THE EFFECT OF GUIDED-DISCOVERY INSTRUCTIONAL STRATEGY ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT

By

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Dedication

This study is dedicated to my family.

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- Finally, I want to thank the Almighty God for giving me the strength, wisdom and courage to persevere in the completion of this study. May the glory and honour be unto God.

Declaration

I declare that THE EFFECT OF GUIDED-DISCOVERY ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

Maake Mampageti Rebecca

Full names

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Signature **Date**

Abstract

The purpose of this study was to investigate the effect of guided discovery instructional strategy on the grade 9 learners' performance in chemical reactions. Secondly, to determine the effect of guided discovery instructional strategy on gender (boy and girl). The quantitative, descriptive and inferential research was conducted to determine if there were any differences between the performance of learners taught using Guided discovery and learners taught using direct instruction. Data collection was done using pre-test and post-test. Two groups of learners participated in the study. The experimental group (n = 40) was taught through Guided discovery. The second was Control Group (n = 35) taught through direct instruction. The findings reveal that guided discovery instructional strategy resulted in better performance of learners in science than direct instruction. Learners expressed an increased interest, motivation and self-efficacy after being exposed to guided discovery. Therefore, the study recommends that teachers need to move learners from dependent direct instruction to more independent learning through guided instruction.

KEY TERMS

Guided discovery learning, performance, learner

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Chapter 1

1.1 Introduction

Poor performance in science is a national concern (Lumadi, 2014). Grade 12 learners are unable to perform at the level that may allow them entrance to university science degrees. Academics view science as a gateway to future professions in a variety of fields such as medicine, engineering and others. Diagnostic reports provided by the department of education to evaluate learners' performance in grade 12 Physical Sciences indicate that learners performed poorly in the rate of reactions with a mean score of 23.7%. The rate of the reaction was the most poorly answered question. Weaker candidates still experience problems answering high order, interpretive questions. Their explanations are poor and not detailed enough (Department of Basic Education: NSC Examinations diagnostic report, 2013). In my view, poor explanations are a result of poor understanding of concepts which are basically in grade nine content. Moreover, learners could not write down the name of CO_2 (g) or else they did not know that (g) means gas (Department of Basic Education: NSC Examinations diagnostic report, 2012). Therefore, Chemical reactions should be thoroughly addressed in Natural Sciences Grade 9 and again revised in Grade 12.

The chemical reaction is one of the difficult concepts taught in high school Natural Sciences (Ayyildiz & Tarhan, 2012). As a result, learners perform poorly on this topic. In South Africa, the concept of chemical reactions is first taught in Grade 9 as required by the Curriculum Assessment Policy Statements (CAPS). Learners start with the basics in the lower primary school and expand on it in the senior phase. It is a topic that forms the basis of the rate of reaction in Grade 12. The difficulty is compounded by lack of resources in some schools. This is true in schools where there is no laboratory equipment and also large classes pose challenges. In addition, there are conceptual challenges surrounding the understanding of chemical reactions (Marina, Vladimir & Bojan, 2012). These challenges may emanate from misconceptions associated with the breadth and complexity of the topic.

Prominent factors identified by several studies as contributing to persistent learners' underperformance in science include amongst others, large classes, lack of resources, lack of professionally qualified teachers, inadequate mastery of subject content by some teachers, teaching strategies, conceptual challenges (misconceptions), lack of motivation and interest, non-completion of the syllabus and lack of assessment (Mji & Makgato, 2006; Ajaja, 2009). Science is one of the gateway subjects to university science related courses. Therefore, learners should have a solid foundation in the subject. Studies indicate that learners who enter university with good symbols tend to do well as compared to those with weaker symbols. Weaker learners tend to drop out due to lack of foundation in the gateway subject (Lumadi, 2014). Hence, these factors should be taken into consideration.

It has been reported that a lack of resources has resulted in poor teaching standards (Mji & Makgato, 2006). This situation has resulted in the teaching of science, for example, remaining at the theoretical level without any experiments to enhance understanding and application of the knowledge (Mji & Makgato, 2006). Learners reported that it is abstract to learn about sulphuric acid, while they do not know what it looks like. When you mix this and that gives you that, you do not know what that is. This is abstract for both teachers and learners (Mji & Makgato, 2006).

Moreover, the difficulty lies in the abstract nature of chemical reactions (Fatokun, 2006). Different methods have been used in teaching chemistry over the years at the secondary school level but the effectiveness of any of these methods as measured by their performances of the learner involved has not been really encouraging (Burns, 1999). Furthermore, the difficulties may be attributed to the learners' learning styles as well as the teaching strategies of the teachers (Mji & Makgato, 2006; Hesse & Anderson, 1992). Thus, teachers need to have the knowledge of content as well as the strategy of presenting that content. The knowledge of content to be taught as well as the strategy of presenting the content is called the pedagogical content knowledge (PCK). Studies indicate that teachers today do not have problems of content to be taught but the strategy of presenting the content (Udo, 2010; Du Plessis, 2013).

Teachers use direct instruction to teach chemical reactions. Direct instruction is defined as providing information that fully explains the concepts and procedures that learners are required to learn (Clark, Kirschner, & Sweller, 2006). It is a teaching strategy in which the teacher presents well defined knowledge and skills and explicitly guides the learning process. Learners are required to memorise what the teacher says rather than allowed to discover ideas (Mayer, 2004). Yet, there is evidence from the literature that learners use their experiences to create the understanding that makes sense to them rather than delivering knowledge to them in already organised forms (Eggen & Kauchak, 2012, p. 124).

Moreover, studies indicated that traditional teaching strategies are less effective with learner performance (Udo & Udo, 2007). However, teachers are still showing confidence in this teaching strategy over guided discovery teaching strategy. Guided discovery is generally defined as instruction in which learners, rather than being presented with all essential information and asked to practice using it, must discover or construct some or all of the essential information for themselves (Clark, Kirschner, & Sweller, 2012). Teachers specify learning objectives, arrange information so that clearly defines the patterns can be found and guides learners to the objectives (Moreno, 2004).

Therefore, learners are guided to avoid misconceptions that cause poor performances in examinations. Misconceptions arise when learners are left to discover facts on their own and without help, learners often become lost and frustrated (Moreno, 2004). Throughout the literature, misconceptions have been documented and studies investigating misconceptions and difficulties in learning and understanding chemical concepts have been reported (Kariper, 2011; Taber, 2011; Wenning, 2008). Yet, teaching strategies to overcome such difficulties are less investigated. In this regard, the proposed study investigated the effect of guided discovery on learners' performance in chemical reactions.

1.2 Statement of the problem

The poor academic performance of science learners in the Limpopo Province has been a concern for quite some time (Lumadi, 2014). Two high schools, namely, School A and School B are Schools in the Mankweng Circuit that are performing poorly in science (Department of basic education, 2014). The problem is that most learners do not perform at a level that would allow them entry into university science degrees. The final results of Grade 12 learners at School A and School B high schools from 2011-2013 are reflected in Tables 1.1 below:

Table 1.1: Percentage passes in physical sciences in two schools in Mankweng Circuit from 2011-2013

Year	% pass for high school A	% pass for high school B
2011	45.9	33.2
2012	57.3	39.6
2013	32.1	40.4

The problem is reflected upon the methods of instruction (Mji & Makgato, 2006). Teachers prefer to use direct instructional teaching strategies (traditional methods) over constructivist teaching strategies (Mirasi, Osodo & Kibirige, 2013). When learners are taught through these strategies, they do not learn to understand the concepts. Instead, they memorise and later forget what they were taught (Mayer, 2004). Additionally, this method results in what is called the ‘drill and kill’ method (Eggen & Kauchak, 2012). Learners in Grade 12 do not understand why teachers talk about things done the previous year instead of teaching them now (Mji & Makgato, 2006). Consequently, learners perform poorly in both public and internal examinations (Udo, 2010). It is imperative to find teaching strategies that could improve learners’ understanding of science concepts.

1.3 Purpose of the study

The purpose of this study was to investigate the effect of guided discovery instructional strategy on the Grade 9 learners' performance in chemical reactions. Secondly, to determine the effect of guided discovery on gender (boy and girl).

1.4 Hypotheses

The following null hypotheses were formulated for testing:

- There is no significant difference in learners' performance in chemical reactions when taught with guided-discovery and direct instruction teaching methods.
- There is no significant difference between the performance of boy and girl learners in chemical reactions when taught using guided-discovery and direct instruction teaching methods.

1.5 Research questions

- What is the effect of guided discovery on learners' performances in chemical reactions?
- What is the effect of guided discovery on the performance of boys and girls in the Experimental Group?

1.6 Significance of the study

The proposed study might help the curriculum developers to identify teaching strategies that work best for South African science classrooms in chemical reactions. This study might also assist the teachers in school A and school B to improve their teaching of science from Grade 9. The findings of this study would help science teachers especially those who teach in Grade 9 to make informed decisions on appropriate and effective teaching strategies that can be used to improve the performance and motivation of learners.

1.7 Definition of terms

For the purpose of this study, the following terms have been defined:

Guided discovery instructional strategy

Guided discovery is an approach to instruction in which the teacher presents learners with examples of a specific topic and guides learners to an understanding of the topic (Eggen & Kauchak, 2012).

Performance

Performance refers to the learner's ability to demonstrate understanding and show that learning has taken place through an activity or task (Woolfolk, 2007).

Learner

Learner refers to persons studying in ordinary public schools (Mothata, 2000).

Misconceptions

Misconceptions refer to what learners themselves develop erroneously and different from scientifically accepted concepts (Kose, 2008).

Poor performance

Poor performance refers to learners obtaining marks below 30% in the National Senior Certificate Examination, and thereby failing the subject (Department of Education, 2003).

1.8 Organization of the study

Chapter 1: Outlines the introduction and rationale for the study, statement of the problem, hypotheses, research questions, purpose of the study, and significance of the study, definition of terms and chapters outline.

Chapter 2: Contains the review of relevant literature from books, journal articles, reports and internet searches on the topic of the study.

Chapter 3: Outlines the methodology and procedures used to collect data for the study. The study was designed as quasi-experimental pre-test post-test non-randomised group design (Cohen, Manion & Morrison, 2007). The teaching strategy is the independent variable and performance of learners in chemical reactions the dependent variable.

Chapter 4: Presents the results and analysis of the data obtained in the study. The data obtained are presented in the form of tables. Statistical methods were used to analyse the results.

Chapter 5: Contains the summary, implications and recommendations for future research. The findings of the research including limitations of the study are outlined in the chapter.

