learners choose their subjects from Grade 10. The Grade 11 and 12 learners doing Mathematics and Physical Sciences wrote the IQ and Chemistry common tests, with the Grade 10 learners unable to write it because of administrative issues. There were a total of 58 learners, 32 doing Grade 11 and 26 doing Grade 12.

- **Tswelelopele High School**

This is a school situated in Itsoseng township outside Lichtenburg. It is a science school where Mathematics, Physical Science, Geography and Life Sciences are compulsory to all learners in the FET phase. It is a school which has a good track record of quality performance of learners in Grade 12. This was the third school where an IQ test and Chemistry common test were administered and the results were compared to that with the other schools. There were a total of 131 learners, 56 doing Grade 10, 47 doing Grade 11 and 28 doing Grade 12.

- **Baitshoki High School**

This is also a school situated in Itsoseng township. It is a general school offering Mathematics, Mathematics Literacy, Physical Sciences, Geography, Life Sciences, Agriculture and History and learners choose their subjects in Grade 10. It was the last school to administer the IQ and Chemistry common tests. There were a total of 84 learners, 35 doing Grade 10, 27 doing Grade 11 and 22 doing Grade 12.

3.4.2 Ethical issues

All the students who participated in this research project did so voluntarily and were free to ask questions regarding the writing of the IQ and Chemistry common tests. They were briefed on the aims and objectives of the experiment and why it was it was important for them to participate.

The teachers from different schools supported the research project. The following Physical Sciences teachers agreed to assist with administering of the IQ and Chemistry common tests:
Mr Shapiro Masapo (Baitshoki High School)
Mr Bakudi Mocoancoeng (Tswelelopele High School)
Ms Sonia Shole (Tau-Rapulana High School)
Mr Itumeleng Molaakgosi (Bodibe Secondary School)
The principals of all the four schools gave permission to use the learners as participants of this research project.

3.4.3 Administration of revision to the control group

After the research was done and concluded, the control group was given the same assistance as the experimental group with revision of Grade 10 and 11 to help them understand the concepts of Grade 12 better and give them an equal chance as with the experimental group to do well in the examination.

Conclusion

Summary of all methods used and their justification; the administering of the IQ and Chemistry common tests; Grade 10 and 11 topics revised plus Grade 12 selected topics for the study; subjects used in the study i.e. schools, learners, teachers, parents and principals; and ethical issues have all been reviewed in this chapter. In chapter 4, the results of the study will be outlined.

CHAPTER 4

RESULTS

4.1 Introduction

The results of all the tests are discussed in this chapter. The first results discussed are of the IQ test and Chemistry common test written by FET phase learners of the four selected schools. The second results discussed are those of the experimental and control group's classwork exercises and revision classwork exercises. The last results discussed are those of the post-test written by both the experimental and control groups were it was finally checked if revision could help learners understand Chemistry content or not.

4.1.1 IQ Test

The first test to be administered was an IQ test. This was administered in four schools, namely Tau Rapulana High School, Tswelelopele High School, Baitshoki High School and Bodibe Secondary School. At Tau Rapulana only Grade 11 and 12 were tested, while learners across all grades in the FET phase were tested at the other three schools. The IQ test was done to check their ability to master a subject like Physical Science and the Mathematical skills.

4.1.2 Questions from the IQ test

1. If 1 mile = 1.609344 kilometres, then how much is 87 kilometres in miles?

a) 45 miles b) 54 miles c) 28 miles d) 65 miles

2. Mary, who is sixteen years old, is four times as old as her brother. How old will Mary be when she is twice as old as her brother?

a) 24 years old b) 28 years old c) 36 years old d) None of the answers is correct

3. How much is the sum of $(-2)^3+(-3)^4+(-4)^5+(-5)^6$

a) 154826 b) 14785 c) 23658 d) 14674

4. A spacecraft travels 360 000 km to the moon at an average speed of 1200m/s. How long does the journey take in days, hours and minutes?

a) 3 days&11 hours b) 3 days&5hours c) 4 days&2hours d) 2 days&6hours

5. A water tank is filled at a constant rate of 2.5 litres per minute. If the tank can hold 5 kilolitres (1kl=1000l) of water, what percentage of the tank is filled in 3 hours?

a) 8% b) 9% c) 10% d) 11%

6. A certain clothing company employs machinists and supervisors. The company uses the formula y=35x+1 to determine the numbers of machinists and supervisors. The

machinists are represented by y and the supervisors are represented by x. if y=841, determine by making use of the formula, the number of supervisors employed by the company

a) 15 b) 19 c) 24 d) 10

7. My sister is 12 years older than I am. Our combined age is half the age of our grandfather. Our grandfather is 68 years old. How old am I?

a) 11 b) 14 c) 12 d) 7

8. John needs 13 bottles of water from the store. John can only carry 3 at a time. What is the minimum number of trips John need to make to the store?

a) 1 b) 2 c) 3 d) 5

9. Which number completes the series? 1-1-2-3-5-8?

a) 9 b) 10 c) 11 d) 12 e) 13

10. Solve: 20.44% of 511 =

a) 4 b) 105 c) 11 d) 51

4.1.3 Results of the IQ test

The results of the IQ test conducted in four schools are given in Tables 4.1.1 to 4.1.11.

Bodibe Secondary School

Grade 10

Table 4.1.1 Bodibe Grade 10 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	14	33.3%
30-39%	8	19.1%
40-49%	5	11.9%
50-59%	6	14.3%
60-69%	6	14.3%
70-79%	2	4.8%
80-100%	1	2.4%

N = 42

Grade 11

Table 4.1.2 Bodibe Grade 11 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	10	29.4%
30-39%	6	17.7%
40-49%	6	17.7%
50-59%	6	17.7%
60-69%	2	5.9%
70-79%	3	8.8%
80-100%	1	2.9%

N = 34

Grade 12

Table 4.1.3 Bodibe Grade 12 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	5	12.2%
30-39%	7	17.1%
40-49%	7	17.1%
50-59%	5	12.2%
60-69%	8	19.5%
70-79%	5	12.2%
80-100%	4	9.8%

N = 41

Tau Rapulana High School

Grade 11

Table 4.1.4 Tau-Rapulana Grade 11 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	12	37.5%
30-39%	7	21.9%
40-49%	9	28.1%
50-59%	2	6.3%
60-69%	0	0%
70-79%	2	6.3%
80-100%	0	0%

N = 32

Grade 12

Table 4.1.5 Tau-Rapulana Grade 12 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	7	26.9%
30-39%	5	19.2%
40-49%	8	30.8%
50-59%	3	11.5%
60-69%	1	3.9%
70-79%	1	3.9%
80-100%	1	3.9%

N = 26

Tswelelopele High School

Grade 10

Table 4.1.6 Tswelelopele Grade 10 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	23	41.1%
30-39%	10	17.9%
40-49%	7	12.5%
50-59%	5	8.9%
60-69%	4	7.1%
70-79%	3	5.4%
80-100%	4	7.1%

N = 56

Grade 11

Table 4.1.7 Tswelelopele Grade 11 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	20	42.6%
30-39%	7	14.9%
40-49%	5	10.6%
50-59%	4	8.5%
60-69%	2	4.3%
70-79%	4	8.5%
80-100%	5	10.6%

N = 47

Grade 12

Table 4.1.8 Tswelelopele Grade 12 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	5	17.9%
30-39%	3	10.7%
40-49%	3	10.7%
50-59%	2	7.1%
60-69%	5	17.9%
70-79%	5	17.9%
80-100%	5	17.9%

N = 28

Baitshoki High School

Grade 10

Table 4.1.9 Baitshoki Grade 10 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	13	37.1%
30-39%	11	31.4%
40-49%	4	11.4%
50-59%	5	14.3%
60-69%	0	0%
70-79%	2	5.7%
80-100%	0	0%

N = 35

Grade 11

Table 4.1.10 Baitshoki Grade 11 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	12	44.4%
30-39%	5	18.5%
40-49%	6	22.2%
50-59%	0	0%
60-69%	2	7.4%
70-79%	1	3.7%
80-100%	1	3.7%

N = 27

Grade 12

Table 4.1.11 Baitshoki Grade 12 results of the IQ test

Percentages of the test	Number of learners	Class performance percentage
0-29%	2	9.1%
30-39%	4	18.2%
40-49%	7	31.8%
50-59%	3	13.6%
60-69%	2	9.1%
70-79%	2	9.1%
80-100%	2	9.1%

N = 22

4.2 Chemistry common test

Before the start of the teaching programme, an initial Chemistry test was given to all the learners to check their knowledge of Chemistry as they progressed to different grades across the FET phase.

4.2.1 Questions from the Chemistry common test

1. What does the chemical symbol "Fe" represents?

a) Phosphate b) Iron c) Steel

2. What is the chemical symbol for Gold?

a) G b) Au c) Pl

3. Which subatomic particle consists of a positive charge?

a) Neutron b) Proton c) Electron d) Atom

4. What is the chemical symbol for Mercury?

a) Mr b) Cy c) Hg d) Me

5. What is the atomic mass of magnesium?

a) 24 b) 39 c) 40 d) 42

6. Which one of the following elements is a noble gas?

a) Potassium b) Oxygen c) Boron d) Xenon

7. Which of the following does not belong to this group?

a) Iron b) Sodium c) Lead d) Oxygen

8. In a neutral atom, the number of electrons and protons is equal.

a) True b) False c) It depends

9. Rust occurs when there is a combination of oxygen and .....

a) Acids b) Sulfur c) Iron d) Copper

10. Metals that can be easily beaten into sheets are known as ________ metals.

a) Ductile b) Polymer c) Malleable

11. A pH below 7 indicates

a) Purity b) Neutrality c) Acidity d) Alkalinity

12. The three basic components of an atom are:

a) Protons, neutrons & electrons b) Protons, neutrons & ions c) Protons, nucleus & ions

13. An element is determined by the number of:

a) Atoms b) Electron c) Neutrons d) Protons

14. What are allotropes?

a) Elements with the same structure b) Elements with the same atomic mass

c) Identical forms of the same element d) Different forms of the same element

15. Give 2 semiconductors

a) Cobalt & Sodium b) Lead & Chromium c) Silicon & Germanium d) Tin & Nickel

4.2.2 Results of the Chemistry common test

The results of the Chemistry common test conducted in four schools are given in table 4.2.1 to 4.2.11

Bodibe Secondary School

Grade 10

Table 4.2.1 Bodibe Grade 10 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	15	35.7%
30-39%	5	11.9%
40-49%	5	11.9%
50-59%	4	9.5%
60-69%	5	11.9%
70-79%	6	14.3%
80-100%	2	4.8%

N = 42

Grade 11

Table 4.2.2 Bodibe Grade 11 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	8	23.5%
30-39%	6	17.7%
40-49%	7	20.6%
50-59%	4	11.8%
60-69%	5	14.7%
70-79%	1	2.9%
80-100%	3	8.8%

N = 34

Grade 12

Table 4.2.3 Bodibe Grade 12 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	3	7.3%
30-39%	5	12.2%
40-49%	7	17.1%
50-59%	7	17.1%
60-69%	11	26.8%
70-79%	6	14.6%
80-100%	2	4.9%

N = 41

Tau Rapulana High School

Grade 11

Table 4.2.4 Tau-Rapulana Grade 11 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	9	28.1%
30-39%	6	18.8%
40-49%	4	12.5%
50-59%	6	18.8%
60-69%	4	12.5%
70-79%	3	9.4%
80-100%	0	0%

N = 32

Grade 12

Table 4.2.5 Tau-Rapulana Grade 12 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	3	11.5%
30-39%	3	11.5%
40-49%	6	23.1%
50-59%	10	38.5%
60-69%	1	3.9%
70-79%	2	7.7%
80-100%	1	3.9%

N = 26

Tswelelopele High School

Grade 10

Table 4.2.6 Tswelelopele Grade 10 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	25	44.6%
30-39%	11	19.6%
40-49%	6	10.7%
50-59%	7	12.5%
60-69%	3	5.4%
70-79%	3	5.4%
80-100%	1	1.8%

N = 56

Grade 11

Table 4.2.7 Tswelelopele Grade 11 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	17	36.2%
30-39%	10	21.3%
40-49%	5	10.6%
50-59%	10	21.3%
60-69%	2	4.3%
70-79%	2	4.3%
80-100%	1	2.1%

N = 47

Grade 12

Table 4.2.8 Tswelelopele Grade 12 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	4	14.3%
30-39%	3	10.7%
40-49%	5	17.9%
50-59%	5	17.9%
60-69%	3	10.7%
70-79%	4	14.3%
80-100%	4	14.3%

N = 28

Baitshoki High School

Grade 10

Table 4.2.9 Baitshoki Grade 10 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	16	45.7%
30-39%	8	22.9%
40-49%	5	14.3%
50-59%	4	11.4%
60-69%	2	5.7%
70-79%	0	0%
80-100%	0	0%

N = 35

Grade 11

Table 4.2.10 Baitshoki Grade 11 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	5	18.5%
30-39%	3	11.1%
40-49%	4	14.8%
50-59%	5	18.5%
60-69%	3	11.1%
70-79%	4	14.8%
80-100%	3	11.1%

N = 27

Grade 12

Table 4.2.11 Baitshoki Grade 12 results of the Chemistry common test

Percentages of the test	Number of learners	Class performance percentage
0-29%	2	9.1%
30-39%	1	4.6%
40-49%	1	4.6%
50-59%	6	27.3%
60-69%	5	22.7%
70-79%	5	22.7%
80-100%	2	9.1%

N = 22

4.3 Revision classwork exercises, Grade 12 classwork exercises and Test

The experimental group were taught revision concepts from Grade 10 and 11 that linked directly with the content in Grade 12. The revision was an introduction to the selected topics with which learners struggled in Paper 2 examinations (Department of Basic Education, 2014). Revision included teaching and assessment by means of revision classwork for each topic taught. After revision was taught and a classwork exercise was written, Grade 12 content was then taught and classwork exercises from Grade 12 content were written. The control group was only taught Grade 12 content and no revision of Grade 10 and 11 content was taught. Both groups wrote the same Grade 12 classwork exercises and their performances were compared to see if the experimental group was performing better as they had been taught revision to remind them of concepts of previous grades that continue with the Grade 12 content.

4.3.1 Organic Chemistry

Organic chemistry was one of the topics which was poorly answered by learners in the 2013 (Department of Basic Education, 2013) and 2014 Paper 2 examinations (Department of Basic Education, 2014). Learners had challenges with the naming and drawing of organic compounds, the effect of intermolecular forces on boiling points and melting points of organic compounds, and the effect of structure of compounds on their chemical properties (Department of Basic Education, 2014).