Chapter 2

Literature review

2.1 Introduction

Poor performance is a concern to the nation (Lumadi, 2014). Matric results for the last decade show that South African learners perform poorly in science subjects (Department of basic education, 2014). For that matter, teachers continuously search for new ways to help their learners learn. Science curricula are organised to foster continual learning. Learners learn the basics of chemical reactions in Grade 9. They are then required to utilize the knowledge acquired from Grade 9 chemical reactions in Grade 12 rates of reaction. Teachers use direct instruction to teach chemical reactions. This method fully explains the concepts and procedures that learners are required to learn (Clark, Kirschner & Sweller, 2006). Learners are required to memorise what the teacher says rather than allowed to discover ideas on their own (Mayer, 2004). Therefore, on questions that require thinking learners perform poorly.

2.2 Theoretical framework

This study is informed by the theoretical framework of constructivism. Science as a subject requires an active learning strategy instead of a passive learning. Active learning involves both students and teachers. Learning becomes a two-way process with both the teacher and the learner learning from each other. Outcomes Based Education (OBE) placed tremendous emphasis on making learning a two-way process. OBE is a learner–centred teaching method. Which shift the focus of activities on the educator to the learners. Learner centred approach is compatible with constructivist learning theory (Friesen, 2011).

The advantages of active learning are that a larger quantity of information is assimilated by learners at one time, interaction amongst learners is improved, learners' academic performance improves, it allows for stimulation of higher order thought as well as developing respect for the views and opinions of others. Active learning requires not only a hands-on approach but it also needs for learners to have an inquiring mind and engage in the process of inquiry learning (Woolfolk, 2007). One of the theories that had been neglected in the teaching of Science is constructivism. Constructivists believe that learners can construct knowledge on their own rather than knowledge transmitted to them by the educator. Constructivism recognises that learning is a cognitive process that involves the construction of ideas. Learners are meaning makers emphasis should be on designing activities which provide active knowledge, instead of traditional knowledge transmission. Constructivist theorists hold the view that teachers should deal not only with rather than passive recipients of factual knowledge (Coetzee & Imenda, 2012). The constructivist teaching requires learning where learners are actively involved in the learning process allowing them to build a better understanding.

2.2 Studies on the poor performance of learners in science

There is a considerable amount of literature on poor performance in science. TIMSS studies in 2015 were conducted to determine the level of Grade 9 learners performance in Natural Sciences showed that learners underperformed with a mean score of 32%. In 2003, 13% of science learners achieved a score of over 400. This percentage increased to 25.2% in 2011 and to 32% in 2015. Between 2003 and 2015 there was an increase of 19% points. The findings of the study also showed that the percentage of learners in Grade 9 attaining high levels (scoring over 550) in Sciences is 4.9%. Based on the consistently low scores of learners in these sciences assessment studies, recommendations are that achievement information is used to inform policy and practice issues in the education domain with a view to improving learners' performance in Science.

Mji and Makgato (2006), conducted a study that investigated factors associated with high school learners' poor performance. Amongst other factors, teaching strategies, content knowledge, motivation, laboratory use, and non-completion of the syllabus were found to be responsible for the poor results. Learners were taught to memorise and they did not understand what was taught. If learners are taught to memorise, they later forget what was taught. Lack of parental involvement and language usage were also implicated for the poor results. Many parents are illiterate and it is difficult for them to assist their children with homework. Some parents do not allocate time for homework for their children. Learners were taught in the language that was not their mother tongue. Learners found it difficult to understand some of the science concepts, as result learners develop alternate conceptions. Further research was recommended aimed at addressing the above-mentioned factors.

Amukowa and Karue (2013) in Embu District of Eastern Province, found that unfavourable home environments and family backgrounds were responsible for poor performance. The lack of reading materials, chores at home, poor lighting, bad company, lack of proper accommodation, chronic absenteeism emanating from lack of school fees, admission of weak students at form one entry, inadequate instructional materials and physical facilities were responsible for poor performance.

Dhurumraj (2013) studied the causes of poor learner performance in Physical Sciences in Grade 12 in the Further Education and Training (FET) phase in public schools in the Pinetown District, KwaZulu-Natal Two public schools in the Pinetown District participated in this study and the results were that schools that performed poorly lacked resources. The language of learning and teaching (LoLT) was not their mother tongue, learners doing Mathematical Literacy instead of Mathematics, socio-economic status of learners, parent involvement minimal, large classes, the low developmental level of learners, and the curriculum was not relevant to their immediate needs. No single factor, however, was accountable for poor performance in Physical Sciences. Recommendations for improvement in the areas identified were provided and topics for future research on the curriculum of Grade 8 and 9 Natural Science were suggested.

Lumadi (2014) did a project aimed at reversing the trend of dismal performance in disadvantaged schools Moreover, the teachers who were unable to produce satisfactory results for these subjects made themselves available for the interviews. Results indicated that lack of facilities, HIV/AIDS pandemic, under qualified teachers and lack of motivation from learners were found to be responsible for the dismal performance (Lumadi, 2014). Pedagogical content knowledge (PCK) plays an important role in the classroom today. Teachers need to have the knowledge of the content as well as the strategy of presenting that content. Studies indicate that teachers today do not have problems of content to be taught but the strategy of presenting the content (Udo, 2010; Duplessis, 2013). The new curriculum recommends that science teachers use constructivist teaching strategies in order to engage learners in problem-solving activities, independent learning, critical thinking and understanding, and creative learning, rather than rote learning and memorization.

However, teachers are still resistant to change. They still rely on the traditional way of presenting the science concepts. The lessons are teacher centred. The teacher pours information into empty vessels. Learners are required to memorise what the teacher says rather than be allowed to discover ideas on their own (Mayer, 2004). On the other hand, the learner-centred approach allows learners to construct knowledge. The role of the teacher is to facilitate learning. Learners are encouraged to be responsible, autonomous and construct their own understanding of scientific concepts.

2.3 Gender differences in science achievement

There are mixed results with regard to the gender gap in science achievement. In some studies, girls perform equal to their boy counterparts. However, some studies reveal that there is a difference in girl and boy science achievement. Musau, *et al*. (2013) did a study on the determinants of girls' performance in science, mathematics and technology subjects in public secondary schools in Kenya. There had been incessant low academic performance in Science, Mathematics and Technology (SMT) subjects especially among girls at Form Four level in Kitui Central District over the years. The findings from the study explained why form four girls in Kitui County were not doing well in SMT subjects. The outcome of the study is expected to influence policy and decision-making on girls' better performance in the subjects. Different approaches were recommended based on the findings to improve girls' performance in SMT subjects.

Sahranavard and Hassan (2013) compared science performance among boy and girl Iranian eighth-grade students. The main objective of the study was to explore the comparison of boy and girl science performance. The results showed that there is no significant difference between boy and girl students in science performance. This

study supports the new findings that girls perform better than boys in the science subject and has resulted in a larger mean score in girls in science
Performance rather than boys.

2.4 Findings that support guided discovery instructional strategy

There is a great deal of evidence that supports the effectiveness of Guided-discovery instructional strategy in promoting learner performance. In the study by Udo (2010), the effect of guided-discovery instructional strategy on science performance of SS2 chemistry students was investigated. The guided discovery was found to be the most effective teaching strategy followed by learner centred demonstrations. This study lends support to the claim that guided-discovery instructional strategy can promote learner performance. The research findings of Akinbobola and Afolabi (2010) support the effectiveness of guided-discovery as a teaching strategy. The researcher investigated the effects of guided-discovery learners' cognitive achievement. Studies were done in Nigerian senior secondary school physics. The results indicated that guided discovery was more effective than expository teaching approaches (Akinbobola & Afolabi, 2010).

In addition, the research by Olufunmilayo (2010) supported the relative effectiveness of guided discovery method as against the new teaching method of concept mapping. This study investigated the effect of guided discovery on school learners' performance in chemistry. He found that guided discovery and concept mapping strategies were equally powerful in terms of improving student performance in chemistry in schools. The effectiveness of guided discovery instructional strategy in improving performance is also supported by the research of Garuma and Tesfaye (2012). They investigated the relative effectiveness of guided discovery, demonstration and traditional lecture method of teaching on learners' achievement in rotational motion. They concluded that guided discovery is more effective in improving learners' achievement. They also found that there is no significant difference between boy and girl. The learners' achievement was found to be related to the background performance levels (high, medium, and low achievers) besides the effect of instructional method.

Another support for the effectiveness of guided discovery instructional strategy comes from the study of Mirasi *et al*. (2013). The researchers investigated and compared the effect of guided discovery and exposition- with-interaction on learners' achievement in secondary schools. Learners taught using guided discovery achieved higher than their counterparts. The guided discovery was recommended as a teaching strategy for biology over exposition-with-Interaction methods which results in rote learning and memorization. In guided discovery, learners get actively involved in a process of meaningful and knowledge construction rather than passively receiving information. In addition, Gholamian (2013) studied the influence of guided discovery learning as one of the active methods of teaching learners having creative thinking. The results showed that guided discovery learning is an efficient way of reinforcing the creative thinking of students.

Similar studies were done by Akanbi and Kolawole (2014). Akambi and Kolawole examined the effects of guided discovery and self-learning strategies on Senior Secondary school learners' achievement in biology. Student performance improved after the intervention. Self-learning and guided discovery strategies improved students' achievement in biology. It was, therefore, recommended that teachers, curriculum developers and textbook writers adopt the two strategies for the improvement of students' learning outcomes in biology. Further, affirming the effectiveness of guided discovery instructional strategy in improving academic performance is the study of Makoolati *et al* (2013). The researchers investigated the effectiveness of guided-discovery learning on the learning and satisfaction of nursing students. The study compared guided discovery learning and lecture method. Their results showed that learners in guided discovery group instruction performed better than learners taught using the traditional lecture method.

The findings of Akanmu *et al*. (2013) also support the effectiveness of guided discovery. They investigated the effect of guided-discovery learning strategy on student performance in mathematics alongside the influence of gender and scoring levels ability of the students. There was favour on those exposed to guided discovery as compared to those not taught through guided discovery. Both boys and girls performed equally well. The research findings of Fatokun and Eniayeju (2014) support the effectiveness of guided discovery learning as a teaching strategy. The researchers investigated the effect of concept mapping-guided discovery integrated teaching approach on the achievement and retention of chemistry students. The results indicated that learners exposed to concept mapping-guided discovery integrated teaching approach out-performed those taught using direct instruction significantly. Similarly, the result of the study of Yuliani and Saragih (2015) on the development of learning devices based on guided discovery model to improve understanding concept and critical thinking mathematical ability of students at Islamic Junior High School of Median. It was found that guided discovery instructional strategy can improve concept and critical thinking mathematical ability of students.