4.3.2 Revision Classwork Exercise 1

Group A (Experimental Group) was taught revision from Grade 10 content. A revision class work was administered before Organic chemistry was introduced. This was done to remind learners about how particles bond i.e. covalent or ionic bonding etc.; how to draw Lewis diagrams to give them a clear understanding of organic structures such as cyclic organic compounds, and structural formulas.

Revised Topic	:	Matter & Materials (Atom & Chemical Bonding)
FOA (Form of Assessment)	:	Classwork
Revised Grade	:	10
Marks	:	20

Question 1

1. What is meant by the term valency? (2)
2. Write the valency of the following atoms:
   a) N
   b) Na
   c) Al
   d) C
   e) Mg
   f) O (6)
3. Differentiate between covalent bond and ionic bond (2)
4. Consider the following compounds. Decide which bonds are covalent and which ones are ionic
   a) CO
   b) KCl
   c) AlF_3
   d) CS_2 (4)
5. Use Lewis diagrams to represent the following compounds
   a) Ammonia : NH_3
   b) Carbon dioxide : CO_2
   c) Methane gas : CH_4 (6)

The results of revision classwork exercise 1 are shown in Table 4.3.1

Group A Results

Table 4.3.1 Experimental group results on revision classwork exercise 1

Percentages of the test	Number of learners	Class performance percentage
0-29%	1	5%
30-39%	1	5%
40-49%	3	15%
50-59%	2	10%
60-69%	2	10%
70-79%	6	30%
80-100%	5	25%

N = 20

4.3.3 Classwork Exercise 1

After the revision classwork was done, Organic chemistry was taught and the revised content was linked with the content introduced. The form of assessment (FOA) was classwork.

Grade : 12

FOA : Classwork

Marks : 20

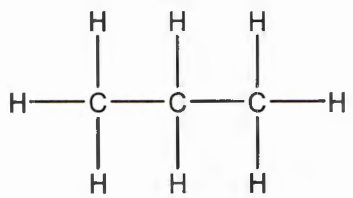
1.1 Write down whether the following are showing the molecular formula, the condensed structural formula or the structural formula for the organic compound.

a) $CH_3CH_2CH_3$

b) C_3H_8

c) CH_3

d)



(4)

1.2 Draw the structural formula for:

a) Butane

b) Hexane

c) Propene

d) Pent-2-ene

e) But-2-yne (10)

1.3 Use the general formula for alkanes, alkenes and alkynes to determine the molecular formula for:

a) Ethane

b) Propene

c) Octyne (6)

The results of the two groups of classwork 1 are shown in Tables 4.3.2 and 4.3.3.

Group A Results

Table 4.3.2 Experimental group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance percentage
0-29%	0	0%
30-39%	2	10%
40-49%	1	5%
50-59%	3	15%
60-69%	4	20%
70-79%	3	15%
80-100%	7	35%

N=20

Group B Results

Table 4.3.3 Control group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance percentage
0-29%	1	4.8%
30-39%	1	4.8%
40-49%	2	9.5%
50-59%	6	28.6%
60-69%	5	23.8%
70-79%	3	14.3%
80-100%	3	14.3%

N=21

4.3.4 Revision Classwork Exercise 2

The second revision classwork that was given was based on halogens, their electron configuration and polarity of molecules. This was done so that the learners could be reminded of the names, symbols and chemical properties of halogens, and how these chemical properties will affect alkyl halides. The polarity of molecules was revised so that the learners could be reminded that electrons can be congregated on one side. This was also needed for the discussion of boiling points and melting point of different compounds such as alcohols, ketones and aldehydes.

Revised Topics : Halogens, Electron Configurations and Polarity

Revised Grade : 10

Marks : 12

1. Give the names of the following halogen symbols

a) Cl b) Br c) I (3)

2. Give the electron configurations of F and Cl (2)
3. What is the valency of the halogens? (1)
4. Give the definitions of the following terms

a) Polar molecule

b) Non-polar molecule

c) Ionic bond (6)

The results of revision classwork exercise 2 are shown in Table 4.3.4

Group A Results

Table 4.3.4 Experimental group results on revision classwork 2

Percentages of the test	Number of learners	Class performance percentage
0-29%	3	15%
30-39%	1	5%
40-49%	2	10%
50-59%	7	35%
60-69%	5	25%
70-79%	1	5%
80-100%	0	0%

N=20

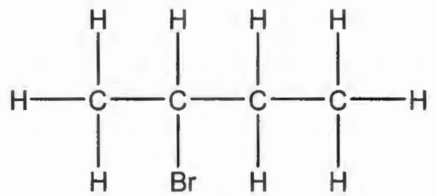
4.3.5 Classwork Exercise 2

The second classwork was administered after revision of halogens and the electron configuration of halogens which helped learners understand the bond between the halogens and the organic compounds. This was also used to explain the chemical properties of alkyl halides and their IUPAC names.

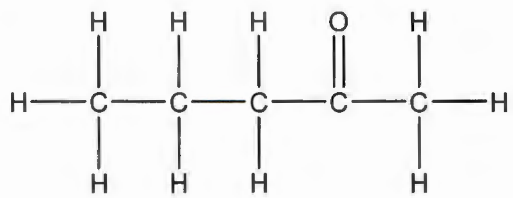
Grade	:	12
FOA	:	Classwork
Marks	:	16

1. Name the following alkyl halides, aldehydes, ketones and alcohols

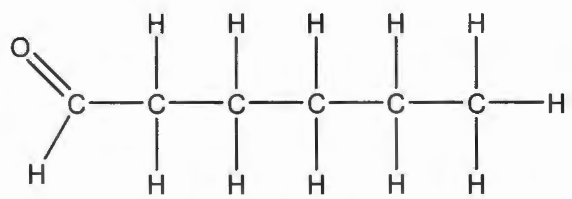
a)



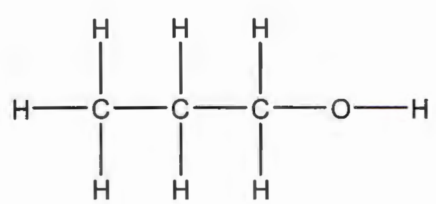
b)



c)



d)



(8)

2. Draw the structural formulas of:
    a) Pentanal
    b) Octane-4-one
    c) 2-Chloropentane
    d) Butan-2-ol (8)

The results of the two groups of classwork exercise 2 are shown in Tables 4.3.5 and 4.3.6

Group A Results

Table 4.3.5 Experimental group results on classwork exercise 2

Percentages of the test	Number of learners	Class performance Percentage
0-29%	3	15%
30-39%	2	10%
40-49%	0	0%
50-59%	3	15%
60-69%	7	35%
70-79%	2	10%
80-100%	3	15%

N=20

Group B Results

Table 4.3.6 Control group results on classwork exercise 2

Percentages of the test	Number of learners	Class performance percentage
0-29%	2	9.5%
30-39%	5	23.8%
40-49%	2	9.5%
50-59%	4	19.1%
60-69%	2	9.5%
70-79%	4	19.1%
80-100%	2	9.5%

N=21

4.3.6 Revision Classwork Exercise 3

The third revision classwork was written by the experimental group to remind them of some aspects of chemical reactions, and intermolecular forces. Since the chapter on Organic chemistry includes the comparison of boiling point, melting point and vapour pressure between different compounds of different homologous groups, a revision of intermolecular forces was crucial in ensuring they understood the concepts on a microscopic level.

Revised topic : Chemical reactions (Intermolecular forces)

Revised grade : Grade 11

Marks : 30

1.1 Explain the following terms

a) Intermolecular force

b) Van der waals forces

c) Dipole-dipole force

d) Induced dipole force

e) Ion-induced dipole force (10)

1.2 Consider the compounds PH_3 and SbH_3. As the elements P and Sb are found in the same group in the Periodic Table, it is to be expected that they should have very similar properties. On closer investigation, their boiling points are found to be:

PH_3: -88^0C and SbH_3: -17^0C

a) Which of PH_3 and SbH_3 should have the highest vapour pressure? Give a reason for your answer. (3)

1.3 In each case, compare the two given substances with each other in terms of boiling points. Each time, show which substance should have the highest boiling point, and give a reason for your choice.

a) CH_3F and HF (3)

1.4 Consider the following substances and show in each case if it will most likely dissolve in H_2O or CCl_4. Also give a reason for your choice in terms of the intermolecular forces between the molecules of the solvent and the solute.

a) Na_2S

b) HCl

c) CS_2

d) Br_2 (8)

1.5 Both H_2O and CCl_4 are popular solvents in which other substances are dissolved. Complete the table below and draw comparison between the two solvents

Solvent	Molecular shape	Polar or non-polar molecules	Intermolecular forces between molecules
H_20			
CCl_4			

(6)

The results of revision classwork 3 are shown in Table 4.3.7

Group A Results

Table 4.3.7 Experimental group results on revision classwork 3

Percentages of the test	Number of learners	Class performance Percentage
0-29%	8	40%
30-39%	3	15%
40-49%	4	20%
50-59%	4	20%
60-69%	1	5%
70-79%	0	0%
80-100%	0	0%

N=20

4.3.7 Classwork Exercise 3

The third classwork was linked with revision classwork 3. The chemical properties of different homologous groups such as alkanes, alcohols and carboxylic acids were taught. These properties were explained in terms of the intermolecular forces between them. The classwork was written by both the control group and experimental group.

Grade : 12

FOA : Classwork

Marks : 15

1. Which substance will have the higher boiling point? Ethanol or Ethane? Explain (3)
2. Which substance is more likely to dissolve in water? Butane or Butanol? Explain (3)
3. The boiling points of 3 organic compounds are given in the table below.

SUBSTANCE	CONDENSED STRUCTURAL FORMULA	BOILING POINT
A	$CH_3CH_2CH_2OH$	+97 ^{0}C
B	CH_3 CH_2CH_3	-42 ^{0}C
C	CH_3CH_2CHO	+48 ^{0}C

a) To which different homologous series do substances A, B and C belong to? (3)

b) Arrange the substances in order of increasing boiling point (1)

c) Explain why the boiling point of substance B is significantly lower than boiling point of substance A and C. (2)

d) Which substance, if comparing 2 equal size bottles containing the same volume of liquid, will exert a higher vapour pressure, butane or butanol? Explain. (3)

The results of the two groups of classwork 3 are shown in Tables 4.3.8 and 4.3.9

Group A Results

Table 4.3.8 Experimental group results on classwork exercise 3

Percentages of the test	Number of learners	Class performance Percentage
0-29%	2	10%
30-39%	2	10%
40-49%	2	10%
50-59%	4	20%
60-69%	4	20%
70-79%	2	10%
80-100%	4	20%

N=20

Group B Results

Table 4.3.9 Control group results on classwork 3

Percentages of the test	Number of learners	Class performance Percentage
0-29%	14	66.7%
30-39%	2	9.5%
40-49%	2	9.5%
50-59%	0	0%
60-69%	1	4.8%
70-79%	2	9.5%
80-100%	0	0%

N=21

4.4 Reaction Rate

Reaction rate was one of the topics with which learners struggled in the 2013 (Department of Basic Education, 2013) and 2014 Paper 2 examinations (Department of Basic Education, 2014). Learners had difficulty with questions that required explanations of concepts based on reaction rate. They also had difficulty in understanding the factors affecting rate of reactions and activation energy (Department of Basic Education, 2014).

4.4.1 Revision Classwork Exercise 1

The Grade 11 subchapter which dealt with Exothermic and Endothermic reactions was revised and linked to reaction rate which is taught in Grade 12. The experimental group was reminded of the role of activation energy in a chemical reaction and the enthalpy of the exothermic and endothermic reactions. The difference in the energy graphs of exothermic and endothermic reactions was also explained to them.

Revised topic : Energy changes during chemical reactions

Revised grade : Grade 11

Marks : 20

Question 1

1.1 Explain the following terms

a) Catalyst (2)

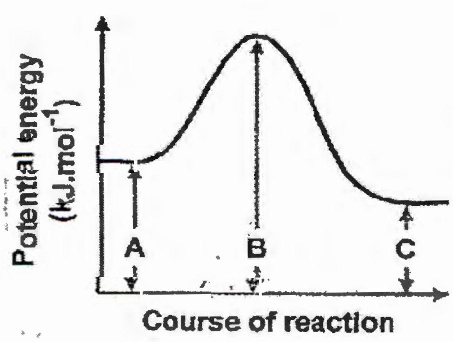
b) Activation energy (2)

c) Enthalpy (2)

d) Concentration (2)

Question 2

The hypothetical reaction between substance X_2 and Y_2 to form product XY can be illustrated by the energy diagram below



$$X_2 + Y_2 \rightarrow 2XY$$

2.1 Use the letters to indicate the interval on the graph that represents each of the following:

a) The potential energy of the product XY (1)

b) The heat of the reaction (1)

c) The activation energy for the forward reaction (1)

d) The energy of the activated complex (1)

2.2 Indicate whether the reaction is exothermic or endothermic (1)

2.3 Copy the graph and indicate the changes in the energy values if a catalyst was added (7)

The results of revision classwork exercise 1 are shown in Table 4.4.1

Group A Results

Table 4.4.1 Experimental group results on revision classwork 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	0	0%
40-49%	2	10%
50-59%	5	25%
60-69%	6	30%
70-79%	1	5%
80-100%	6	30%

N=20

4.4.2 Revision Classwork Exercise 2

The second revision classwork was done for further clarification of concepts of reaction rate. The experimental group was reminded how to calculate activation energy, value of enthalpy, the role of a catalyst in the lowering of activation energy and the different values of the activation energy when a catalyst is used.