In addition, a study by Amor and Maaloul (2016) investigated the influence of guided discovery on student learning outcomes. Performance of learners was improved by guided discovery instructional strategy. However, there were shortcomings or difficulties in using the method. There are many reasons why guided discovery instruction has been effective. Its major strength is the ability to promote learners' motivation. Learners are motivated when faced with problems and questions that stimulate curiosity (Schunk *et al*., 2008). In addition, the active involvement of learners in guided discovery lessons increases learners' interest in the activity, contributing to motivation. Finally developing an understanding that is practical and makes sense increases students' sense of self-efficacy, their belief in their capability to accomplish tasks and understand the world curiosity (Schunk *et al*., 2008). This makes guided-discovery one of the most effective strategies for increasing learner motivation.

The benefits of using guided discovery include an intrinsic need to learn science. Learners are motivated to move beyond knowledge and comprehension and into application and analysis. In addition, guided discovery increases intellectual potency by enhancing the learner's ability to organize and classify information (Akimbobola & Afolabi, 2010; Mirasi, Osodo & Kibirige, 2013). Information becomes embedded in the cognitive structures of leaners. This information can be retrieved later on in the learner's memory. Amor and Maaloul (2016) indicated that learners taught through guided discovery develop confidence and construct their creativity skills, to familiarize themselves with the world. Creativity is encouraged when learners are actively involved. They also become responsible in self-learning and keep what they have learned (Gholamian, 2013).

In addition, guided discovery does not discriminate against gender or abilities (Akanmu & Fajemidagba, 2013; Akinbobola & Afolabi, 2010). Applying appropriate teaching can help both boy and girl learners learn and remember facts, apply skills comprehend concepts, analyse and synthesize principles. When learners are participating freely, they develop a deep understanding of the concepts. Guided discovery has worked well in other countries. The question remains that with regard to guided discovery will it work well in South African schools in Limpopo Mankweng. Therefore, the purpose of this study was to investigate the effect of guided discovery instruction on Grade 9 learners' performance in chemical reactions in Mankweng circuit.

2.5 concluding remarks

In this chapter, poor performance, gender differences and guided discovery instructional strategy were discussed. The findings from the literature recommend guided discovery as an instructional strategy that improves learner performances. Reviewed literature on performance revealed that grade 9 learners are underperforming in chemical reactions. This affects their performance in the rate of reaction grade 12. The researcher was then interested in using guided discovery in improving the understanding of chemical reactions.

Chapter 2

Research methodology

3.1 Introduction

This chapter discusses the research design, the instruments and the procedures used to collect and analyse the data. It also gives an overview of the instruments and procedures used to answer the research questions. Generally, there are two main approaches to educational research, qualitative and quantitative (McMillan & Schumacher, 2010). The mixed method approach is also used in educational research. Mixed method uses both qualitative and quantitative research approach. The instruments are the tools used to collect data. In science education, the instruments generally used to collect data are questionnaires, interviews, diagnostic tests and observation schedules. Procedures are methods used to collect data, organize and analyse the data collected. The design, instruments and procedure used to collect the data were chosen by looking at the nature of the research problem, the research questions and the purpose of the research. This study used the quantitative approach in order to answer the following questions: What is the effect of guided discovery on learners' performances in chemical reactions and what is the effect of guided discovery on gender?

3.2 Experimental research design

In experimental research, the researcher controls and manipulates the conditions which determine the events in which the researcher is interested in. He/she introduces an intervention and measures the difference that it makes. An experiment involves making a change in the value of one variable called the dependent variable and observing the effect of the change on another variable called the dependent variable. Experimental research seeks to support or not support a null hypothesis. An independent variable is the input variable, whereas the dependent variable is the outcome variable. In an experiment, the post-test measures the dependent variable and the independent variables are isolated and controlled carefully.

In the present study, the researcher adopted a quasi-experimental pre-test post-test non-randomised group design (Cohen, Manion & Morrison, 2007). There was no random selection and assignment of subjects. This design was found suitable as it allowed a comparison of the experimental and control groups. In addition, this design is often used in classroom experiments when experimental and control groups are in their natural classroom setting which cannot be disrupted for the research purpose. The researcher used the samples that are as alike as possible. Two groups of learners participated in this research project. The learners who received the guided discovery constituted the experimental group (EG), and the learners who received direct instruction method constituted the control group (CG).

The independent variable manipulated in this study was the teaching strategy which differed in the experimental and control group. The experimental group was taught using guided-discovery instructional strategy while the control group was taught using direct instructional teaching method. The dependent variable measured due to the different teaching strategies was the test scores of the groups in the post-test. The pre-test and post-test scores for the groups were then compared for any statistically significant difference by implementing the dependent samples t-test.

3.3 Threats to internal validity

The internal validity of a study according to McMillan and Schumacher (2010) refers to the judgment that is made concerning the confidence with which plausible rival hypotheses can be ruled out as explanations for the results. It illustrates the degree to which the independent variable influenced the experiment (Leedy, 2001). According to Merriam (2002), research findings are trustworthy to the extent that there has been some accounting for their validity and reliability, that is, the extent to which they can be replicated in another study. The quasi-experimental design provides reasonable control over threats to the internal validity of a study (McMillan & Schumacher, 2010). In this study, the threat of selection was controlled as the two selected secondary schools were randomly assigned to experimental and control group. In the same vein, the threat of maturation was controlled because the sample of the study consisted of Grade 9 learners of approximately the same age and similar academic backgrounds.

Both learners in the experimental and control group did not differ much in academic abilities.

The schools used in this study were far apart from each other as a result, conditions meant for one group were not transmitted to the other group. In this way, the threat of diffusion of treatment was controlled. The threat of history to internal validity was controlled to some extent in this study as there was no major school disruption or strike during the course of the study. However, there might be events or experiences unique to individual learners in the course of this study that may have influenced the results.

Instrumentation was not considered a threat to internal validity for this study because both the experimental and control group were administered with the same science test. The teacher who taught in this study was professionally trained and qualified and was currently teaching Grade 9 Natural Sciences. In this way, the threat of the experimenter effect to internal validity was controlled.

3.4 Research Sites

The study was conducted at school A and school B high schools. The schools are situated in the Eastern part of Polokwane City, to the left-hand side of the R71 road towards Tzaneen. School A is located in Mankweng Township, but also serves Makanye and Mentz villages. School B is also located in Mankweng Township and serves learners from Hlahlaganya and Matsea villages. This study investigated the effect of guided discovery on learners' performance in chemical reactions. Therefore, two public schools where teaching and learning of science take place were used. The two schools were selected based on the knowledge of the researcher about the schools in Mankweng circuit. The schools had the following in common: one class of grade 9, and multi-gender and serves learners from disadvantaged backgrounds.

3.5 Population and Sample

For the purpose of this study, two schools out of 12 government schools available in the Mankweng circuit were used. The two schools were selected purposively. The two schools were divided into experimental group and control group. In purposive sampling, the researcher selects particular elements from the population that will be representative or informative about the topic of interest (McMillan & Schumacher, 2010). Purposive sampling is appropriate where the researcher has previous knowledge of the population and has a specific purpose for the study and therefore relies on personal judgment to select a sample that includes subjects with needed characteristics (McMillan & Schumacher, 2010). For Emily and Roger (2010), purposive sampling is based entirely on the judgment of the researcher on the elements that will facilitate an investigation.

In this study, the researcher used purposive sampling to select two schools with comparable characteristics in terms of location, learners, teaching and learning facilities. Purposive sampling is based on what the researcher wishes to discover, understand, and gain insight and therefore must use a sample from which the most can be learnt (Merriam, 2002). For the purpose of the study, all grade 9 classes from each school were used. The classes were purposively selected, based on their poor performance. These classes were required to write a pre-test before the intervention. After one week of intervention learners from both the experimental and control groups were required to re-write the same test. The schools were randomly assigned to groups. School A was the EG (N=40) and school B was the CG (N=35). The same test was administered to the learners of both groups, before the intervention (pre-test), and after the intervention (post-test).

3.6 Data Collection

3.6.1 Instrument

Teacher designed test was used as pre- and post-tests for both EG and CG (see Appendix E). The test was designed by the researcher and moderated by science experts for its content validity. The test was based on the content to be taught during the study.

3.6.2 Content validity

The designed pre-test and post-tests were presented to the expert from the University for Content Validation. Also, the neighbouring high school science teachers were consulted to check the suitability of the tool. Experts and teachers mapped concepts and ideas related to the tests. Each one scored the pre- and post-test using a four Likert
scale (see Appendix F) to find consistency in the content.

The two groups were separated to avoid a threat to external validity. External validity is threatened when the two groups of learners attend the same school. It is reasonable to assume that learners mix outside of lessons and share ideas, thus potentially contaminating the results. In this study, different schools were used.

3.6.3 Reliability

Before administering the instrument to the selected sample, reliability was ensured. For reliability, a pilot study was conducted. In the pilot study ten Grade 9 learners were selected, from the two schools, but learners other than those involved in the main study (Best & Khan, 2006). The pilot group helped to establish the internal consistency and test-retest reliability of the guided-discovery evaluation tool. The Cronbach alpha was calculated to find the suitability of tools in the study. A reliability coefficient of greater than 0.7 suggested that the tool was suitable to be used (Muijs, 2011). The calculated Cronbach alpha was 0.960 suggesting that these tools were suitable to be used in the study.

3.7 Procedure

Data were collected over a one-week period, through a pre and post-test. Both the EG and CG were given a pre-test to determine levels of pre-conception. The experimental group was taught using guided-discovery method (see lesson plan, appendix F). The control group was taught using the direct instruction methods. The experimental and control groups were taught by the researcher. This means both the EG and CG were taught by the same teacher. A post-test similar to the pre-test was administered to both groups, to compare the marks for the two groups.

3.8 Data Analysis

Two types of statistical analysis were conducted with the data gathered from the test: The first were descriptive statistics, in which the final scores from the EG were compared to those of the CG. For that purpose, tables are used to illustrate the differences. The second was a statistical test called analysis of covariance (ANCOVA). This test was conducted to find out whether there was a significant difference, after one week of intervention, between the EG (learners taught through guided discovery) and CG (learners taught without intervention).

3.8.1 Descriptive statistics

Data were analysed statistically, using independent T-test. Pre- and post-test data were entered into the Statistical Package for Social Sciences (SPSS). A paired sample t-test analysis was conducted and tested at the 0.05 level to determine if there was any significant difference between scores from the pre-test and post-test. Pre-test and post-test scores were compared employing a pre-test-post-test non-equivalent-groups design (Morgan *et al*., 2006). Moreover, an independent-sample t-test was conducted to determine if there was any significant difference between boys and girls in the pre-test and post-test separately. Effect sizes (d) were calculated using Cohen's d (Cohen, Manion & Morrison, 2011). Effect size (d) measures the practical significance of a given result. It is a scale-free measure of the separation between two group means expressed in terms of their common standard deviation or that of the untreated population. Thus, a d of 0.25 indicates that one-quarter standard deviation separates the two means (Valentine & Cooper, 2003). Cohen, Manion & Morrison, 2011 labelled an effect size weak if $0.00 \leq d \leq 0.20$. They suggested modest magnitudes of effect $0.21 \leq d \leq 0.50$. Moderate sized effects were placed between these two extremes, that is, $0.51 \leq d \leq 1.00$ and strong effect for $d>1$ Alpha was set at $p < 0.05$ (Valentine & Cooper, 2003).

3.8.2 Analysis of covariance (ANCOVA)

ANCOVA is a parametric test used when the data is normally distributed. One of the advantages of using ANCOVA is that one increases the power of the statistical test by showing the differences between the groups under study. The analysis of the covariance (ANCOVA), using pre-test scores as covariate, was used to remove the effect of pre-test scores and fairly compare post-test scores between EG and CG (Fancher, 2013). The pre-test scores were used as the covariate to reduce the error variance and eliminate systemic bias (Dimitrov & Rumrill, 2003).

3.9 Ethical considerations

Ethics has to do with the application of moral principles to prevent harming or wronging others, to promote the good, to be respectful and to be fair (Opie *et al.*, 2004)

3.9.1 Informed consent

Before a person can participate in a research study, the researcher must give the prospective participant a description of all the features of the study that might reasonably influence his or her willingness to participate (Johnson & Christense, 2008). The principal should provide his/her consent before research could begin. The researcher scheduled an appointment with the principal to request permission to do the research. A detailed letter (see Appendix A) providing information about the research project was given to the principal. Then the researcher was able to discuss with principals as to whether the research could move forward and also the process for contacting learners and to find permission from their parents.

According to Section 71 of the South Africa Health Act, 2012 Minors are required, in principle, to be assisted by their parent/guardian in the informed consent process. A letter providing information was given to parents also, so as to provide consent for their children before the research could begin (see Appendix D). After data collection, extra lessons were organised for learners in the CG so that they were also taught using the guided-discovery method in order to advantage them as well.

3.9.2 Confidentiality

Education researchers ensure that confidential information provided by research participants, such as learner records, performance data, and personal information, whether verbal or written is protected (Jacobs & Walker, 2014). To ensure confidentiality, the participant's identity, although known to the researcher, was not revealed to anyone outside the research staff. Any information obtained remained private.

3.9.3 Respect

Respect means the researchers have a special obligation to protect the rights, welfare, and dignity of participants (Jacobs & Walker, 2014) The researcher was sensitive to cultural, individual, and role differences, and did not tolerate any form of bias or discrimination.

3.9.4 Anonymity

Anonymity means that the identity of the participants is not known to the researcher (Johnson & Christense, 2008). Pseudo names were used in this study to protect the identity of participants. Information that directly or indirectly identified the participants was not used in this study.

3.9.5 Ethical clearance

Clearance application forms were completed online. Clearance certificate from the Turfloop Research and Ethics Committee (TREC) was obtained before commencing with the study (see Appendix H).

3.10 Concluding remarks

In this chapter, the research design, population, sampling, data collection methods and threats to the internal validity of the study were discussed. Finally, methods of data analysis, interpretation and ethical consideration were discussed. Therefore, the next chapter will present the results and analysis of the data obtained from the study.

Chapter 4

Results

4.1 Introduction

The results of the Analysis of Covariance (ANCOVA) indicates a significant treatment effect, ($F = 361.488$, $p < 0.05$) in favour of the EG (Table 4.2). The experimental group and control group's pre-test scores were similar at the beginning before the study and there was no significant difference between them ($p < 0.05$). After teaching the two groups: the EG ($M = 22.250$, $SD = 6.159$) performed better than the CG ($M = 2.171$, $SD = 0.932$) (Table 4.3) and the gain was high Cohen d of 4.4 in EG compared to 0.2 in the CG (Table 4.3). Also, boys and girls in the EG performance did not differ after the intervention. After the intervention, the null hypothesis was not supported because there was a significant difference in learners' performance in chemical reactions when taught with guided-discovery and direct instruction teaching methods. Conversely, the null hypothesis was supported because there was no significant difference between boys' and girls' performance of chemical reactions when taught using guided-discovery and direct instruction teaching methods.

The results showed significant positive changes for the Experimental group and no significant changes for the control group. The mean scores confirm that learners using Guided discovery demonstrate significant gains in their ability to recall information taught (see Table 4.1). The pre and post-test were analysed using an independent t-test. The results revealed a statistically significant difference ($p > 0.00$) in the experimental (Guided discovery) group. A non-significant difference ($p > 0.00$) was found (see Table 4.5) in the control group using Direct Instructions.

The mean scores of the pre- and post-test revealed a significant gain in the experimental (Guided discovery) group (mean pre = 1.83, mean post = 22.28) and a non-significant difference in the control (direct instruction) group (mean pre=1.77, mean post = 2.17). The results revealed that the experimental group performed better than the control group.

The results of the pre-test post-test for both the experimental and control groups are shown as raw scores out of 33 in the table below.

Table 4.1: Pre-test post-test scores of both the control and experimental groups.

EXPERIMENTAL GROUP			**CONTROL GROUP**	
NO.	Pre-test scores	Post-test scores	Pre-test scores	Post-test scores
1	1	18	1	2
2	1	13	3	3
3	0	30	6	2
4	0	27	1	1
5	0	33	0	4
6	3	32	0	1
7	2	33	1	2
8	3	33	1	2
9	2	20	0	4
10	1	28	0	1
11	0	18	2	3
12	5	20	4	3
13	2	21	0	4
14	0	24	1	1
15	0	30	7	1
16	1	11	0	4
17	1	22	2	2
18	6	23	2	1
19	5	17	6	2
20	0	20	1	2
21	1	27	6	2
22	0	28	1	3
23	0	20	1	2
24	0	17	6	2
25	3	18	2	2
26	3	17	1	1
27	5	15	0	3
28	5	27	0	3
29	3	13	3	2
30	1	23	0	2
31	1	20	2	2
32	1	27	0	2
33	1	29	2	1
34	0	18	0	2
35	9	19	0	2
36	1	25		

37	2	28		
38	0	15		
39	3	19		
40	1	13		
TOTAL	73	189	62	76
MEAN	1.83	22.28	1.77	2.17

Effect of teaching methods on learners' performance

There is no significant mean difference on the performance of the learners after being taught with the different methods (i.e. guided-discovery and direct-instruction teaching method).

Table 4.2: ANCOVA summary of post-test: pre-test as the covariate.

source	**df**	**Mean square**	**F**	**p**
Pre-test	1	8.518	.409	.525
Post test	1	7530.767	361.488	.000
Error	72	20.833		

a. R Squared = .834 (Adjusted R Squared = .829)

Table 4.2 presents the summary effects of treatment on learners' performance in chemical reactions. ANCOVA shows significant F value for the teaching methods employed ($F = 361.488$, $p < 0.05$). The R squared value indicates that approximately 83% of the total variance in the performance in chemical reactions can be attributed to the specific teaching methods employed. The analysis indicates a significant treatment in favour of the EG. However, this result doesn't tell us which method of teaching is most significant.

Question 1: Do the learners in the experimental group differ significantly from those in the control group in regard to their average pre-test and post-test?

An independent sample t-test was conducted in order to test whether there is a significant difference between the groups. The values of the mean scores, standard deviation, t-values are presented in the table below (Table 4.3).

Table 4.3: T-test and mean scores of the pre-test post-test for control and experimental groups (significant at p < 0.05).

	n	M	SD	t	p	d
				0.111	0.912	0.0
Pre-test						
Experimental	40	1.8250	2.06			
control	35	1.7714	2.102			
Post- test				19.084	0.000	4.6
Experimental	40	22.250	6.159			
Control	35	2.1714	0.923			

Table 4.3 report outcomes of an independent samples *t*-test for the overall mean scores for the experimental and control groups. Table 4.3 shows that there was no significant mean difference of the pre-test of the experimental group (M=1.8250, SD=2.06) and control group (M = 1.7714, SD = 2.10162) with the effect size of (d=0.0). Here we can clearly see that there is no significant baseline difference, implying that the groups had similar characteristics and were therefore suitable for the study. The post-test result revealed a statistically significant difference between the experimental and control group. The significant differences observed in the post-test mean scores suggest that the experimental group (M = 22.250, SD = 6.159) performed better than the control group (M = 2.1714, SD = 0.923) with a strong effect size of (d = 4.6).

Question2: Are any significant differences between pre-test and post-test scores of the experimental as well as the control group? A t-test analysis was used to compare the results of the pre and post-test of the experimental, the results are compared in the table below (Table 4.4).

Table 4.4: T-test results of the pre and post-test in both the experimental and control group (significant at p < 0.05).

	n	M	SD	t	p	d
				-19.889	0.000	4.4
Experimental group						
Pre-test	40	1.825	2.062			
Post–test	40	22.250	6.159			
Control group				-1.031	0.306	0.2
Pre–test	35	1.771	2.102			
Post-test	35	2.171	0.923			

Table 4.4 reports outcomes of an independent samples *t*-test for the overall mean scores for the experimental group and the control group. Table 4.4 shows that the

overall mean differences revealed a statistically significant difference between the pre-test (M = 1.825, SD = 2.062) and post-test (M = 22.250, SD = 6.159) scores for the experimental group. Here we can clearly see that guided discovery had a strong effect on learner performance with a strong effect size of (d = 4.4). There was no significant difference between the pre-test (M = 1.771, SD = 2.102) and post-test (M = 2.171, SD = 0.923) mean score for the control group with a weak effect size of 0.2. According to these results, Experimental group resulted in better performance than the control group.

Question3: Is there any significant difference in the performance of boys and girls.
Table 4.5 compare performance of boys and girls.