Revised topic	:	Endothermic and exothermic reactions
Revised grade	:	Grade 11
Marks	:	10

Hydrogen gas and oxygen react to form water according to the following balanced equation:

$2H_2(g)+O_2(g) \rightarrow 2H_2O(g) + 241.8\ kJ.mol^{-1}$

The activation energy (E_A) for this reaction is 1370 $kJ.mol^{-1}$

a) Define the term activation energy (2)

b) Sketch a potential energy versus reaction coordinate graph for the above reaction. Clearly label the axes and indicate the following on the graph:

- ΔH
- E_A for the forward reaction
- Reactions (R) and products (P)
- Activated complex (X) (5)

c) Write down the value of the:

i) Heat of reaction (1)

ii) Activation energy for the following reaction:

$2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$ (2)

The results of revision classwork 2 are shown in Table 4.4.2

Group A Results

Table 4.4.2 Experimental group results on revision classwork 2

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	1	5%
40-49%	1	5%
50-59%	0	0%
60-69%	2	10%
70-79%	4	20%
80-100%	12	60%

N=20

4.4.3 Classwork Exercise 1

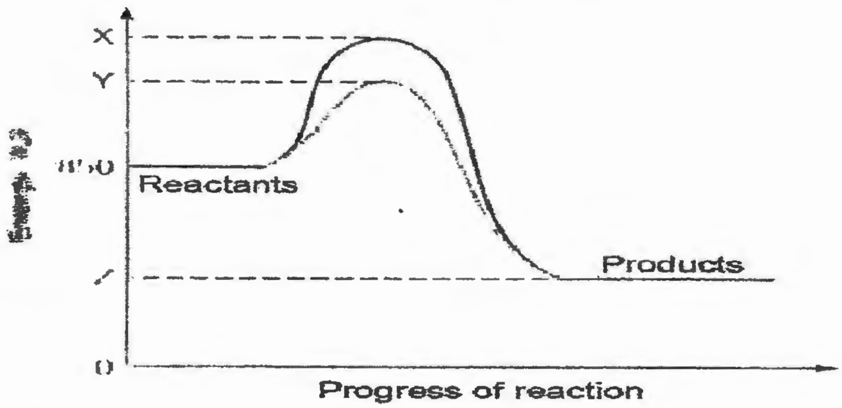
The classwork was written by both the experimental group and the control group. The content was a direct link with exothermic and endothermic reactions studied in Grade 11.

Grade : 12

FOA : Class work

Marks : 10

1. The graph in Figure 6.19 shows an energy graph for a chemical reaction



a) Is this reaction endothermic or exothermic? Explain (3)

b) Copy the graph into your book. Fill in the values of X, Y and Z on your graph if the following information is given

- The activation energy without a catalyst is 480kJ (1)
- The activation energy with a catalyst is 350Kj (1)
- The energy released in the formation of products in the uncatalysed reaction is 1030Kj (1)

c) What is the value of ΔH for this reaction? (2)

d) How is the value of ΔH affected by the use of a catalyst? (2)

The results of the two groups of classwork exercise 1 are shown in Tables 4.4.3 and 4.4.4

Group A Results

Table 4.4.3 Experimental group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	0	0%
40-49%	1	5%
50-59%	4	20%
60-69%	4	20%
70-79%	1	5%
80-100%	10	50%

N=20

Group B Results

Table 4.4.4 Control group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	9	42.9%
30-39%	8	38.1%
40-49%	1	4.8%
50-59%	2	9.5%
60-69%	1	4.8%
70-79%	0	0%
80-100%	0	0%

N=21

4.4.4 Classwork Exercise 2

A revision classwork based on the factors affecting chemical reactions was not done but the concepts were strongly emphasised during the revision classes of the introduction of the Reaction Rate content.

Grade : 12

FOA : Classwork

Marks : 10

1. Which of the reactions in each of the following pairs, (a) or (b) will have the highest reaction rate? Give a reason for your answer

1.1 a) $Zn(s) + 2HCl\ (0.1\ mol.dm^{-3}) \rightarrow ZnCl_2(aq) + H_2(g)$

b) $Zn(s) + 2HCl\ (0.2\ mol.dm^{-3}) \rightarrow ZnCl_2(aq) + H_2(g)$ (2)

1.2 a) $Mg(s) + 2H_2O\ (l) \rightarrow MgOH_2(aq) + H_2$ at 50^0C

b) $Mg(s) + 2H_2O\ (l) \rightarrow MgOH_2(aq) + H_2$ at 20^0C (2)

1.3 a) $Mg(s) + I_2(s) \rightarrow MgI_2(g)$ (I_2 is in a pellet form

b) $Mg(s) + I_2(s) \rightarrow MgI_2(g)$ (I_2 is in a crushed form) (2)

1.4 a) Mg powder + $2HCl \rightarrow MgCl_2 + H_2$

b) Mg ribbon + $2HCl \rightarrow MgCl_2 + H_2$ (2)

1.5 a) $H_2(g) + I_2(g) \rightarrow 2HI\ (g)$ (300kPa)

b) $H_2(g) + I_2(g) \rightarrow 2HI\ (g)$ (150kPa) (2)

The results of the two groups of classwork exercise 2 are shown in Tables 4.4.5 and 4.4.6

Group A Results

Table 4.4.5 Experimental group results on classwork exercise 2

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	1	5%
40-49%	0	0%
50-59%	0	0%
60-69%	0	0%
70-79%	1	5%
80-100%	18	90%

N=20

Group B Results

Table 4.4.6 Control group results on classwork exercise 2

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	0	0%
40-49%	2	9.5%
50-59%	3	14.3%
60-69%	4	19.1%
70-79%	4	19.1%
80-100%	8	38.1%

N=21

4.5 Electrochemical cells

Electrochemical cells is a topic in Grade 12 which is also challenging for learners to understand (Department of Basic Education, 2013 and 2014). Learners have difficulty in determining the reduction and oxidation potential of half-cells, calculating emf and determining the direction of the flow of electrons in the cell (Department of Basic Education, 2013).

4.5.1 Revision Classwork Exercise 1

The topic of Electrochemical cells studied in Grade 12 is a continuation of the topic of redox reactions which was studied in Grade 10 and 11. Most of the revised content was from Grade 11. The experimental group was reminded of the definitions of oxidizing and reducing agents, and the flow of charge between the reducing agent and oxidizing agent. The group was also reminded how to balance an ionic equation and calculate the emf of the half reaction between an oxidizing agent and reducing agent.

Revised topic	:	Redox reactions
Grade	:	Grade 10 and 11
Marks	:	12

1. Determine the oxidation number of the underlined atoms in the following compounds

   1.1 $\underline{N}O_3^-$ (1)

   1.2 $\underline{Cr_2}O_3$ (1)

2. What is electronegativity? (2)

3. Determine which substance is an oxidizing agent and which one is a reducing agent. Give a reason for your answer. (4)

   $$2NaCl(s)+2H_2O \rightarrow H_2(g)+Cl_2(g)+2NaOH(aq)$$

4. Balance the following redox reactions. Use a table of half reactions

   4.1 $SO_4^{2-} + Sn^{2+} \rightarrow SO_2 + Sn$ (2)

   4.2 $MnO_2 + H_2O \rightarrow Mn^{2+} + S$ (2)

The results of revision classwork 1 are shown in Table 4.5.1

Group A Results

Table 4.5.1 Experimental group results on revision classwork 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	2	10%
30-39%	2	10%
40-49%	2	10%
50-59%	10	50%
60-69%	2	10%
70-79%	0	0%
80-100%	2	10%

N=20

4.5.2 Classwork Exercise 1

The classwork exercise on galvanic cells was a continuation of work done on redox reactions in Grade 11 and 10. The galvanic cell, which has an anode and a cathode, depended on the oxidizing and reducing agents present for electrons to flow through the conductors connected via the electrodes. This content relied on the foundation of Grade 11 content.

Grade	:	12
FOA	:	Class work
Marks	:	16

1. The following half-reactions takes place in an electrochemical cell:

$$Fe \rightarrow Fe^{3+} + 3e^-$$
$$Fe^{2+} + 2e^- \rightarrow Fe$$

a) Which is the oxidation half-reaction and which is the reduction half-reaction? (2)
b) Give the ionic equation for this cell (2)
c) Calculate the emf of this cell (2)

2. Consider the galvanic cell represented by the following cell notation:

$$Al(s)/Al^{3+}(aq) \;||\; Ag^+(aq)/Ag(s)$$

a) Identify which electrode is the cathode and which electrode is the anode (2)
b) In which direction will electrons flow in the cell? (1)
c) Which substance will act as the reducing agent? (1)
d) Write down the net ionic reaction for the cell (2)
e) Calculate the net cell potential (emf) of the cell. (2)
f) State two important functions of the salt bridge in this cell (2)

The results of the two groups of classwork exercise 1 are shown in Tables 4.5.2 and 4.5.3

Group A Results

Table 4.5.2 Experimental group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	0	0%
30-39%	2	10%
40-49%	0	0%
50-59%	1	5%
60-69%	4	20%
70-79%	2	10%
80-100%	11	55%

N=20

Group B Results

Table 4.5.3 Control group results on classwork exercise 1

Percentages of the test	Number of learners	Class performance Percentage
0-29%	2	9.5%
30-39%	8	38.1%
40-49%	4	19.1%
50-59%	4	19.1%
60-69%	2	9.5%
70-79%	1	4.8%
80-100%	0	0%

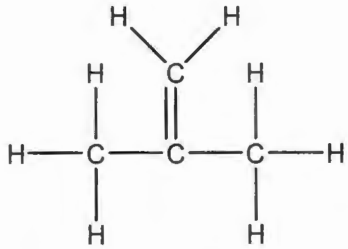
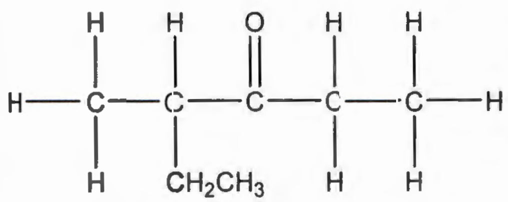
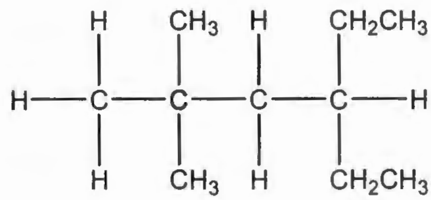
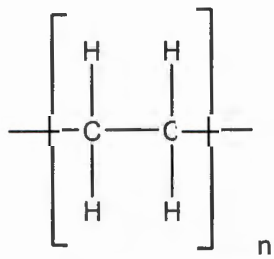
N=21

4.6 Test

After all the revision classwork exercises and Grade 12 classwork exercises had been done, the learners from the experimental and control groups wrote Chemistry post-test. The test was a combination of all three chapters which had been covered, being Organic Chemistry, Reaction Rate and Electrochemistry.

LEARNING AREA	: Physical Science	DURATION :	1 Hour
MARKS	: 30	FOA :	Test

Question 1: Look at the below table and answer the questions that follow

A		B	2-methylbutanoic acid
C		D	
E	But-2-ene	F	

1.1 Name the functional group of compound B (1)

1.2 Write down the IUPAC name of:

1.2.1 Compound C (1)

1.2.2 Compound D (1)

1.3 Write down the structural formula of:

1.3.1 Compound B (2)

Total = 5

Question 2

Learners use compound A to C, shown in the table below, to investigate a factor which influences the boiling point of organic compounds

A	$CH_3CH_2CH_2CH_3$
B	$CH_3CH_2CH_2CH_2CH_3$
C	$CH_3CH_2CH_2CH_2CH_2CH_3$

2.1 Which one of the following compounds (A, B or C) has the highest boiling point? (1)

2.2 Write down the name of the type of Van der Waals forces that occurs between the molecules of compound B (1)

Now compare the boiling point of compound D to that of compound E, shown in the table below

D	$CH_3CH_2CH_2CH_2CH_2OH$
E	$CH_3CH_2CH_2COOH$

2.3 How does the boiling point of compound D compare to that of compound E? Write down HIGHER THAN, LOWER THAN or EQUAL TO. Fully explain the answer. (4)

Total = 6

Question 3

A group of learners use the reaction of EXCESS hydrochloric acid (HCl) with zinc (Zn) to investigate factors which influence reaction rate. The balanced equation for the reaction is:

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

They use the same volume of HCl and 1.2g of zinc in each of 5 experiments. The reaction conditions and temperature readings before and after completion of the reaction in each experiment are summarized in the table below:

Experiment	Reaction conditions				Time (s)
	Concentration of HCl (mol.dm^3)	Temperature (^{0}C)		State of division of the 1.2g of Zn	
		Before	After		
1	0.5	20	34	Granules	50
2	0.5	20	35	Powder	10
3	0.8	20	36	Powder	6
4	0.5	35	50	Granules	8
5	0.5	20	34	Granules	11

3.1 Is the reaction between Hydrochloric acid and zinc EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer by referring to the data in the table (2)

3.2 Give a reason for the difference in reaction observed in Experiments 1 and 2 (1)

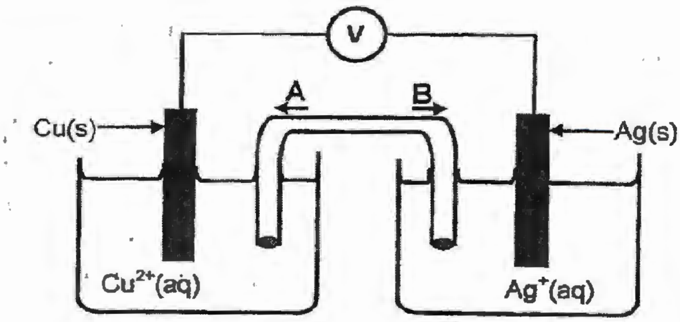
3.3 The learners compare the results of Experiment 1 and 3 to draw a conclusion regarding the effect of concentration on reaction rate. Give a reason why this is not a fair comparison(1)

3.4 How does the reaction rate of the reaction in Experiment 5 compare to that in Experiment 1? Write down FASTER THAN, SLOWER THAN or EQUAL TO. Write down the factor responsible for the difference in the reaction rate and fully explain, by referring to the collision theory, how this factor affects reaction rate. (5)

Total = 9

Question 4

A learner sets up a galvanic cell as shown below. The cell functions under standard conditions



4.1 Write down the energy conversion that takes place in this cell (1)

4.2 In which direction (A or B) will ANIONS move in the salt bridge? (1)

4.3 Calculate the emf of the above cell under standard conditions (4)

4.4 Write down the balanced equation for the net cell reaction that takes place in this cell. (3)

4.5 How will the addition of $100cm^3$ of 1 $mol.dm^3$ silver nitrate solution to the silver half-cell influence the initial emf of the cell? Write down only INCREASE, DECREASE or REMAINS THE SAME (1)

Total = 10

GRAND TOTAL = 30

The results of the two groups of the test are shown in Tables 4.5.4 and 4.5.5

Group A Results

Table 4.5.4 Experimental group results on the test

Percentages of the test	Number of learners	Class performance Percentage
0-29%	1	5%
30-39%	1	5%
40-49%	1	5%
50-59%	2	10%
60-69%	5	25%
70-79%	7	35%
80-100%	3	15%

N=20

Group B Results

Table 4.5.5 Control group results on the test

Percentages of the test	Number of learners	Class performance Percentage
0-29%	3	14.3%
30-39%	6	28.6%
40-49%	5	23.8%
50-59%	5	23.8%
60-69%	1	4.8%
70-79%	1	4.8%
80-100%	0	0%

N=21

Conclusion

The data and results of the IQ and Chemistry common tests from the four schools were collected; data and results of revision class works administered to the experimental group, class works of grade 12 content administered to both the experimental and control group, as well as the main test were all also collected and been reviewed in this chapter. In chapter 5, the discussion results of the study will be outlined.

CHAPTER 5
DISCUSSION OF RESULTS

5.1. IQ Test

The objectives of the test were to test the learners' ability to solve mathematics and science problems and to check their intelligence, which would give an indication of whether the learners studying Physical Sciences at these four schools had the ability to cope with the subject. Some of the questions required high order thinking skills while some were common numerical problems which needed basic common sense. Some questions needed a background of Natural Sciences from Grade 8 and 9. Grade 10 learners were expected to know at least 60-70% of the questions since 70% of the questions required knowledge of Maths and Natural Sciences from the GET phase. The learners who were doing Grade 11 and 12 were expected to know at least 80-100% of the IQ test questions as some questions included Maths content from Grade 10 and 11. Four high schools, Bodibe Secondary, Tau-Rapulana, Tswelelopele and Baitshoki wrote the IQ test. The test was administered to all learners across the FET phase, except in Tau-Rapulana where only the Grade 11s and 12s wrote, due to administrative reasons that occurred during that day.

5.1.1 Results of the IQ test from the four different schools:

i) Bodibe Secondary School

Grade 10 Results (See table 4.1.1)

The average percentage obtained was 33%. 52.4% of the class scored between 0-40%, 26.2% scored between 40-60%. 21.4% of the class scored between 60-100% (see Table 4.1.1.).

Grade 11 Results (See table 4.1.2)

The average percentage obtained was 37%. 47.1% of the class scored between 0-40%, 35.3% scored between 40-60%. 17.7% scored between 60-100% (see Table 4.1.2).

Grade 12 Results (See table 4.1.3)

The average percentage obtained was 49%. 29.3% of the class scored between 0-40%, 29.3% scored between 40-60% and 41.5% scored between 60-100% (see Table 4.1.3).

In this school the results in Grade 12 were better than the other grades.

ii) Tau-Rapulana High School

Grade 11 Results (See table 4.1.4)

The average percentage obtained was 33%. 59.4% of the class scored between 0-40%, 34.4% scored between 40-60% and only 6.3% scored between 60-100% (Table 4.1.4).

Grade 12 Results (See table 4.1.5)

The average percentage obtained was 38%. 46.2% of the class scored between 0-40%, 42.3% scored between 40-60% and 11.5% scored between 60-100% (Table 4.1.5).

This showed some increase in ability to solve Maths and Science problems from Grade 11 to Grade 12.

iii) Tswelelopele High School

Grade 10 Results (See table 4.1.6)

The average percentage obtained was 37%. 58.9% of the class scored between 0-40%, 21.4% scored between 40-60% while 19.6% scored between 60-100% (Table 4.1.6).

Grade 11 Results (See table 4.1.7)

The average percentage obtained was 38%. 57.5% of the class scored between 0-40%. 19.2% scored between 40-60%. 23.4% scored between 60-100% (Table 4.1.7).

Grade 12 Results (See table 4.1.8)

The average percentage obtained was 71%. 28.6% of the class scored between 0-40%, 17.9% scored between 40-60% while 53.6% scored between 60-100% (Table 4.1.8).

The results between the three Grades showed that the Grade 10 and 11 results were much the same (37 – 38%), whereas the Grade 12 learners showed an increase in skill (71%).

iv) Baitshoki High School

Grade 10 Results (See table 4.1.9)

The average percentage obtained was 32%. 68.6% of the class scored between 0-40%, 25.7% scored between 40-60% and 5.7% scored between 60-100% Table 4.1.9).

Grade 11 Results (See table 4.1.10)

The average percentage obtained was 34%. 62.9% of the class scored between 0-40%, while 22.2% scored between 40-60% and 14.8% scored between 60-100% (Table 4.1.10).

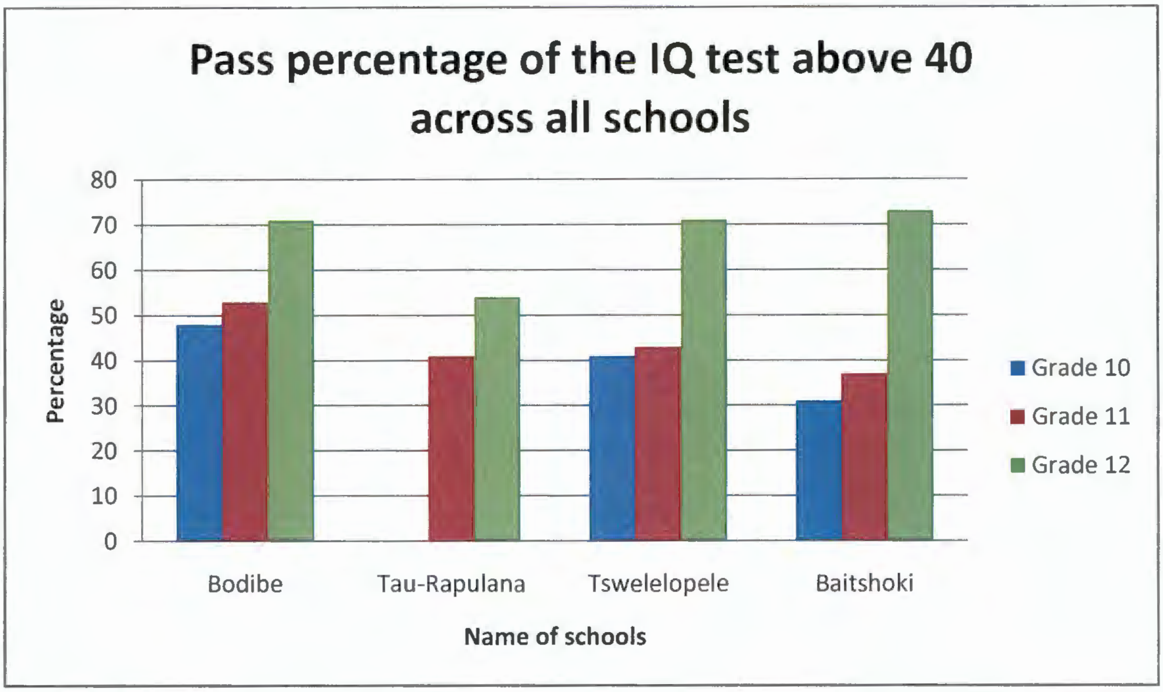
Grade 12 Results (See table 4.1.11)

The average percentage obtained was 51%. 27.3% of the class scored between 0-40%, 45.5% scored between 40-60% and 27.3% scored between 60-100% (Table 4.1.11).

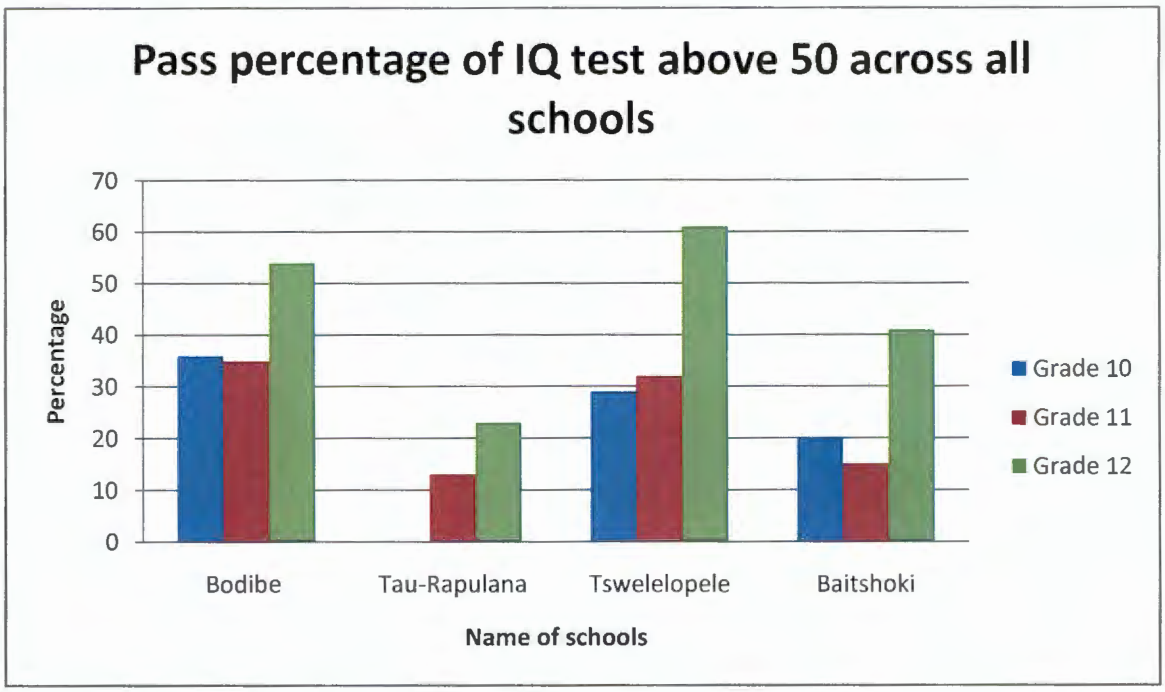
Even though there was a better performance by the Grade 12s as expected, the questions in the IQ test proved difficult for the learners across the FET phase.

5.1.2 Analysis and comparison of the averages of all the schools

Graph 5.1.1 Pass percentage of the IQ test from the four schools above 40 per cent



Graph 5.1.2 Pass percentage of the IQ test from the four schools above 50 per cent



Grade 10 Pass percentages and Averages

Graph 5.1.1. shows that the pass percentage of 40 and above in Bodibe is at 47.6%, Tswelelopele at 41.1% and Baitshoki at 31.4%, while graph 5.1.2 shows that the pass percentage of 50 and above in Bodibe is at 35.7%, Tswelelopele at 28.6 and Baitshoki at 20%. Learners in Bodibe had the highest pass rate in both 40 and 50 per cent and above, followed by Tswelelopele and lastly Baitshoki.

Bodibe had an average percentage of 33%, Tswelelopele had an average percentage of 37% and Baitshoki had an average of 32%, while Grade 10 Tau-Rapulana learners did not write the IQ test. It is interesting to note, from the averages of the three schools, that Tswelelopele, which is a science school, had the highest average mark, while Baitshoki, which is a general school, had the lowest average mark. Bodibe, which had a Grade 10 class for the third year since becoming a high school, scored better than Baitshoki. When considering all the schools, on average 59.4% the Grade 10's performed lower than 40%, 24.1% performed between 40-60% and 16.5% scored between 60-100%.

This showed that the learners in these schools doing Physical Science at Grade 10 did not adequately understand the concepts of Mathematics and Science taught in the GET phase before they entered the FET phase.

Grade 11 Pass percentages and Averages

Graph 5.1.1. shows that the pass percentage of 40 and above in Bodibe is at 53.0%, Tau-Rapulana at 40.7%, Tswelelopele at 42.6% and Baitshoki at 37.0%, while graph 5.1.2 shows that the pass percentage of 50 and above in Bodibe is at 35.3%, Tau-Rapulana at 12.6, Tswelelopele at 31.9 and Baitshoki at 14.9%. Learners in Bodibe had the highest pass rate at both 40 and 50 per cent and above; at 40 per cent and above followed by Tswelelopele and Tau-Rapulana, with Baitshoki last; at 50 per cent and above Bodibe and Tswelelopele were similar, with Tau-Rapulana and Baitshoki performing far worse.

From a comparison of the Grade 11 results, it can be seen that Bodibe had an average percentage of 37%, Tau-Rapulana had an average of 33%, Tswelelopele had an average percentage of 38% and Baitshoki had an average of 34%. Thus Tswelelopele had the highest average mark. Bodibe, had the second highest mark, Baitshoki was third while Tau-Rapulana, which is also a general high school, had the lowest average mark.

On average, 56.4% of the Grade 11's in the four schools scored lower than 40%, while 27.1% scored between 40-60% and 16.4% scored between 60-100%. This also demonstrated the lack of skills in both Mathematics and Science in the Grade 11's.

Grade 12 Pass percentages and Averages

Graph 5.1.1. shows that the pass percentage of 40 and above in Bodibe is at 70.7%, Tau-Rapulana at 53.9%, Tswelelopele at 71.4 and Baitshoki at 72.7%, while graph 5.1.2 shows that the pass percentage of 50 and above in Bodibe is at 53.7%, Tau-Rapulana at 23.1%, Tswelelopele at 60.7% and Baitshoki at 40.91%. Learners in Baitshoki had the highest pass rate at 40 per cent and above, followed by Tswelelopele, Bodibe and lastly Tau-Rapulana. Learners in Tswelelopele had the highest pass rate at 50 per cent and above, followed by Bodibe, Baitshoki and lastly Tau-Rapulana.

From the results of all the schools, Bodibe had an average percentage of 49%, Tau-Rapulana had an average of 38%, Tswelelopele had an average percentage of 71% and Baitshoki had an average of 51%. From the averages of the three schools, Tswelelopele, had the highest average mark, followed by Baitshoki, Bodibe and lastly Tau-Rapulana.

From the results of all the schools combined, on average, 32.5% of the Grade 12's in the four schools scored lower than 40%, 32.5% scored between 40-60% and 35.1% scored between 60-100%. Thus Grade 12's performed better than the Grade 11's and 10's, but not as well as expected and not many learners scored in the region of 60-100%. The Grade 12's proved that they still had problems in terms of skills and ability to think at a microscopic level when it comes to Mathematics and Science.

5.2 Chemistry common test

The test was aimed at assessing the learners' background knowledge of Chemistry across all the Grades in the FET phase, and whether their knowledge of Chemistry builds up as they progress from Grade10 to 11 and 12. The concepts mainly required middle-order thinking skills with a few higher order questions. They included knowledge about the properties of an atom and its sub-particles, atomic number, mass number; names of groups, chemical properties of metals, non-metals and semi-metals; acids and bases; conductors and semi-conductors and allotropes. This content should be well understood by the Grade 12 learners since the Grade 10 and 11 syllabuses covers all the concepts. The Grade 10s were expected to be able to answer about half of the questions since they covered the topics in introductory Chemistry in Grade 8 and 9, especially the questions on groups, chemical properties of groups, metals and non-metals; mass number and atomic number. The Grade 11s were expected to answer 75% of the questions as all these mentioned concepts are done in Grade 10.

5.2.1 Results of the four schools on the Chemistry common test

i) Bodibe Secondary School

Grade 10 Results (See table 4.2.1)

The average percentage obtained was 41%. 47.6% of the Grade 10s scored between 0-40%, 21.4% scored between 40-60%. 31.0% of the class scored between 60-100% (Table 4.2.1).