Table 4.5: t-test comparison of pre-test and post-test mean scores boys and girls in the experimental group (significant at p<0.05)

	n	M	SD	t	p	d
				-0.979	0.343	0.6
Pre-test EG						
boys	18	1.5385	0.519			
girls	22	1.2500	0.500			
Post- test EG				1.833	0.075	0.6
boys	18	24.167	6.836			
girls	22	20.682	5.186			

Data in Table 4.5 report outcomes of an independent samples *t*-test for the overall mean scores of boys and girls for the experimental group. Table 4.5 shows that there is no significant difference between boys (M = 1.539, SD = 0.519) and girls (M = 1.250, SD = 0.50) with moderate effect size (d = 0.6), performance in the pre-test. Similarly, there was no significant difference in performance of boys and girls after being taught with guided discovery method in the post-test. That is, the performance of boy learners (M = 24.167, SD = 6.836) did not show any significant difference with that of girl learners' (M = 20.682, SD=5.186) with a moderate effect size of 0.6.

Question4: is there any statistically significant difference in performance of boys and girls with regard to their pre-test and post-test?
Table 4.6 The comparison of the mean score of the boys and girls.

Table 4.6: t-test comparison of pre-test and post-test overall mean scores of boys and girls in the control group (significant at p < 0.05).

	n	M	SD	t	p	d
				0.534	0.597	0.2

Pre-test CG						
Boys	19	1.947	2..248			
Girls	16	1.563	1.965			
Post- test CG				0.635	0.530	0.2
boys	19	2.263	1.147			
girls	16	2.063	0.574			

Table 4.6 reports outcomes of an independent samples *t*-test for the overall mean scores of boys and girls for the control group. Table 4.6 shows that there is no significant difference between boy learners (M = 1.947, SD = 2.248) and girl learners (M = 1.563, SD = 1.965) with weak effect size (d = 0.2), performance in the pre-test. Similarly, there was no significant difference on the performance of boys and girls after being taught with guided discovery method in the post-test. That is, the performance of boy learners (M = 2.263, SD = 1.147) did not show any significant difference with that of girl learners (M = 2.063, SD = 0.574) with a weak effect size of 0.2.

Question5: Do boys in the experimental group differ significantly from those in the control group in regard to their average pre-test and post-test scores.

Table 4.7: Mean scores of the pre-test and post-test and t-test of the boys in both the experimental and control groups (significant at p<0.05)

	n	**M**	**SD**	**t**	**p**	**d**
Experimental group				-13.674	0.000	4.9
Pre- test	18	1.444	1.723			
Post – test	18	24.167	6.836			
Control group				-0.545	0.589	0.2
Pre – test	19	1.947	2.248			
Post - test	19	2.263	1.147			

Data in Table 4.7 report outcomes of an independent samples *t*-test for the overall mean scores for the experimental group and the control group for boys. Table 4.7 shows the overall mean differences revealed a statistically significant difference between the pre-test (M = 1.444, SD = 1.723) and post-test scores (M = 24.167, SD=6.836) for the experimental, with strong Effect size of 4.9. However, the control group did not show any significant difference between the pre-test (M = 1.947, SD = 2.248) and post-test (M = 2.263, SD = 1.147) boys, with weak effect size of 0.2. Boys taught through guided discovery performed better than boys in direct instruction.

Question6: Do girls in the experimental group differ significantly to those in the control group in regard to their average pre-test and post test scores.

Table 4.8: mean scores of the pre-test and post-test and T test of girls in both the experimental and control groups girls (significant at p<0.05)

	n	M	SD	t	p	d
Experimental group				-15.410	0.000	4.6
Pre- test	22	2.046	2.299			
Post – test	22	20.682	5.186			
Control group				-0.977	0.336	0.1
Pre – test	16	1.563	1.965			
Post - test	16	2.063	0.574			

Data in Table 4.8 report outcomes of an independent samples *t*-test for the overall mean scores for the experimental group and the control group for girls. Table 4.8 shows the overall mean differences revealed a statistically significant difference between the pre-test (M = 2.046, SD = 2.299) and post-test (M = 20.682, SD=5.186) scores for the experimental group with the effect size of d=4.6. There was not a statistically significant difference between the pre-test (M = 1.563, SD =1.965) and post-test (M = 2.063, SD = 0.574) scores for the control group with effect size of d = 0.1. According to the results, the overall mean difference between the pre-test and the post-test for the experimental group girls revealed a strong effect size.

Table 4.9: Pre-test results for both experimental and control groups (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
Pre-test	1	Experimental	0.45	0.64	0.335	0.738	0.04
		Control	0.40	0.65			
	2	Experimental	0.20	0.52	0.550	0.584	0.07
		Control	0.14	0.36			
	3	Experimental	0.15	0.36	-0.796	0.429	0.09
		Control	0.23	0.49			
	4	Experimental	0.10	0.38	-0.174	0.862	0.01
		Control	0.11	0.32			
	5	Experimental	0.13	0.33	1.539	0.128	0.19
		Control	0.03	0.17			
	6	Experimental	0.13	0.33	-0.224	0.823	0.01
		Control	0.14	0.36			
	7	Experimental	0.15	0.36	-0.847	0.400	0.09
		Control	0.09	0.28			

	8	Experimental	0.58	1.78	0.933	0.354	0.11
		Control	0.29	0.46			
	9	Experimental	0.20	0.46	-0.510	0.611	0.06
		Control	0.26	0.51			
	10	Experimental	0.05	0.22	-0.583	0.562	0.08
		Control	0.09	0.28			

Table 4.9 shows mean scores (per item) for chemical reactions knowledge on the pre-test for the experimental group and the control group. Data in Table 4.9 report the outcome of an independent samples t-test. Table 1 shows there were no statistically significant differences between the experimental and control mean scores for learners in the pre-test. According to the results, the effect sizes of these mean differences between the experimental and control group for the pre-test revealed no effect for all the questions: 1, 2, 3,4,5,6,7,8,9 and 10 with effect sizes less than 0.2. Here we can clearly see that there is no significant baseline difference, implying that the groups had similar characteristics and were therefore suitable for the study.

Table 4.10: Post-test results for both experimental and control groups (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
Post-test	1	Experimental	2.33	1.10	4.582	0.000	0.47
		Control	1.31	0.76			
	2	Experimental	1.90	1.06	2.818	0.006	0.31
		Control	1.29	0.79			
	3	Experimental	1.90	0.96	2.860	0.006	0.32
		Control l	1.31	0.80			
	4	Experimental	1.63	1.21	2.665	0.009	0.30
		Control	0.94	0.97			
	5	Experimental	1.63	1.25	0.086	0.932	0.01
		Control	1.60	1.26			
	6	Experimental	1.83	1.22	3.168	0.002	0.34
		Control	0.94	1.19			
	7	Experimental	2.13	0.99	3.643	0.001	0.39
		Control	1.17	1.27			
	8	Experimental	2.58	1.08	6.927	0.000	0.63
		Control	0.94	0.94			
	9	Experimental	2.78	1.37	4.584	0.000	0.47
		Control	1.43	1.14			
	10	Experimental	3.58	0.96	7.849	0.000	0.67
		Control	1.77	1.03			

Table 4.10 shows mean scores (per item) for chemical reactions knowledge on the post-test for the experimental group and the control group. Data in table 1 report the

outcome of an independent samples t-test. Table 4.10 shows these mean differences revealed statistically significant differences between the experimental and control mean scores for learners in the post-test on the following questions: 1, 6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the experimental and the control for the post-test revealed moderate effect sizes for questions 8 (d = 0.63), 10 (d = 0.67), and modest effect sizes for questions 1 (d = 0.47), 2 (d = 0.31), 3(d = 0.32), 4 (d = 0.30), 6(d = 0.34), 7(d = 0.39), and 9 (d=0.47). Question 5 revealed no effect as it is less than 0.2.

Table 4.11: Experimental boys item analysis, pre-test vs. post-test (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
Experimental	1	Pre-test	0.36	0.59	-8.723	0.000	0.80
group		Post - test	2.45	0.97			
	2	Pre-test	0.32	0.65	-5.261	0.000	0.62
		Post - test	1.73	1.08			
	3	Pre-test	0.18	0.39	-6.009	0.000	0.67
		Post - test	1.45	0.91			
	4	Pre-test	0.14	0.47	-3.752	0.001	0.49
		Post - test	1.18	1.22			
	5	Pre-test	0.18	0.39	-3.904	0.000	0.05
		Post - test	0.14	0.35			
	6	Pre-test	1.68	1.29	-5.434	0.000	0.37
		Post - test	2.64	1.14			
	7	Pre-test	0.14	0.35	-7.818	0.000	0.76
		Post - test	2.05	1.09			
	8	Pre-test	0.91	2.33	-3.128	0.003	0.43
		Post - test	2.64	1.14			
	9	Pre-test	0.23	0.53	-7.436	0.000	0.74
		Post - test	2.73	1.49			
	10	Pre-test	0.10	0.30	- 16.499	0.000	0.93
		Post - test	3.55	0.91			

Table 4.11 shows mean scores (per question) for chemical reactions knowledge on the pre-test for the boys in the experimental group. Data in Table 4.11 report the outcome of an independent samples t-test. Table 4.11 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the experimental group on the following questions 1,2,3,4,5,6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the

pre-test and the post-test for the experimental group revealed moderate effect sizes for questions 1 (d = 0.80), 10 (0.93) moderate effect sizes for questions 2 (d = 0.62), 3(d = 0.67), 7(d = 0.76), 9(d = 0.74), and modest effect sizes for questions 6(d = 0.37) and 8(d = 0.43).

Table 4.12: pre- and post-test results for Experimental group (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
Experimental	1	Pre-test	0.45	0.64	-9.354	0.000	0.72
group		Post -test	2.33	1.10			
	2	Pre-test	0.20	0.52	-9.137	0.000	0.71
		Post -test	1.90	1.06			
	3	Pre-test	0.15	0.36	-10.834	0.000	0.77
		Post -test	1.90	0.96			
	4	Pre-test	0.10	0.38	-7.590	0.000	0.65
		Post -test	1.63	1.21			
	5	Pre-test	0.13	0.33	-7.306	0.000	0.63
		Post -test	1.63	1.25			
	6	Pre-test	0.13	0.33	-8.517	0.000	0.69
		Post -test	1.83	1.22			
	7	Pre-test	0.15	0.36	-11.831	0.000	0.00
		Post -test	2.13	0.99			
	8	Pre-test	0.58	1.78	-6.067	0.000	0.56
		Post -test	2.58	1.08			
	9	Pre-test	0.20	0.46	-11.274	0.000	0.78
		Post -test	2.78	1.37			
	10	Pre-test	0.05	0.22	-22.683	0.000	0.93
		Post -test	3.58	0.96			

Table 4.12 shows mean scores (per question) for chemical reactions knowledge on the pre- test for the experimental group. Data in Table 4.12 report the outcome of an independent samples t-test. Table 4.12 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the experimental group on the following questions: 1,2,3,4,5,6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the pre-test and the post-test for the experimental group revealed moderate effect sizes for question 9 (d=0.93), and moderate effect sizes for questions 1 (d = 0.72), 2 (d = 0.71), 3 (d = 0.77), 4 (d = 0.65), 5 (d = 0.63), 6 (d = 0.69), 8 (d = 0.56), and 9 (d=0.78).