Grade 11 Results (See table 4.2.2)

The average percentage obtained was 47%. 41.2% of the Grade 11's scored between 0-40%, 32.4% scored between 40-60%. 26.5% scored between 60-100% (Table 4.2.2)

Grade 12 Results (See table 4.2.3)

The average percentage obtained was 55%. 19.5% of the class scored between 0-40%, 34.2% scored between 40-60% and 46.3% scored between 60-100% (Table 4.2.3)

In this school, a slightly higher percentage of the Grade 10's performed better than the Grade 11's in the regions between 40-60% and 60-100%. This could be due to the number of learners who had actually not passed Grade 10 but were progressed to Grade 11 due to the age-cohort policy (Department of Education, 2008) which states that a learner cannot stay in one Grade for more than two years or more than four years in one phase (Department of Education, 2008). These learners who were progressed, lowered the results of the grade 11s. Overall, an increase in Chemistry knowledge was evident but not at the rate expected since more than half of the Grade 12s did not perform in the mark range of 60-100%

ii) Tau-Rapulana High School

Grade 11 Results (See table 4.2.4)

The average percentage obtained was 45%. 46.9% of the Grade 11s scored between 0-40%, 31.2% scored between 40-60%. 21.9% scored between 60-100% (Table 4.2.4)

Grade 12 Results (See table 4.2.5)

The average percentage obtained was 51%. 23.1% of the class scored between 0-40%, 61.5% scored between 40-60% and 15.4% scored between 60-100% (Table 4.2.5).

The increase in knowledge of Chemistry between the Grade 11's and 12's was evident, but was also not as large as expected. The performance of the Grade 12's showed that they still lacked knowledge of the Chemistry content. More of the Grade 11's than the Grade 12's performed in the region 60-100%. This could be due to the number of progressed learners in Grade 12.

iii) Tswelelopele High School

Grade 10 Results (See table 4.2.6)

The average percentage obtained was 41%. 64.3% of the Grade 10's scored between 0-40%, 23.2% scored between 40-60%. 12.6% of the class scored between 60-100% (Table 4.2.6).

Grade 11 Results (See table 4.2.7)

The average percentage obtained was 43%. 57.5% of the Grade 11's scored between 0-40%, 31.9% scored between 40-60%. 10.6% scored between 60-100% (Table 4.2.7).

Grade 12 Results (See table 4.2.8)

The average percentage obtained was 59%. 25.0% of the class scored between 0-40%, 35.7% scored between 40-60% and 39.3% scored between 60-100% (Table 4.2.8).

There was increase in Chemistry knowledge in the three Grades. The general performance of the learners in the test was not acceptable especially the Grade 11s and 12s.

iv) Baitshoki High School

Grade 10 Results (See table 4.2.9)

The average percentage obtained was 38%. 68.6% of the Grade 10s scored between 0-40%, 25.7% scored between 40-60%. 5.7% of the class scored between 60-100% (Table 4.2.9).

Grade 11 Results (See table 4.2.10)

The average percentage obtained was 53%. 29.6% of the Grade 11's scored between 0-40%, 33.3% scored between 40-60%. 37.0% scored between 60-100% (Table 4.2.10).

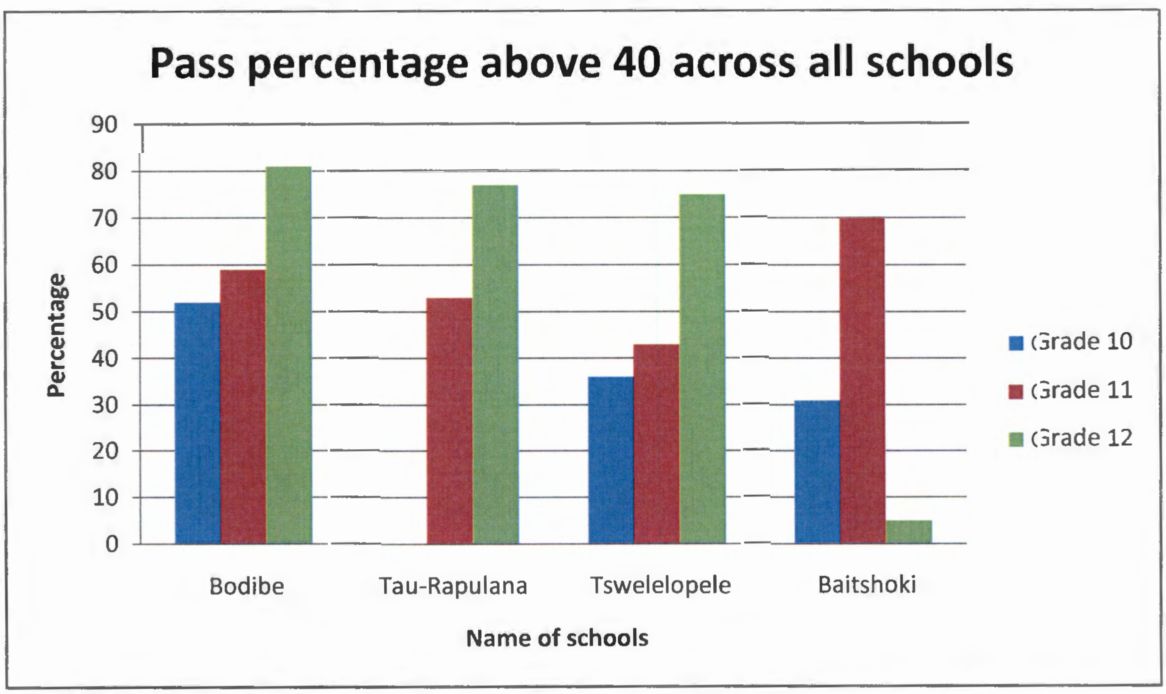
Grade 12 Results (See table 4.2.11)

The average percentage obtained was 61%. 13.6% of the class scored between 0-40%, 31.8% scored between 40-60% and 54.6% scored between 60-100% (Table 4.2.11).

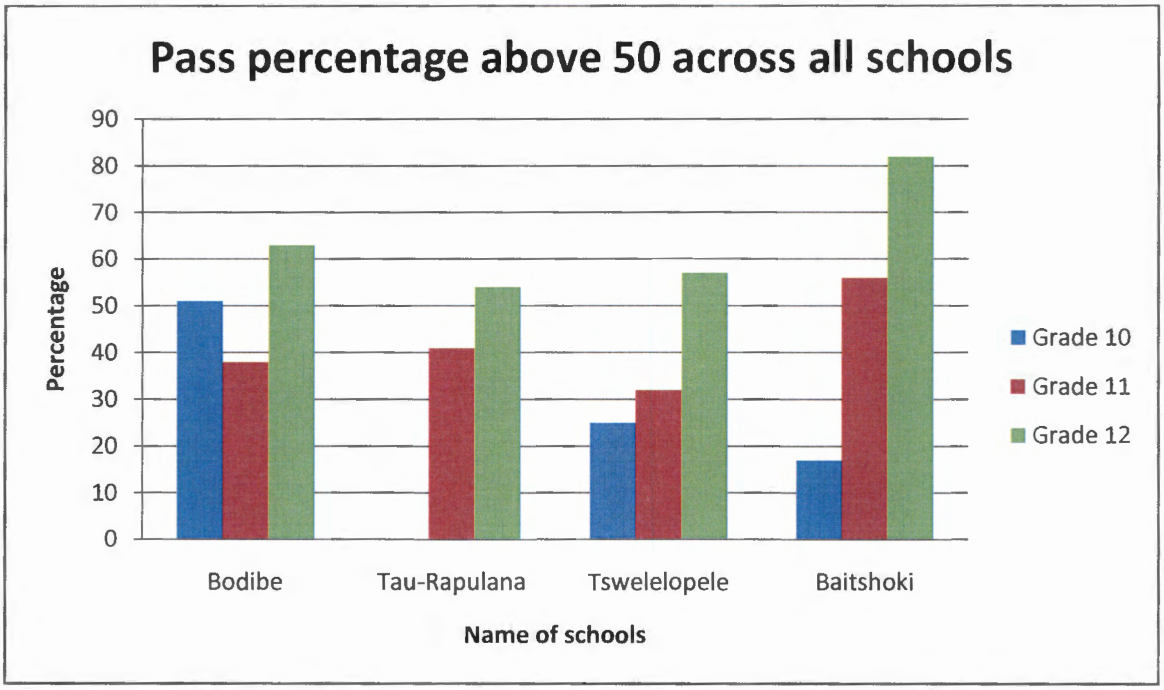
Increase in Chemistry knowledge was evident, but similarly to other schools, it was not what was expected in Grade 11 and 12. This also showed that the Grade 11's and 12's still did not understand concepts in Chemistry.

5.2.2 Analysis and comparison of the averages of all the schools of the Chemistry common test

Graph 5.2.1 Pass percentage of the Chemistry common test from the four schools above 40 per cent



Graph 5.2.2 Pass percentage of the Chemistry common test from the four schools above 50 per cent



Grade 10 Pass percentages and Averages

Graph 5.2.1. shows that the pass percentage of 40 and above in Bodibe is at 52.4%, Tswelelopele at 35.7% and Baitshoki at 31.4%, while graph 5.2.2 shows that the pass percentage of 50 and above in Bodibe is at 40.5%, Tswelelopele at 25% and Baitshoki at 17.1%. Learners in Bodibe had the highest pass rate in both 40 and 50 per cent and above, followed by Tswelelopele and lastly Baitshoki.

From the results of all the schools, Bodibe and Tswelelopele had an average percentage of 41%, Baitshoki had an average of 38% while Grade 10 learners from Tau-Rapulana did not write the Chemistry common test. From the averages of the three schools, Bodibe and Tswelelopele had the highest average percentage, followed by Baitshoki.

From the results of all the schools combined, on average, like in the IQ test, 60% the Grade 10s scored lower than 40%, 20% performed between 40-60% and again like in the IQ test, 11% scored between 60-100%. The Grade 10s did not perform as well as expected since half of the questions were from Grade 8 and 9 Natural Sciences content.

Grade 11 Pass percentages and Averages

Graph 5.2.1. shows that the pass percentage of 40 and above in Bodibe is at 58.8%, Tau-Rapulana at 53.1%, Tswelelopele at 42.6 and Baitshoki at 70.4%, while graph 5.2.2 shows that the pass percentage of 50 and above in Bodibe is at 38.2%, Tau-Rapulana at 40.6%, Tswelelopele at 31.9% and Baitshoki at 55.6%. Learners in Baitshoki had the highest pass rate at 40 per cent and above, followed by Bodibe, Tau-Rapulana and lastly Tswelelopele. Learners in Baitshoki had the highest pass rate at 50 per cent and above, followed by Tau-Rapulana, Bodibe and lastly Tswelelopele.

From the results of all the schools, Bodibe had an average percentage of 47%, Tau-Rapulana had an average of 45%, Tswelelopele had an average percentage of 43% and Baitshoki had an average of 53%. From the averages of the four schools, Baitshoki, had the highest average percentage, followed by Tau-Rapulana, Bodibe and lastly Tswelelopele.

From the results of all the schools combined, on average, 44% of the Grade 11s in the four schools scored lower than 40%, 33% scored between 40-60% and 23% scored between 60-100%. The Grade 11s from all the schools did not perform well, their knowledge of basic Chemistry was lacking.

Grade 12 Pass percentages and Averages

Graph 5.2.1. shows that the pass percentage of 40 and above in Bodibe is at 80.5%, Tau-Rapulana at 76.9%, Tswelelopele at 75.0% and Baitshoki at 86.6%, while graph 5.2.2 shows that the pass percentage of 50 and above in Bodibe is at 63.4%, Tau-Rapulana at 53.9%, Tswelelopele at 57.9% and Baitshoki at 81.8%. Learners in Baitshoki had the highest pass rate at 40 per cent and above, followed by Bodibe, Tau-Rapulana and lastly Tswelelopele. Learners in Baitshoki had the highest pass rate at 50 per cent and above, followed by Bodibe, Tswelelopele and lastly Tau-Rapulana.

From the results of all the schools, Bodibe had an average percentage of 55%, Tau-Rapulana had an average of 51%, Tswelelopele had an average percentage of 59% and Baitshoki had an average of 61%. From the averages of the four schools, Baitshoki, had the highest average percentage, followed by Tswelelopele, Bodibe and lastly Tau-Rapulana.

From the results of all the schools combined, on average, 21% of the Grade 12s in the four schools scored lower than 40%, 41% scored between 40-60% and 39% scored between 60-100%.

There was a small increase of knowledge of Chemistry concepts within the three grades but the Grade 12s should have performed far better than the other two Grades. Tswelelopele, as a science school, came second to Baitshoki, which is a general school. Bodibe, which is a new high school, performed better than the already established general school Tau-Rapulana. This showed that the performance of learners in Chemistry was not about which school, learners attend, and that it is more about the methodology in which the Chemistry content is taught in general.

5.3 Organic Chemistry

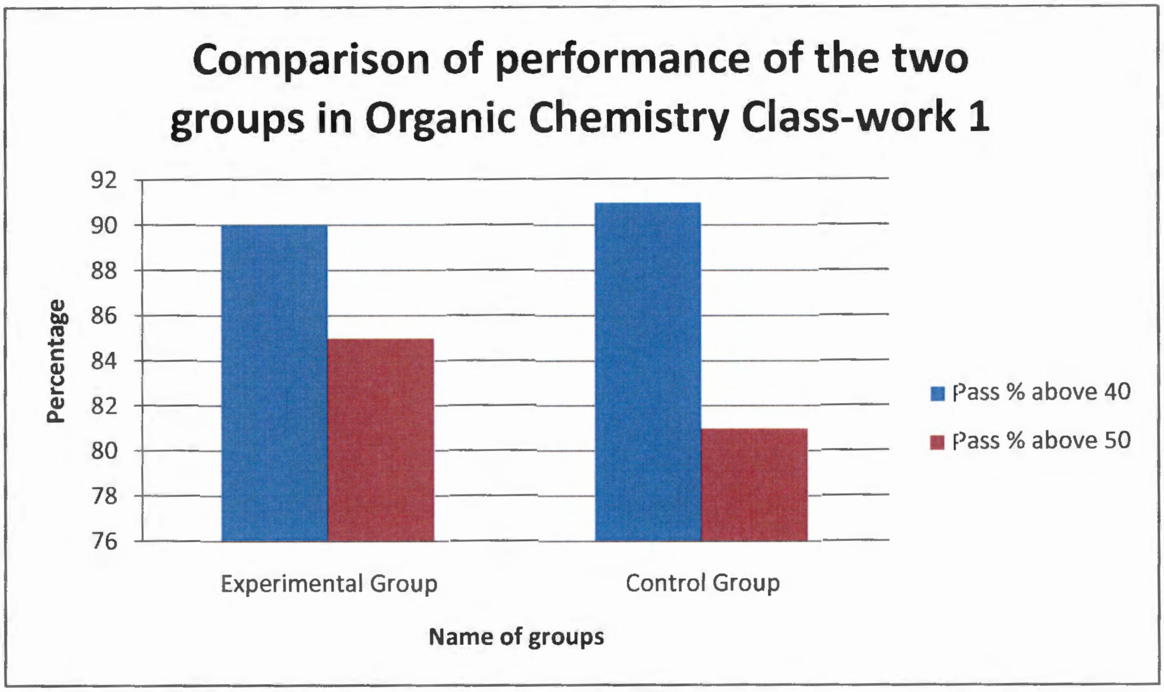
5.3.1 Revision Classwork Exercise 1 (See table 4.3.1)

The learners were reminded about the importance of understanding the valency of atoms, because this would help to explain the bonds and structures of organic molecules. The learners were also reminded how to draw the Lewis dot structures to assist them in determining the shape and structural formulae of compounds. Revision of valency, Lewis dot structures, electron configuration and VSEPR theory from Grade 10 and 11 aimed at helping learners understand the structure of organic compounds better, for example, the tetrahedral structure of methane, the double-bond in the carbonyl group, the hydroxyl group in alcohols etc. Only the experimental group wrote the test, 5% of the class scored between 0-40%, 25% scored between 40-60% and 70% scored between 60-100%. The average percentage of the revision classwork of the experimental group was 63%.

Some learners in the experimental group had difficulty drawing the Lewis dot structure of carbon dioxide as they struggled to understand that the four valence electrons in carbon could form two double bonds with two oxygen atoms. They needed to understand this because in Organic Chemistry in Grade 12, the presence of a double bond between oxygen and carbon affects the boiling points and melting points of compounds.

5.3.2 Classwork Exercise 1 (See table 4.3.2 and 4.3.3)

Graph 5.3.1 Pass percentage of the Organic Chemistry class-work exercise 1 from the two groups from 40 and 50 per cent and above



The first class-work exercise given built on the content taught in the first revision class work. It contained questions on different structures of organic compounds and different structural formulas. The learners in the experimental group were able to link the Lewis dot structure and the VSEPR theory that they had revised with the structural formulas of alkanes, alkynes and alkenes.

In the test, 10% of the experimental group scored between 0-40%, while 20% scored between 40-60% and 70% scored between 60-100%. The control group also had 10% scoring between 0-40%, while 39% scored between 40-60% and only 52% scored between 60-100%. The average percentage of the experiment group was 70% while of the control group was 59%. Graph 5.3.1 shows the performance of the learners of the two groups in classwork 1, pass percentage at 40% for the experimental group is at 90% and for control group is 91%; while pass percentage at 50% is at 85% for the experimental group and 81% for the control group. Even though, control group performed better than the experimental group at 40%, they have a higher percentage of learners who scored from 60%-100%

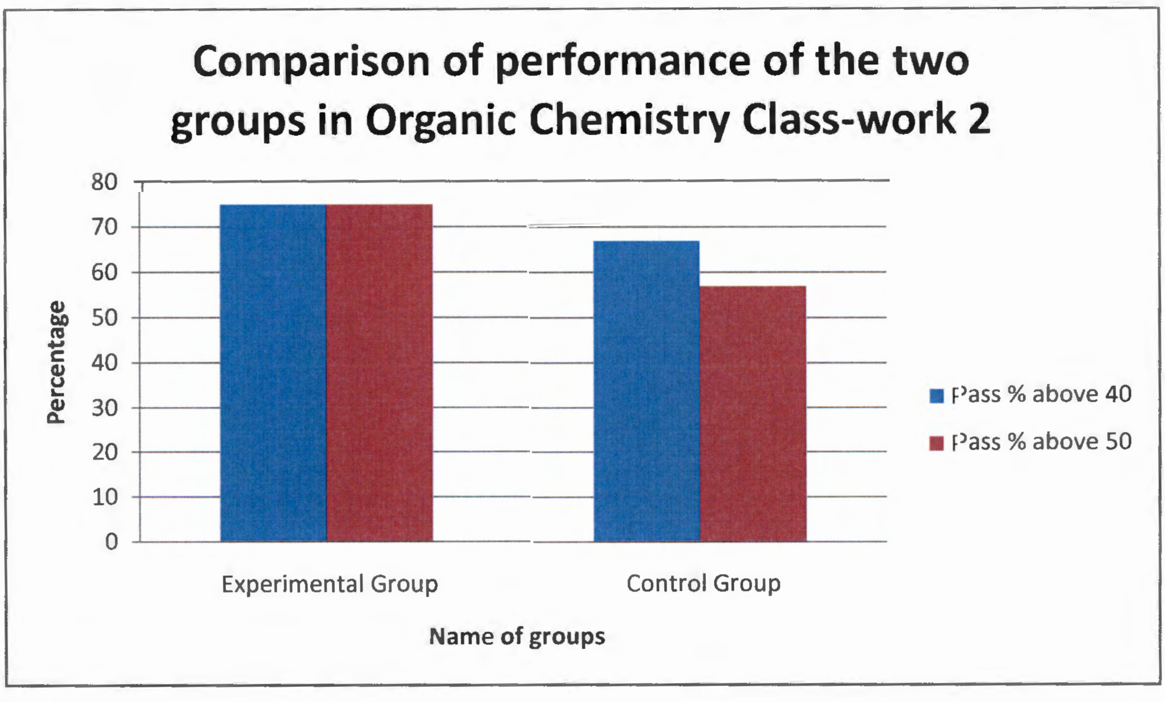
The manner in which the experimental group approached and answered questions was better than the control group. 12 out of 20 learners (60%) in the experimental group drew the correct structural formulae of butane, hexane, propene, pent-2-ene and but-2-yne as compared to the 5 out 21 (24%) in the control group. The learners in the experimental group linked the structural formulas of the organic compounds with the revised content from Grade 10 and 11 of the VSEPR theory and the Lewis dot structures. The usage of the Lewis dot structures was evident because the experimental group understood the double bonding and triple bonding found in propene and but-2-yne respectively.

5.3.3 Revision Classwork Exercise 2 (See table 4.3.4)

The experimental group revised various aspects of halogens, such as their names, electron configuration and the concept of polarity from Grade 10. The revision was relevant because alkyl halides have one or more halogen atoms attached to one or more carbon atoms in the main chain (McLaren, Gray, du Plessis, 2013). Only the experimental group wrote the revision class-work; 20% scored between 0-40%, 45% scored between 40-60% and 30% scored between 60-100%. The average percentage obtained by the experimental group was 48%.

5.3.4 Classwork Exercise 2 (See table 4.3.5 and 4.3.6)

Graph 5.3.2 Pass percentage of the Organic Chemistry class-work exercise 2 from the two groups from 40 and 50 per cent and above



The second class work exercise on Organic Chemistry had four questions based on the naming of alkyl halides, aldehydes, ketones and alcohols. Even though the revision concerned alkyl halides only, the experimental group also showed better understanding of the naming of the aldehydes, ketones and alcohols. The second question was based on the structural formulas of ketones, aldehydes, alkanes and alcohols and was also answered better by the experimental group. The question on aldehydes in particular, required the learners to know and understand the carbon-oxygen double-bond in the functional group. This was a clear indication that the experimental group linked this concept with the Lewis dot structure of the C=O double bond and the C-H single bond revised earlier.

A graph 5.3.2 show that at pass percentage of 40% and above, the experimental group pass percentage was 75% compared to the control group at 66.7%, while pass percentage at 50 for the experimental group was 75% and the control group at 57.1%. Only 25% of the experimental group scored between 0-40%, 15% scored between 40-60% and 60% between 60-100%. In the control group, 34% scored between 0-40%, 29% between 40-60% and 39% between 60-100%. The control group confused the structure of ketones and carboxylic acids, while some learners attached a hydrogen atom to the carbonyl group in the ketone.

5.3.5 Revision Classwork Exercise 3 (See table 4.3.7)

The third revision class-work required learners to have revised the key concepts from Grade 11, including that the shape and structure of an organic compound affects its physical properties such as melting point, boiling point and physical state (Louw, 2013). Intermolecular forces from Grade 11 were revised, and these intermolecular forces were the weak Van der Waals forces such as London forces., dipole-dipole and induced-dipole dipole forces; and the stronger Hydrogen bond. Forces between ions and polar and non-polar molecules i.e. ion-dipole and ion-induced dipole forces were also revised.

The process of boiling and melting were further explained with reference to intermolecular forces. The learners were reminded of three key facts:

1. Non-polar molecules with only Van der Waal forces between molecules have low boiling points and low melting points. (Louw, 2013);

2 Polar covalent molecules (with a dipole) have stronger intermolecular forces and therefore have higher boiling points and melting points (Louw, 2013); and

3. Hydrogen bonding is a strong intermolecular force between small molecules with high electronegativity e.g., H_2O, HF, NH_3 etc. and compounds with Hydrogen bonding have the highest boiling and melting points although they may have smaller molecular masses (Louw, 2013).

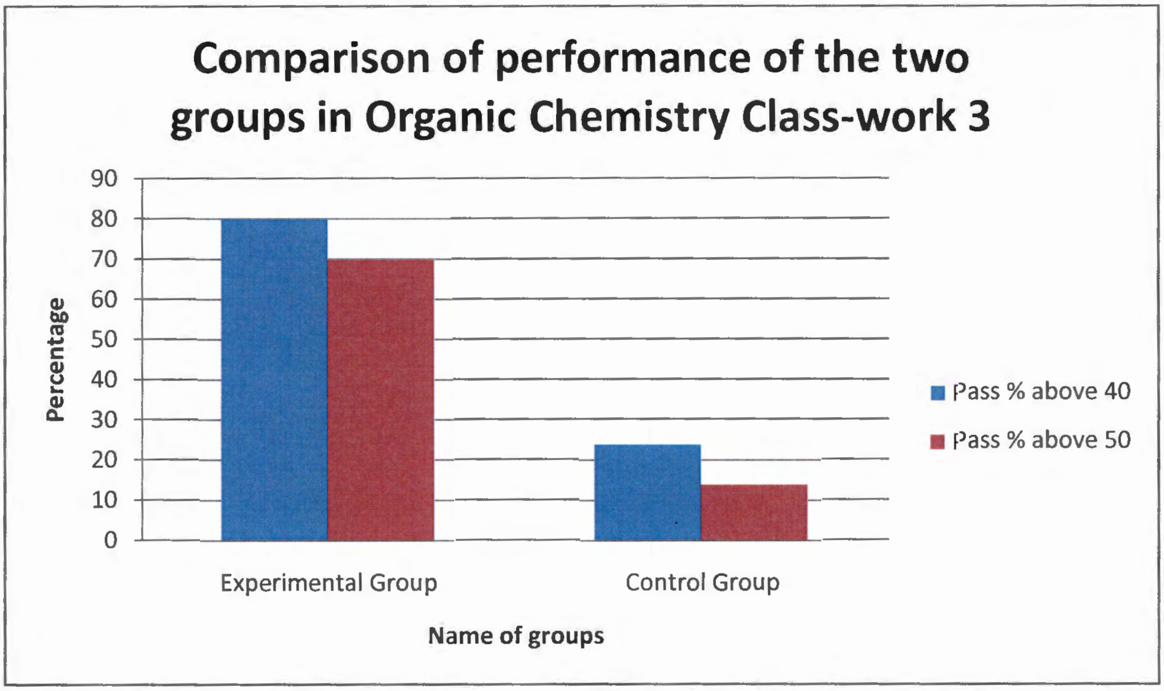
The last important aspect of revision was to remind learners that the solubility of a substance depended on whether the intermolecular attraction forces between the particles of the dissolved substance and those of the solvent were strong enough to overcome the mutual forces of attraction between the particles of the substances. Solubility revision was summed up by the key facts:

1. Substances are soluble in one another if the intermolecular forces between the particles of the separate substances are of the same order of magnitude i.e. if they are similar substances. (Louw, 2013);
2. Ionic and polar substances dissolve in polar solvents i.e. sodium chloride dissolves well in water (Louw, 2013); and
3. Non-polar substances dissolve in non-polar solvents e.g. iodine dissolves well in carbon tetrachloride (Louw, 2013).

The results of the third revision classwork proved that the concepts were difficult for the experimental group to understand. Many learners in this group could not identify which compounds had hydrogen bonding and which had London forces, ultimately not knowing which compounds had a higher boiling point and which ones had lower boiling point. Many learners could not distinguish between a polar and a non-polar substance. Since they did not understand polarity, learners failed to identify which substance could dissolve in water (polar) and which could dissolve in carbon tetrachloride (non-polar). Polarity had to be revised in addition to the content of Grade 11. Corrections were done, concepts reinforced and explained again before the introduction of intermolecular forces in Organic chemistry. 55% of the class scored between 0-40%, 40% scored between 40-60% while 5% scored between 60-100%. The average percentage of the third revision classwork obtained by the experimental group was 35%.

5.3.6 Classwork Exercise 3 (See table 4.3.8 and 4.3.9)

Graph 5.3.3 Pass percentage of the Organic Chemistry class-work exercise 3 from the two groups from 40 and 50 per cent and above



In class-work number 3, the boiling points of different homologous groups were compared and explained in terms of their structures. It also contained questions on the vapour pressure of organic compounds of different homologous groups. The experimental group showed better understanding of why some compounds have higher boiling points than others. The experimental group explained correctly why alcohols have higher boiling points than aldehydes and alkanes. The main conceptual difference between the experimental group and the control group was that the experimental group understood concepts at a microscopic level and could reason better than the control group. The control group did mention hydrogen bonding as the reason for higher boiling points which was correct, but the experimental group was able to explain that even though the alcohol and aldehyde are both polar, it takes more energy to break the bond within the hydroxyl group i.e., between the hydrogen and oxygen than within the carbonyl group i.e., between the carbon and oxygen. The experimental group answered high order questions better than the control group.

Graph 5.3.3 shows that at pass percentage from 40 and above was 80% for the experimental group as compared to the 23.8% of the control group. Pass percentage of 50 and above for the experimental group was 70 and for the control group was 14.3. 20% of the experimental group scored between 0-40%, 30% scored between 40-60% and 50% scored between 60-100%. In the control group about 77% scored between 0-40%, 10% scored between 40-60% and 13% scored between 60-100%. The average percentage obtained by the experimental group on the third classwork was 59%, while the average mark obtained by the control group was 29%.