Table 4.13: Experimental girls item analysis, pre-test vs. post-test (significant at $p<0.05$)

Treatment	Question	Type of test	M	SD	t	P	d
Experimental	1	Pre-test	0.50	0.70	-4.768	0.000	0.62
group		Post - test	2.17	1.25			
	2	Pre-test	0.06	0.24	-8.310	0.000	0.81
		Post - test	2.11	1.02			
	3	Pre-test	0.11	0.32	- 12.766	0.000	0.91
		Post - test	2.44	0.70			
	4	Pre-test	0.06	0.24	-8.842	0.000	0.83
		Post - test	2.17	0.99			
	5	Pre-test	0.06	0.24	-7.232	0.000	0.77
		Post - test	2.11	1.18			
	6	Pre-test	0.11	0.32	-6.776	0.000	0.75
		Post - test	2.00	1.14			
	7	Pre-test	0.17	0.38	-9.101	0.000	0.83
		Post - test	2.22	0.88			
	8	Pre-test	0.17	0.51	-8.511	0.000	0.82
		Post - test	2.50	1.04			
	9	Pre-test	0.17	0.38	-8.662	0.000	0.82
		Post - test	2.83	1.25			
	10	Pre-test	0.00	0.00	- 14.775	0.000	0.93
		Post - test	3.61	1.04			

Table 4.13 shows mean scores (per question) for chemical reactions knowledge on the pre- test for the girls in experimental group. Data in Table 4.13 report the outcome of an independent samples t-test. Table 4.13 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the experimental group on the following questions: 1,2,3,4,5,6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the pre-test and the post-test for the experimental group revealed moderate effect sizes for questions 2 (d = 0.81), 3 (d = 0.91), 4(d = 0.83), 7(d = 0.83), 8(d = 0.82), 10(d =

0.93), and moderate effect sizes for questions 1 (d = 0.62), 5(d = 0.77) and 6(d = 0.75).

Table 4.14: Control boys item analysis, pre-test vs. post-test (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
control	1	Pre-test	0.13	0.34	-4.869	0.000	0.65
group		Post -test	1.00	0.63			
	2	Pre-test	0.19	0.40	-6.429	0.000	0.75
		Post -test	1.38	0.62			
	3	Pre-test	0.25	0.58	-3.962	0.000	0.57
		Post -test	1.19	0.75			
	4	Pre-test	0.13	0.34	-2.366	0.025	0.39
		Post -test	0.75	1.00			
	5	Pre-test	0.00	0.00	-5.960	0.000	0.73
		Post -test	1.88	1.26			
	6	Pre-test	0.13	0.34	-1.832	0.077	0.32
		Post -test	0.56	0.89			
	7	Pre-test	0.06	0.25	-2.775	0.009	0.44
		Post -test	1.25	1.69			
	8	Pre-test	0.31	0.48	-1.333	0.193	0.23
		Post -test	0.63	0.81			
	9	Pre-test	0.25	0.45	-4.583	0.000	0.63
		Post -test	1.13	0.62			
	10	Pre-test	0.13	0.34	-10.510	0.000	0.88

Table 4.14 shows mean scores (per item) for chemical reactions knowledge on the pre- test for the boys in control group. Data in Table 4.14 report the outcome of an independent samples t-test. Table 4.14 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the control group on the following questions: 1,2,3,5,6,9 and 10. According to the results, the effect sizes of these mean differences between the pre-test and the post-test for the boys control group revealed moderate effect sizes for question 10 (d= 0.88), and moderate effect sizes for questions 1 (d = 0.65), 2 (d = 0. 75),3 (d = 0.57), 5(d = 0.73), 6(d = 0.32), 9(d = 0.63) and modest effect for questions: 4(d = 0.39) and 8(d = 0.32).

Table 4.15: Control girls item analysis, pre- test vs. post-test (significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
control	1	Pre-test	9.63	0.76	-3.818	0.001	0.53
group		Post -test	1.58	0.77			
	2	Pre-test	0.11	0.32	-4.965	0.000	0.63
		Post -test	1.21	0.92			
	3	Pre-test	0.21	0.42	-5.634	0.000	0.67
		Post -test	1.42	0.84			
	4	Pre-test	0.11	0.32	-4.411	0.000	0.58
		Post -test	1.11	0.94			
	5	Pre-test	0.05	0.23	-4.490	0.000	0.59
		Post -test	1.37	1.26			
	6	Pre-test	0.16	0.37	-3.495	0.001	0.49
		Post -test	1.26	1.33			
	7	Pre-test	0.11	0.32	-5.019	0.000	0.63
		Post -test	1.11	0.81			
	8	Pre-test	0.26	0.45	-3.838	0.000	0.53
		Post -test	1.21	0.98			
	9	Pre-test	0.26	0.56	-4.065	0.000	0.55
		Post -test	1.68	1.42			
	10	Pre-test	0.05	0.23	-5.452	0.000	0.54
		Post -test	1.74	1.33			

Table 4.15 shows mean scores (per item) for chemical reactions knowledge on the pre- test for the girls in control group. Data in Table 4.15 report the outcome of an independent samples t-test. Table 4.15 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the control group on the following questions: 1,2,3,4,5,6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the pre-test and the post-test for the girls control group revealed moderate effect sizes for questions 1(d = 0.53),2 (d = 0.63), 3 (d = 0.67), 4(d = 0.58), 7(d = 0.63), 8(d = 0.53), 9(d = 0.55) and 10(d = 0.93).

Table 4.16: Control item analysis, pre-test vs. post-test (*significant at p<0.05)

Treatment	Question	Type of test	M	SD	t	P	d
control	1	Pre-test	0.40	0.65	-5.414	0.000	0.54
group		Post -test	1.31	0.76			
	2	Pre-test	0.14	0.36	-7.818	0.000	0.68
		Post -test	1.29	0.79			
	3	Pre-test	0.23	0.49	-6.871	0.000	0.63
		Post -test	1.31	0.80			
	4	Pre-test	0.32	0.05	-4.802	0.000	0.94
		Post -test	0.97	0.16			
	5	Pre-test	0.03	0.17	-7.285	0.000	0.66
		Post -test	1.60	1.26			
	6	Pre-test	0.14	0.36	-3.821	0.000	0.41
		Post -test	0.94	1.19			
	7	Pre-test	0.09	0.28	-4.930	0.000	0.51
		Post -test	1.17	1.27			
	8	Pre-test	0.29	0.46	-3.725	0.000	0.40
		Post -test	0.94	0.94			
	9	Pre-test	0.26	0.51	-5.537	0.000	0.54
		Post -test	1.43	1.14			
	10	Pre-test	0.09	0.28	-9.322	0.000	0.74
		Post -test	1.78	1.03			

Table 4.16 shows mean scores (per item) for chemical reactions knowledge on the pre- test for the control group. Data in table 4.16 report the outcome of an independent samples t-test. Table 4.16 shows these mean differences revealed statistically significant differences between the pre-test and post-test scores for learners in the experimental group on the following questions: 1,2,3,4,5,6,7,8,9 and 10. According to the results, the effect sizes of these mean differences between the pre-test and the post-test for the experimental group revealed moderate effect sizes for question 4(d = 0.94), and moderate effect sizes for questions 1 (d = 0.54), 2 (d = 0.68), 3 (d = 0.63), 5 (d = 0.66), 6 (d = 0.41), 7(d = 0.51) 8 (d = 0.40), 9 (d = 0.54) and 10 (d = 0.74).

4.2 Summary

This chapter has presented the findings of the analysis of data obtained from the tests. These data were related to the learners understanding of the concept of chemical reactions before the intervention and after the intervention. The following is the summary of the findings: The results indicated that the level of understanding that grade 9 learners at the beginning of the intervention in both experimental and control were similar, in both groups. After the intervention the results suggest that the intervention used on experimental group considerably enhanced learners' performances. For gender, the results reveal no significant differences in the achievement of boys and girls, before the intervention and after the intervention. The results indicated that guided discovery instructional strategy resulted in better performance in chemical reactions than direct instruction. Direct instructional strategy showed a change in performances. However, the change was not significant. There was an equal performance regarding gender. Therefor It can be concluded that the guided-discovery method is not gender bias.

Chapter 5

5. Discussion

The purpose of this study was to investigate the effect of guided discovery instructional strategy on the Grade 9 learners' performance in chemical reactions. Secondly, to determine the effect of guided discovery on gender (boy and girl). The ANCOVA results show that the difference was indeed due to treatment and not by other variables. Also, the use of guided discovery was not gender-biased because the performance of boys and girls in the EG did not differ significantly. The results of this study showed that the experimental group and the control group's pre-test scores were similar and there was no significant difference between them ($p < 0.05$). This suggests that both EG and CG had similar knowledge on chemical reactions. However, when the scores of the post-test results for the EG and CG were analysed, it was found that there is a significant difference. The mean of post-test scores for the CG was ($M=2.171$, $SD=0.932$), while the mean for EG was ($M=22.250$, $SD=6.159$) (Table 4.3). The results of ANCOVA recorded in Table 4.2 showed that there was a statistically significant difference in performance between the experimental group and control group. The significant differences observed in the post-test mean scores suggest that EG performed better than the CG with a strong effect size of ($d=4.6$). This indicates that guided discovery improved learners' performance in teaching chemical reactions.

There was a statistical difference in learners' performance in chemical reactions when taught with guided-discovery and direct instruction teaching methods. In the study, both the EG and the CG showed an improvement in performance. There was a significant difference when comparing the pre-test and post-test of the EG. However, when comparing the pre-test and post-test of the CG the difference was not significant. The effect size also confirmed that the effect of direct instruction was weak as compared to the strong effect in the EG. This study thus did not find the statistical support for the null hypothesis that, there is no significant difference in learners' performance in chemical reactions when taught with guided-discovery and direct instruction teaching methods.

The mean of post-test scores for the CG was (M=2.171, SD=0.932), while the mean for EG was (M=22.250, SD=6.159) (Table 4.3). The EG got more marks than the CG. This confirms that if learners are taught through guided discovery, then they understand better than those taught through direct instruction method. Improvements were seen from both the EG and CG. The improvements seen from EG suggests that the learners in the EG may have been more active in the learning process than those in the CG and thus have contributed to their higher performance scores. The findings of this study agree with those of Udo (2010), Garuma &Tesfaye (2012) and Mirasi, Osodo & Kibirige (2013) where they found that guided discovery improved the performance of learners than other traditional instructional methods. This is because learners learn better by doing than being passive (Yuliana & Saragih, 2015). Learners taught with direct instruction performed low due to transmission of knowledge. Teachers pass their knowledge on learners as clean slates or empty vessels. The transmission view implies that teachers pass over their knowledge to their learners and learners' role in the learning is passive.

However, these results cannot be generalised due to the small sample size and the non-random selection and assignment of the participants of the study. Thus, when comparing the EG with the CG, although the results indicated the significant improvements in EG and non-significant improvements for the CG, effect size provided more support for the observed tendencies. Therefore, the following section discusses the effect size differences. Effect size is a standardised way in which to represent the magnitude of a difference or relationship. The effect size, power, significance level and sample size are interrelated, and given the differences that were found, it is possible to calculate the sample size that would have yielded even greater significant results.

The change score effect size was strong and indicated that there was a difference between the EG and CG on the post-test. The effect size for pre-test and post-test scores for the EG was strong and that of CG was weak, which means that a reasonable decline in scores took place in both groups. The change score was strong, implying some difference in improvement between the EG and CG. The improvement, as indicated by the effect size for the EG was large. The effect size improvement for the CG was weak, indicating that EG had greater gains than the CG. It does not seem as if other factors, such as history and maturation effects had an effect on the CG. Guided discovery influenced the scores of the EG. However, the small sample size and the non-random nature of the sample must be taken into consideration. A great threat to this study was the small sample size, the non-random selection and assignment of the participants. Although the intervention period was short, it would seem that it did result in some improvement in the EG.

The second major result was that there were no significant differences in the performance of boys (M=1.539, SD=0.519) and girls (M=1.250, SD=0.50) (Table 4.5). This suggests that boys and girls performed equally well when taught chemical reactions using guided discovery. This study corroborates the studies by Ariyibi (2004), Udo & Udo (2007) and Udo (2010). This may be so because any good teaching strategy is not gender-biased. All genders are given equal opportunities to learn science (Bussey & Bandura, 1999). Thus, gender has no effect on learner performance of chemical reactions. This, therefore, implies that the noticed significant differences in performance scores among learners taught with guided discovery may not be linked to gender but entirely to the method of instruction. This indicates the effectiveness of guided discovery as a method of instruction. The intention and recommendation of science education researchers are that whatever method employed for science teaching should allow all learners to learn equally irrespective of gender and learning ability. This is so to bridge the gap between boys and girls in science careers.

In general, both the experimental group and the control group had little knowledge of chemical reactions prior to the intervention. There was, however, room for improvement. Improvements were seen from the experimental group on all questions, and statistically significant improvements were seen on all questions. The learners in the experimental group improved significantly on all 10 questions. However, the effect sizes were different. The learners in the experimental group revealed large effect sizes for questions 3, 9 and 10. These were questions regarding coefficients of one in chemical equations. In actual fact these equations were balanced. However, learners in the control group did not make any large gain in these questions. This was an indication that learners taught through traditional method lacked understanding.

Instead, they memorise and later forget what was taught. Therefore, that guided discovery is a good teaching strategy for conceptual understanding.

5.1 Limitations of the study

The study had limitations. The research was conducted in one circuit of the province and the findings can thus not necessarily be generalizable to the entire province and to the entire country. Secondly, the study was applicable to Grade 9 Natural Sciences learners. Due to time constraints, only two schools participated in the study. The non-random selection and assignment of participants to the experimental group and control group was also a limitation to the study. The two groups were separated to avoid a threat to external validity. External validity is threatened when the two groups of learners attend the same school. It is reasonable to assume that learners mix outside of lessons and share ideas, thus potentially contaminating the results. In this study, different schools were used. After the sample was selected it was not possible to distribute the sample randomly between the experimental and control groups, because schools are natural setting that need not be disturbed. This led to an uneven distribution of boys and girls in the groups and an uneven number of learners in the two groups. The period of intervention was short because the researcher was allowed to use the time required by curriculum policy documents to teach chemical reactions. There could have been more benefits if the intervention was for a longer period.

5.2. Recommendations

Guided discovery instruction has a positive influence on student motivation, interest and learning. Based on the findings of this research, the following recommendations were made: Future studies should include large samples. Thus, studies should be conducted in different provinces in order to generalise the findings. Duration for the study needs to be extended for four years. Thus, to progress with learners from General Education and Training (GET) until they exit at Grade 12. This is to validate that learners perform poorly in Grade 12, due to lack of Grade 9 basics. A further qualitative element of research is needed to find out learners' and teachers' views on guided discovery. Duration intervention and post-testing need to be increased, to observe which group of learners will retain more knowledge for longer periods. Intervention needs to be made during normal school days and post-tested during normal examinations. Science teachers need to be trained on the different teaching strategies, in order to improve on the science performance. Teachers need to move learners from dependent direct instruction to more independent learning (guided-discovery). The Government should improve the infrastructure and equip laboratories. Further research should also include a qualitative component in the form of interviews or observations to triangulate quantitative and qualitative data.

5.3 Conclusion

This study investigated the effect of guided discovery instructional strategy on the Grade 9 learners' performance in chemical reactions. It was found that guided discovery method improves understanding of learners in chemical reactions. However, it should be noted that not only one method of teaching can improve performance to the maximum level. Teachers need to integrate different teaching strategies in order to accommodate learners with different learning abilities.

6. References

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Appendix A

Principal information letter (EG)

P.O. BOX 200

Sovenga

0721

05 /09 /2014

The Principal

High school A

Private bag x 1105

Sovenga

0727

Dear sir/madam

RE: Request for permission to conduct research in high school A

1. Purpose

The purpose of this letter is to request the circuit manager to grant me (M.R. Maake) permission to conduct research in high schools in the Mankweng circuit. My research topic is THE EFFECT OF GUIDED-DISCOVERY AND DIRECT INSTRUCTION TEACHING STRATEGIES ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT. Names of the schools were purposefully selected.

2. Background

I am an educator at Leokaneng High School. I am presently registered with the University of Limpopo for a Master's degree in Education. My research topic is THE EFFECT OF GUIDED-DISCOVERY AND DIRECT INSTRUCTION TEACHING STRATEGIES ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT. I require Grade 9 learners to write a pre-test. Learners will be taught through guided discovery for a period of one week. They will then write the post-test. The learners will be from two schools which will be chosen from the Mankweng circuit. Schools have been selected purposefully.

____

Ms M.R. Maake (082 4002046)

Appendix B

Principal information letter (CG)

P.O. BOX 200

Sovenga

0727

05 /09 /2014

The Principal

High School B

Private bag x 1105

Sovenga

0727

Dear sir/madam

RE: Request for permission to conduct the research in Masese high school

1. Purpose

The purpose of this letter is to request the district manager to grant me (M.R. Maake) the permission to conduct research in high schools in the Mankweng circuit. My research topic is THE EFFECT OF GUIDED-DISCOVERY AND DIRECT INSTRUCTION TEACHING STRATEGIES ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT. Names of the schools were purposefully selected, are listed.

2. Background

I am an educator at Leokaneng High School. I am presently registered with the University of Limpopo for a Master's degree in Education. My research topic is THE EFFECT OF GUIDED-DISCOVERY AND DIRECT INSTRUCTION TEACHING STRATEGIES ON LEARNER PERFORMANCE IN CHEMICAL REACTIONS IN GRADE 9 IN MANKWENG CIRCUIT. I require Grade 9 learners to write a pre-test. Learners will be taught through direct instruction for a period of one week. They will then write the post test. Learners taught using direct instruction will later be taught through guided discovery so as to advantage them also. The learners will be from two schools which will be chosen from the Mankweng circuit. Schools have been selected purposefully.

Yours faithfully,

____

Ms M.R. Maake (082 4002046)

Appendix C

Consent form

I, ………………………………the principal of………………………school hereby consent to Mampageti to involve Grade 9 learners in her investigation.

Signature of principal	Date
………………………………..	…………………..
Signature of Witness	Date
…………………………………………	……………………..
Signature of Researcher	Date
………………………………………..	……………………

Appendix D

Foromo ya tumelelo ya motswadi le ngwana

Le mengwa go tšea karolo dinyakišišong. Morero wa dinyakišišo ke go hwetša mokgwa wa boyba wa go ruta chemical reactions gore bana ba kwišiše. Gape le go hwetša mokgwa wa boyba wa go ruta bašemane le basetsana ba mphato wa senyane (Grade 9).

Tshedimošo

Leina laka ke Mampageti Rebecca Maake, ke moithuti wa Masters Universiting ya Limpopo. Ke dira dinyakišišo ka Effect of Guided-Discovery and Direct Instructional teaching strategies on learner performance in chemical reactions Grade 9 in Mankweng Circuit. Dinyakišišo tše di direlwa go phethagatša lengwalo la masters.

Ngwana wa lena o mengwa go tšea karolo mo dinyakišišong tše. Ke dinyakišišo tša go šomiša mokgwa wo moswa wago ruta (Guided-Discovery), morero e ele go kaonafatša kwešišo ya bana. Ge le ka fa ngwana wa lena tumelelo o tlile go ngwala molekwana ka Chemical reactions. Ka morago ga fao bana ba tla rutwa ka mokgwa wo moswa (Guided-Discovery). Dithuto di tlile go tšea tekano ya beke e tee. Ka morago ga beke batšeakarolo ba tla ngwala molekwana gape.

Kotsi

Go tšea karolo ga go bee bana kotsing. Dipoelo tša melekwana di ka se phatlalatšwe go mang le mang, ntle le bao ba amegago dinyakišišong.

Moputso

Dinyakišišo tše di thuša bana go kwešiša chemical reactions. Di tlile go kaonafatša le dipoelo tša bona tša marematlou go thuto ya tša mahlale.

Sephiri

Ditaba ka moka tša dinyakišišo tše ke sephiri. Tshedimošo ka moka, go swana le dipoelo tša Ngwana di šireleditšwe.

Kgokagano

Ge le na le dipotšišo le lokologile go ikgokaganya le monyakišiši.