5.4 Reaction rate

There were two revision classwork exercises in the chapter involving Reaction rate. The Reaction Rate chapter in Grade 12 required learners to understand first the factors that affect the rate of a reaction i.e., temperature, concentration, surface area, pressure, catalysts and nature of reactants. These factors were revised from Grade 10 and 11, especially the role of temperature (using the Kinetic Molecular Theory in Grade 10), concentration, pressure and usage of the catalyst (from Potential Energy Diagrams in Grade 11). The other important aspect of revision done was the mechanism of reaction and the role of the catalyst. The experimental group was reminded that the catalyst lowers the activation energy needed to start a reaction; they were also reminded of the concept of enthalpy of reaction and; the difference between exothermic and endothermic reactions and their graphs.

5.4.1 Revision Classwork Exercise 1 (See table 4.4.1)

Emphasis was put on the role of the catalyst, activation energy and enthalpy of reaction. This was key because the Grade 12 learners were required to identify these quantities in exothermic and endothermic graphs. Revision emphasised how the value of the activation energy can change when a catalyst is used and the manner in which this value is calculated. The drawing of the potential energy graphs of exothermic and endothermic reactions were also revised from Grade 11 content so that learners could fully understand their definitions and processes.

The experimental group did well in the first revision class work, all the learners in the revision class work scored higher than 40% while 35% scored between 40-60% and 65% scored between 60-100%. The average percentage obtained by the experimental group was 65%.

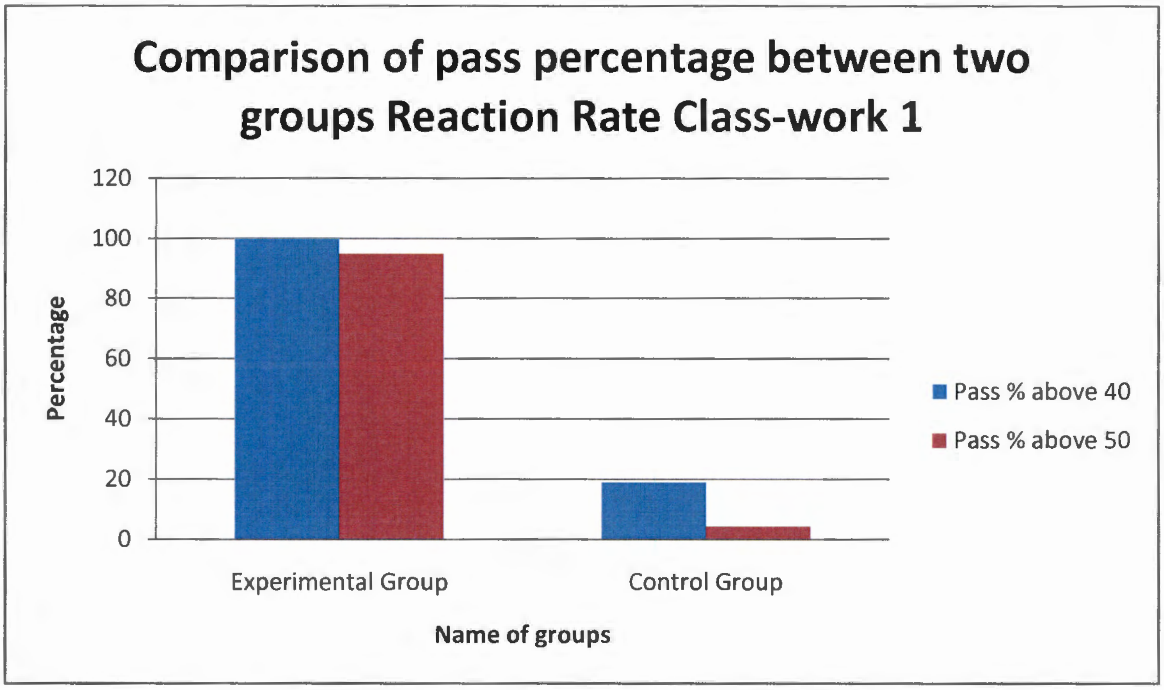
5.4.2 Revision Classwork Exercise 2 (See table 4.4.2)

The second revision class work required learners to sketch the potential energy diagrams for a given activation energy. This was important for clearly labelling aspects of potential energy diagrams such as enthalpy change (ΔH), reactants and products, activation complexes and calculating the value of the heat of reaction and activation energy.

The experimental group performed well and understood the concepts revised and were ready for the Grade 12 chapter. 5% scored between 0-40%, 5% scored between 40-60% and 90% scored between 60-100%. The average percentage obtained by the experimental group was 83%.

5.4.3 Classwork Exercise 1 (See table 4.431 and 4.4.4)

Graph 5.4.1 Pass percentage of Rate of reaction class-work exercise 1 from the two groups from 40 and 50 per cent above

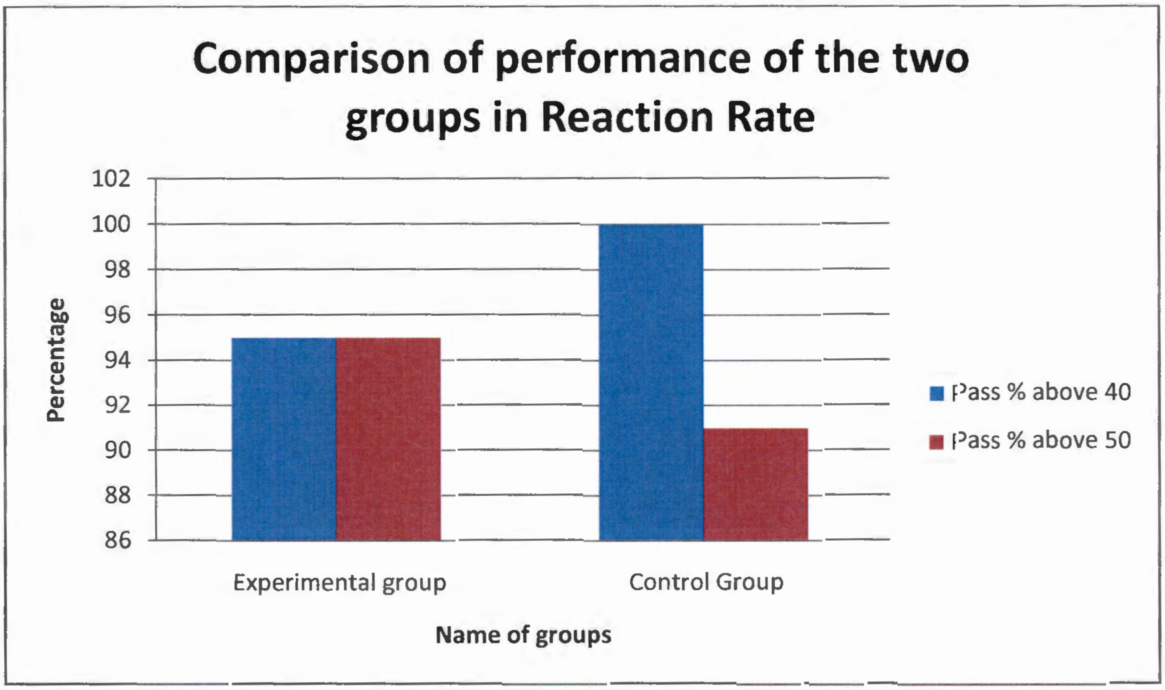


The experimental group performed very well in the classwork. The control group struggled to understand the difference between exothermic and endothermic reactions. Because of the prefix "exo" and the fact that exothermic reactions release energy, most learners in the control group concluded that the energy of the products would be higher than the energy of the reactants during an exothermic reaction. This was a clear indication that there was confusion in the understanding of the concepts in the control group. The majority of the experimental group understood this concept of exothermic reaction better, because of the revision done on potential energy diagrams of exothermic and endothermic reactions. Only three learners in the control group understood that the activation energy would be lowered if a catalyst was used, while the majority of the experimental group got this right.

Graph 5.4.1 shows that all learners in the experimental group scored above 40% in the first classwork of reaction rate while 19.1% of the control group scored at 40% and above. 95% of the learners in the experimental group scored from 50% and above as compared to the 14.3% of the control group. 25% of the experimental group scored between 40-60% and 75% scored between 60-100%. No one in the experimental group failed this class work with less than 40%. The control group had difficulties answering the questions, 81% of the class scored between 0-40%, 15% scored between 40-60% while 5% scored between 60-100%. The average percentage obtained by the experimental group was 68% while the average percentage obtained by the control group was 24%

5.4.4 Classwork Exercise 2 (See table 4.4.5 and 4.4.6)

Graph 5.4.2 Pass percentage of rate of reaction class-work exercise 2 from the two groups from 40 and 50 per cent above



Based on the revision done from Grade 10 and 11 (Chemical Reactions) during the introduction of Reaction Rate (Revision Class work 1 and 2), the learners were tested on their understanding of the factors affecting the rate of reactions. The questions were low order questions and no calculation or explanation was needed.

Both groups did well but the control group still failed to understand the role of the surface area in the rate of reaction. The control group could not understand the difference between pellet form and crushed form, and magnesium powder and ribbon.

Graph 5.4.2 shows that the control group scored better than the experimental group with 100% pass rate at 40% and above compared to the 95% of the experimental group. At 50% pass rate and above, the experimental group scored better with a pass rate of 95% compared to the 90.48% of the control group. Only 5% of the experimental group scored between 0-40%, no learner scored between 40-60% while 95% scored between 60-100%. In the control group, all the learners scored higher than 40%, 24% scored between 40-60% while 76% scored between 60-100%. The average percentage obtained by the experimental group was 86% while the average percentage obtained by the control group was 71%

5.5 Electrochemical cells

Revision from Grade 10 and 11 involving redox reactions was done. The content from Grade 10 which was revised was electrolysis, electrodes and electrolytes, and the definition of oxidation and reduction. The Grade 11 content concerned was the identification of the reducing agent and oxidizing agent; oxidation and reduction half-reaction, electron transfer, oxidation numbers and electronegativity. In addition, balancing redox half reactions was revised. This gave the learners a simple way of calculating the emf in the questions asked in Grade 12 content.

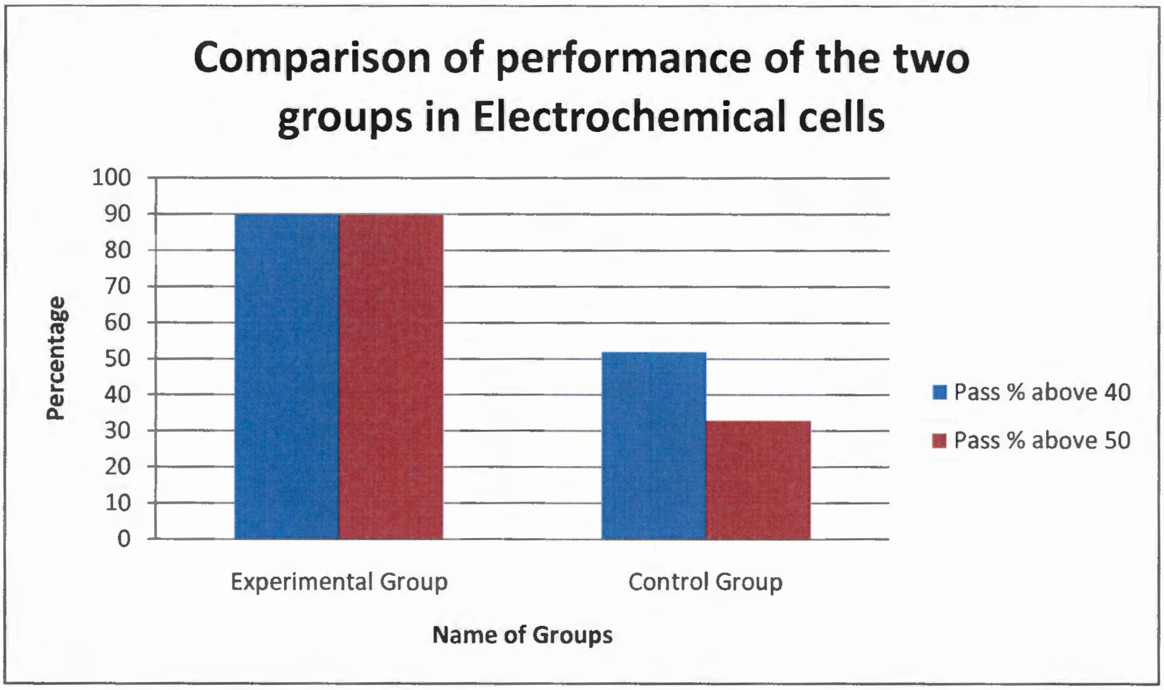
5.5.1 Revision Classwork Exercise 1 (See table 4.5.1)

The revision classwork done by the experimental group showed that some learners in this group struggled to identify reducing and oxidizing agent. This was further reinforced by the revision of increase and decrease of oxidation numbers i.e., if the oxidation number increased that results in oxidation and the compound undergoing oxidation is a reducing agent and that decreasing oxidation number results in reduction i.e., the compound undergoing reduction is an oxidizing agent" (Louw, 2013, p.122).

The balancing of half reactions was difficult to some learners in the experimental group as they struggled to differentiate between balancing half reactions in acidic and basic solutions. 20% of the experimental group scored between 0-40%, 60% scored 40-60% while 20% scored between 60-100%. The average percentage obtained by the experimental group was 52%. Concepts which gave learners difficulties on this topic were further revisited and corrections were done.

5.5.2 Classwork Exercise 1 (See table 4.5.2 and 4.5.3)

Graph 5.5.1 Pass percentage of Electrochemical cells classwork exercise 1 from the two groups from 40 and 50 per cent above



The first classwork exercise was based on the concept of galvanic cells. This content from Grade 12 relied heavily on the Grade 11 content on redox reactions and Grade 10 content on electrolysis. The content of the structure of galvanic cells in Grade 12 required learners to understand how redox reactions can be applied in practice to real life situations. The concepts included electrodes, the use of electrolytes and understanding which electrode was the anode and which one was the cathode.

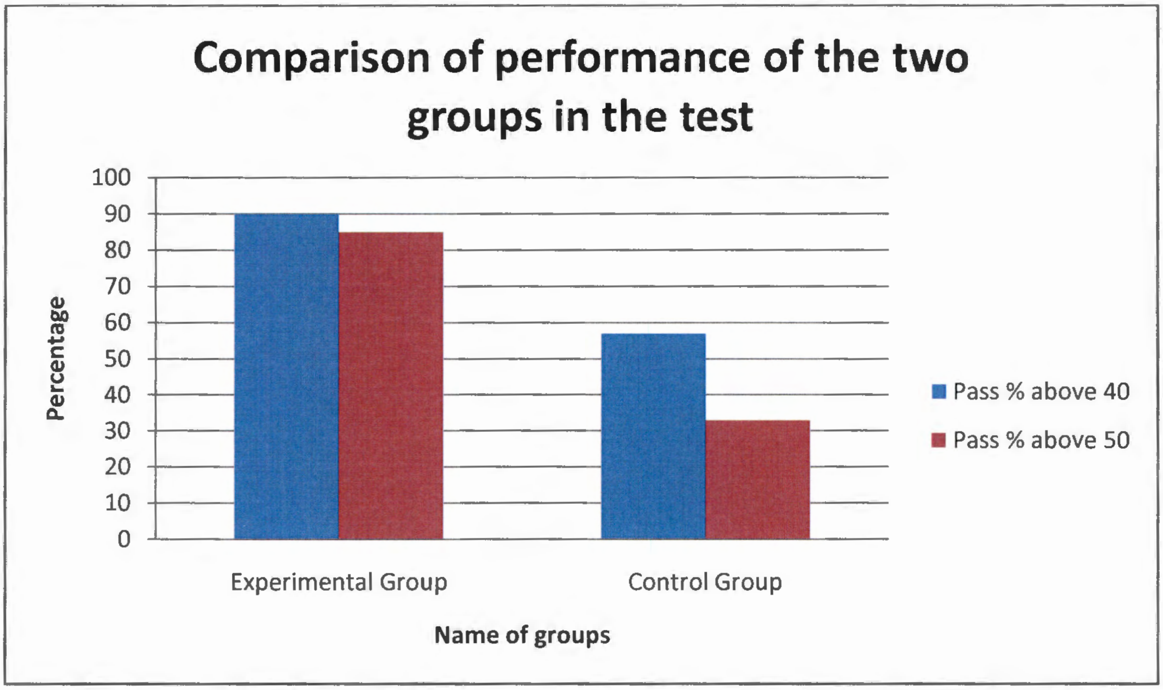
In order to understand the half reactions in galvanic cells, learners are required to have mastered the balancing of half-reactions in Grade 11. Learners were also expected to use the definitions of oxidation and reduction, as the loss of electrons and gain of electrons respectively, which they had revised. This was key because it clarified that since oxidation occurs at the anode, the electrons will move from the anode to the cathode. The calculation of emf was also required in Grade 12, and this was expected to be linked with the correct balancing of oxidation and reduction half reactions revised from Grade 11.

The experimental group performed better than the control group. The control group could not calculate the emf correctly because they confused the anode and the cathode. They also struggled with balancing half-reactions and identifying the direction of the flow of electrons in the cell.

Graph 5.5.1 shows that at 90% of the experimental group passed at 40% and above as compared to the 52.4% of the control group. 90% of the experimental group had passed at 50% and above, compared to the 33.3% of the control group. 10% of the experimental group scored between 0-40%, 15% scored between 40-60% and 85% scored between 60-100%. In the control group, 48% of the class scored between 0-40%, 38% scored between 40-60% and 15% scored between 60-100%. The average mark obtained by the experimental group was 77% while the average mark obtained by the control group was 41%.

5.6 Test (See table 4.5.4 and 4.5.5)

Graph 5.6.1 Pass percentage of the Test from the two groups from 40 and 50 per cent above



The test was a final instrument used to determine the level of achievement of the learners, and whether or not revision of Grade 10 and 11 content was helpful in the understanding of Grade 12 content. It was given as a post-test, after revision of Grade 11 and 10, as well as teaching of Grade 12 content for the experimental group and the teaching of Grade 12 content only with no revision from Grade 10 and 11 for the control group.

The test included the three Chemistry chapters which gave Matric learners problems in previous examinations (DoE, Diagnostic Report, 2013). The experimental group performed far better than the control group.

According to graph 5.6.1, 90% of the experimental group performed at pass rate of 40% and above compared to the 57.14 of the control group. 85% of the experimental group passed at 50% and above compared to the 33.3% of the control group. 10% of the experimental group scored between 0-40%, 15% scored between 40-60% and 85% scored between 60-100%. In the control group, 43% of the class scored between 0-40%, 48% scored between 40-60% and 10% scored between 60-100%. The average percentage obtained by the experimental group was 65.1% while the average percentage obtained by the control group was 40.1%.

Both groups where able to name the IUPAC names of compounds and write down their structural formulas, although some learners struggled with the structural formulas of some compounds. It is interesting to note that the main difference between the two groups was their answering of high order questions. For example, in question 2.3, both groups could explain that it was hydrogen bonding that caused the high boiling points of pentanol and butanoic acid, but the experimental group, explained it better, stating that the boiling point of the alcohol was due to the fact that more energy was needed to overcome the intermolecular forces in the carboxylic acid than in the alcohol since the carboxylic acid had two sites for hydrogen bonding.

The control group had difficulties answering questions 3.2 and 3.4. In question 3.2, they struggled to give a reason for the differences in reaction rate between two experiments with the same reactants in different states (granules and powder). However, the experimental group did not struggle with this question, and they were able to explain that the different surface area was the reason. In question 3.4, almost the whole of the control group failed to explain what caused the difference in the reaction rate between two experiments, with the same concentration, same state of division and same temperature. The majority of the experimental group answered correctly because they linked this question from the Grade 11 content of exothermic reactions where a catalyst is used to speed up the reaction. The experimental group also linked question 3.4 with the revised Kinetic Molecular Theory from Grade 10 to explain how particles collide and how their activation energy will be lowered if a catalyst is used.

The control group struggled with question 4 (Electrochemical cells) as they had difficulties understanding the balancing of half-cell reactions and ultimately did not calculate the value of the emf correctly.

Overall, the performance of the experimental group was more statistically significantly better than that of the control group. Learners in the experimental group where better at answering high order questions and showed better understanding of concepts of Chemistry at a microscopic level.

5.7 T-test analysis of IQ test and test written by both groups at the end of the study

Table 5.7.1 Marks of the IQ test recorded in percentages

Experimental Group	Control Group
20	20
20	20
20	30
30	30
30	30
30	30
40	40
40	40
40	40
50	40
50	50
50	60
50	60
60	60
60	60
60	60
70	70
70	70
80	70
80	80
	80

$$T = \frac{\overline{x1} - \overline{x2}}{\sqrt{\frac{S1^2}{N1} + \frac{S2^2}{N2}}}$$

$$T = \frac{49.5 - 47.5}{\sqrt{\frac{364.8}{21} + \frac{367.1}{20}}}$$

T = 0.334

df = 20+21-2=39

20% means 80% confidence. Critical value of t = 0.8509. My value of t is lower than the critical value, 0.334<0.8509, hence this shows that learners in the control and experimental groups were selected randomly before revision of Grade 10 and 11 topics was done with the experimental group.

Table 5.7.2 Marks of the test recorded percentages

Experimental Group	Control Group
27	21
33	21
47	27
57	30
57	33
60	33
63	33
63	37
67	37
67	40
70	40
70	43
73	47
73	47
77	50
77	50
77	50
80	53
80	53
83	63
	70

$$T = \frac{\overline{x1} - \overline{x2}}{\sqrt{\frac{S1^2}{N1} + \frac{S2^2}{N2}}}$$

$$T = \frac{65.1 - 40.1}{\sqrt{\frac{217.25}{20} + \frac{158.22}{21}}}$$

T = 5.83

df = 20+21-2=39

0.05 means 95% confidence. Critical value of t = 3.5581. My value of t is higher than the critical value. 5.83>3.5581, hence this shows that revision of Grade 10 and 11 chemistry topics in Grade 12 as an intervention method of improving performance of learners was significant.

CHAPTER 6
CONCLUSION

6.1 Summary of the Research

6.1.1 Aims and Objectives

Aim

It was hypothesised that one of the reasons that learners perform poorly in matric is that they do not sufficiently master the content of Grade 10 and 11, and hence do not have an adequate knowledge and skills base to cope with Grade 12. The main aim of this study was to determine whether Grade 12 Chemistry would be improved if certain topics from the contents of Grade 10 and 11 which are particularly challenging to learners in Matric were revised at the start of Grade 12.

Objectives

The objectives of the study were to:

- Check the gradual increase of knowledge of Chemistry content as the learners progress to different grades;
- Check if the learners in the FET phase have the mathematical and scientific skills to learn Physical Sciences;
- Revise the topics from Grade 10 and 11 which correlate with difficult ones in Grade 12 in order to improve their skills of Chemistry in Matric; and
- Investigate whether revision lead to better performance in Matric.

Research questions

The study is thus intended to answer the following questions:

- Does the knowledge of Chemistry content increase as learners progress to different grades?
- Do learners in the FET phase have the mathematical and scientific skills to learn Physical Science?
- Will revision of topics from Grade 10 and 11 which correlate with difficult ones in Grade 12 improve their skills of Chemistry in Matric?
- Does revision leads to better performance in Matric?

6.1.2 Methodology

It must be noted strongly that this research project was aimed at demonstrating the usefulness of revision of previous concepts from different grades in Grade 12. Revision of certain topics does not mean repeating the entire Grade 10 or 11 syllabuses, but only the selected chapters which continues directly with the Grade 12 chapters.

6.1.3 Main conclusion

From the results of the two groups randomly selected, it was concluded that revision of Grade 10 and 11 concepts in Grade 12 assisted the experimental group to perform better than the control group. The revision helped the experimental group to improve greatly in their explanation of higher order questions, their reasoning and drawing of chemical structures. The revision also assisted a lot in the understanding of electrochemical reactions, which causes a lot of difficulties to learners (National Diagnostic Report, 2013 and 2014). The experimental group showed microscopic understanding of complex chemical concepts, such as intermolecular forces in Organic Chemistry, factors affecting rate of reaction and how galvanic cells convert chemical energy into electrical energy. The control group experienced the same challenges that were stipulated in the National Diagnostic Reports (Department of Basic Education, 2013 & 2014). They could not explain concepts correctly, for example intermolecular forces, boiling and melting points etc., they confused some concepts with others, for example reduction and oxidation, reduction and oxidation half-reactions, and they struggled with the drawing of structures of compounds in organic chemistry.

A Grade 10 Physical Sciences teacher for example, should revise Grade 9 Chemistry i.e. periodic table, names of elements and compounds, balancing equations and chemical properties of metals; non-metals and semi-metals etc., before starting to teach Kinetic Molecular Theory (KMT) and Structure of an atom i.e. electrons; neutrons and protons, and electric configuration. If this revision is done properly i.e. revision classes are conducted together with revision classwork exercises, learners might not be confused and might link the concepts together, making it possible for clearer understanding of complex Chemistry topics in Grade 10. The revision pattern should follow in Grade 11 with the revision of Grade 10 and 9 topics and at Grade 12 with the revision of Grade 10 and 11 topics. This will improve the performance of learners in the Chemistry examinations, not only in Grade 12 but in lower grades as well. Learners will able to answer higher order questions correctly, with better reasoning skills and understanding. According to the t-test analysis, revision of previous topics had a 95% significant impact on the improvement of understanding Chemistry better.

6.2 Implication of the research for Chemistry teaching in South Africa

The IQ test and Chemistry common test revealed that learners across all Grades in the FET phase are having difficulties with basic mathematics and scientific skills needed to pass Physical Science, therefore if revision of Grade 9 concepts is done in Grade 10, revision of Grade 10 concepts is done in Grade 11 and revision of Grade 10 and 11 concepts are revised in Grade 12 then learners have a better chance of understanding the concepts they found confusing and too complex in previous grades.

The policy of progression of learners in the FET phase requires learners to pass four subjects at 40% and three subjects at 30%. This causes many learners in the FET phase to progress to different grades knowing only a small amount of important concepts of Chemistry (Department of Education, 2008). Thus it is a problem for a teacher to continue with Grade 12 content where the Grade 11 content left of, for example a teacher will continue with Reaction Rate in Grade 12 assuming that all the learners understood exothermic and endothermic reactions in Grade 11, which is not always the case. Therefore the revision of Grade 10 and 11 content which continues and links with the Grade 12 content will assist the learners understand the Grade 12 concepts better.

The Department of Education's (2008) clause in its progression policy states that learners are not supposed to stay more than four years in the Intermediate Phase (Grade 4-6), Senior Phase (Grade 7-9) and FET phase (Grade 10-11) respectively. This is a disadvantage to both the learners and teachers in the FET phase. Such progressed learners have learning barriers which should be identified early at Primary School and they should be referred to special schools before they reach the Senior Phase (DoE, White Paper 6, 2001). Many of these learners get progressed until they reach the FET phase and some choose to study Mathematics and Physical Science. The Physical Science teachers have problems delivering the content such as Chemistry to these learners because Chemistry is "abstract and complex" (Gabel, 1999). These progressed learners will benefit from revision of complex chemistry content which they did not understand in previous grades in order to cope with Grade 12 content.

6.3 Limitation of the research

According to the CAPS policy, the Chemistry chapters taught in Grade 12 are Organic Chemistry, Rate of reactions, Chemical equilibrium, Acids and bases, Electrochemical cells and Chemical systems. Only three out of six Chemistry chapters were part of this research because they were reported on 2014 NDR as the most challenging of all Paper 2 chapters.

Due to time constrains and administrative issues of the different schools it was difficult to include all the schools in the research. Physical Science learners of the four schools wrote the IQ and Chemistry common tests but only one school (Bodibe) was chosen for the actual research. The Grade 12 learners at Bodibe were divided randomly into two groups i.e. the experimental and control group.

6.4 Suggestion for further research

Further research should be extended to the other three Chemistry chapters in Grade 12 Paper 2. Since this research was based on Chemistry alone, more research should be done on the Physics part of Physical Science (Paper 1) in all the grades of the FET phase.

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APPENDIX A

Consent Letter

I invite you to participate in a research study I am conducting. I am currently enrolled as a MSc student with the North West University (Mafikeng Campus). You are being asked to participate in this research study as a learner of Physical Sciences in Grade 10, 11 or 12. If you agree to be in this study, you will be required to participate in answering some extra chemistry questions. The only personal information you will be asked to provide is your school and grade, and your response will remain confidential. Data from this research will not be disclosed to anyone, other than the researcher and his supervisor.

PARTICIPATION IN RESEARCH IS VOLUNTARY.

You are free to decline to be in this study, or to withdraw from it at any point. The school principal is aware of this study but does not require that you participate in this research and your decision as to whether or not to participate will have no influence on the rest of your studies.

If you have any questions about this project, feel free to contact Prof H. Drummond on 018 3892317/ 2130 between (8:00 am-16:30 pm).

Agreement:

I took part voluntarily in the research, and I confirm that I am above 18 years_______ (Signature).

I give permission for my child who is under 18 to take part in this research ____________ (Signature)

Thank you for your attention.

Yours truly,

Mr I.J Molaakgosi

MSc-Candidate-Chemistry Department

North West University (Mafikeng Campus)