Leina: Maake M.R.

Aterese: University of Limpopo

Nomoro ya mogala: 083 685 2046

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Go tšea karolo

Go tšea karolo mo dinyakišišong tše ga se kgapeletšo. O ka gana go tšea karolo ntle le tefo. Ge o ka tšea sephetho sa go tšea karolo, o dumeletšwe go ikgogela morago nako efe goba efe. Ge o ka ikgogela morago tshedimošo ya gago e tla lahlwa.

Tumelelo

Ke badile foromo ye, ke humane le copy ya yona. Dipotšišo tšaka ka moka di arabilwe. Ke dumela go tšea karolo dinyakišišong tše.

Ke dumelela ngwanaka, ……………………………………………..,go tšea karolo mo dinyakišišong.

Motswadi………………………… Tšatšikgwedi …………………………

Hlatse…………………………….. Tšatšikgwedi ………………………..

Appendix E

Pre and post-test:

Balance the following chemical reactions:

1) ……H_2 + ……O_2→……H_2O
2) ……N_2 + ……H_2→……NH_3
3) ……C + ……O_2→……CO_2
4) ……Mg + ……O_2→……MgO
5) ……Fe + ……O_2→……Fe_2O_3
6) ……Cu + ……O_2→……CuO
7) ……S + ……O_2→……SO_2
8) ……HCl + ……MgO→……$MgCl_2$ +……H_2O
9) ……NaCl + …..F_2→……NaF +……Cl_2
10) ……K + ……MgBr→……KBr +……Mg

SOLUTIONS

Pre and post -test:

Balance the following chemical reactions:

1) $2H_2 + 1O_2 \rightarrow 2H_2O$

2) $2N_2 + 3H_2 \rightarrow 2NH_3$

3) $1C + 1O_2 \rightarrow 1CO_2$

4) $2Mg + 1O_2 \rightarrow 2MgO$

5) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

6) $2Cu + 1O_2 \rightarrow 2CuO$

7) $1S + 1O_2 \rightarrow 1SO_2$

8) $2HCl + 1MgO \rightarrow 1MgCl_2 + 1H_2O$

9) $2NaCl + 1F_2 \rightarrow 2NaF + 1Cl_2$

10) $1K + 1MgBr \rightarrow 1KBr + 1Mg$

Appendix F

TABLE 1: Rating scale for rater 1

QUESTION	Very good 5	Good 4	Moderate 3	Poor 2	Very poor 1	×5
1	√					25
2		√				20
3		√				20
4	√					25
5	√					25
6		√				20
7			√			15
8			√			15
9	√					25
10		√				20

TABLE 2: Rating scale for rater 2

QUESTION	Very good 5	Good 4	Moderate 3	Poor 2	Very poor 1	×5
1	√					25
2		√				20
3	√					25
4	√					25
5		√				20
6			√			15
7			√			15
8			√			15
9	√					25
10		√				20

TABLE 3: Rating scale for rater 3

QUESTION	Very good 5	Good 4	Moderate 3	Poor 2	Very poor 1	×5
1	√					25
2		√				20
3		√				20
4		√				20
5	√					25
6	√					25
7		√				20
8			√			15
9			√			15
10	√					25

TABLE 4: Rating scale for rater 4

QUESTION	Very good 5	Good 4	Moderate 3	Poor 2	Very poor 1	×5
1	√					25
2	√					25
3		√				20
4		√				20
5	√					25
6	√					25
7			√			15
8		√				20
9			√			15
10	√					25

TABLE 5: CVI Calculation

QUESTION	Rater 1	Rater 2	Rater 3	Rater 4	
1	25	25	25	25	1.00
2	20	20	20	25	0.85
3	20	25	20	20	0.85
4	25	25	20	20	0.90
5	25	20	25	25	0.95
6	20	15	25	25	0.85
7	15	15	20	15	0.65
8	15	15	15	20	0.65
9	25	25	15	15	0.80
10	20	20	25	25	0.90

$$\boldsymbol{CVI = \frac{1.00 + 0.85 + 0.85 + 0.90 + 0.95 + 0.85 + 0.65 + 0.65 + 0.80 + 0.90}{10}}$$

= 0.84

Appendix G

Lesson plan

EDUCATOR: Maake M.R.	**SCHOOL/INSTITUTION:** School A
TOPIC: Chemical reactions	**GRADE:** 9
	SUBJECT: Natural sciences
LEARNING OUTCOMES • Specific Aim 1(Doing Science)	**TOPIC/CONTENT** • Chemical equations to represent reactions

Teacher's Activities	Learner's Activities	Resources	**Assessment Strategies**	**Estimated Time**
The teacher quide learners	Learners make models (using beads or play dough) of chemical reactions: $C + O_2 \rightarrow CO_2$ $2H_2+O_2 \rightarrow 2H_2O$ They make models of reactants and rearrange the atoms to show how the products are formed.	• Plastic beads or play dough and tooth picks • Learner's book (spot on grade9)	• Classwork • Test	3 hours

Expanded opportunities: learners are asked to visit chemical industries. Special Needs: learners with special needs are given extra time	**Enrichment/application**: learners who complete the activities first are given extra challenging questions to do **Activities from LSM**: learners were given classwork from their text book.

Notes

Sub atomic particles

Atoms – matter is anything that has mass and takes up space.

Scientists, however, have found out that atoms consist of smaller subatomic particles: protons, neutrons and electrons.

The central region of the atom is called the nucleus. It has two types of particles.

- Protons have a mass and carry a positive charge (+)
- Neutrons are similar to protons, but they do not carry a charge and are said to be neutral.

Around the nucleus, moving around in the outer shell of the atom, are electrons. These have very little mass and negatively (-) charged.

Particles model of matter

Scientists have always been curious as to what makes up matter.

The particle model of matter states:

- All matter (solids, liquids, gases) is made up of particles.
- The particles are too small to see, even with the strongest microscope. In a drop of water there are many billions of water particles.
- There are empty spaces in between the particles.
- The particles are constantly moving. They move spontaneously which means they move on their own.
- There are forces of attraction and repulsion between the particles of matter.

Change of state

The particles model of matter can explain physical changes in matter

Gaining heat

The particles in a solid are very close together. The attractive forces between the particles are very strong. If we add heat, the heat energy breaks the attractive forces between the particles of the solid, causing the solid to melt and turn into a liquid.

Loosing heat

When a gas phase changes back into a liquid, heat energy is given off. The gas particles come closer together. The forces of attraction between the particles increase. This is called condensation.

Building blocks of matter

Matter= anything that has mass and volume.

Atoms

- All matter is made up of atoms- first stated by Democritus who lived 2000 years ago.
- Atoms are made up of subatomic particles-protons, neutrons and electrons.
- Atoms are so small; they can only be seen using computer software that creates an image using a microscope.

Elements

- An element consists of atoms of the same kind.
- Elements of the same kind share the same chemical properties.

Periodic table:

- Contains all known elements.

Dalton's laws

- All these facts about elements helped John Dalton write down elements to help us understand them

Scientific models

- Scientists use models to help them understand the real world and how it works.

Pure substances

- Pure substances= a substance that is made up of the same matter.

  There are two classes of pure substance.

Elements	Compounds
An element consists of atoms that are all the same kind.	A compound consists of two or more kinds of atoms in a fixed ratio.

Elements

- Elements are made up of atoms of the same kind.
- The kind of atom determines the element that is formed.
- This is the reason why different elements have different properties, because their building blocks different.

Sub-microscopic structure of copper (cu)

- It consists of only copper atoms.

Sub- microscopic structure of silver (Ag)

- It consists of only silver atoms.

Leaner activities

Activity 1

1. Draw a structure of an atom.
2. List the first 20 elements of the periodic table.
3. Define the following:
   3.1 Atom
   3.2 Electron
   3.3 Proton
   3.4 Neutron
   3.5 Element
   3.6 Compound

Activity 2

1. Provide names for the following compounds

Compound	**Name**
CCl_4	
Br_3N	
BeO	
S_3	
CuP_2	
MgB_6	
NaF	
AuI_3	
HBr	
ZnSe	

2. Provide formulae for the following compounds

Formula of the compound	Name of the Compound
	Zinc Oxide
	Aluminium nitrate
	Lithium bromide
	Carbon monoxide
	Silicon tetra boride
	Phosphorus trichloride
	Magnesium diboride
	Potassium hydride
	Potassium tetrachloride aluminate
	Sodium chloride

3.Balance the following:

1. $H_2 + O_2 \rightarrow H_2O$
2. $H_2 + O_2 \rightarrow H_2O$
3. $Ca + O_2 \rightarrow Ca\ O$
4. $Ca + O_2 \rightarrow CaO$
5. $H_2 + I_2 \rightarrow HI$
6. $Na + Cl_2 \rightarrow NaCl$
7. $Ca + CO_3 \rightarrow CaCO_3$
8. $NaCl + BeF_2 \rightarrow NaF + BeCl_2$
9. $FeCl_3 + Be_3(PO4)_2 \rightarrow BeCl_2 + FePO_4$
10. $NaOH + HCl \rightarrow NaCl + H_2O$

Activity 3

1. Read the sentences and fill in the missing words. Write the missing word on the line below.
   a) A chemical reaction where a compound and oxygen react during burning to form a new product is called a…………………..
   b) Magnesium + ………..→ Magnesium Oxide
   c) ……………..+ Oxygen → Iron oxide
   d) ……………..+ Oxygen → Copper Oxide
   e) Another word for iron oxide is …………………….
   f) Metal that is covered by a thin layer of zinc is called ……………
   g) The gradual destruction of materials (usually metals) by chemical reaction with the environment is called…………………

h) When the air in a specific area contains moisture mixed with acid or salt, we refer to the area to the area having rust…………………….

i) The product of the reaction between a metal and oxygen is called ………………..

2. Complete the following table

Word equation	Zinc + Oxygen→ Zinc Oxide
Chemical equation	
Picture equation	

Word equation	
Chemical equation	$2Mg + O_2 \rightarrow 2Mgo$
Picture equation	

Word equation	Copper +Oxygen→Copper Oxide
Chemical equation	
Picture equation	

3. How is rust formed?

Activity 4

1. Use the following notation as represented on the periodic table and answer the questions. Zn_{65}^{30}

1.1 Which element is this?
1.2 How many protons does the element have?
1.3 What is the atomic number of the element?
1.4 How many protons and neutrons does the element have?
1.5 How many neutrons does the element have?

Activity 5

1. Balance the following chemical equations by writing the correct number of particles and drawing it.

1.1 Calcium + Chlorine → Calcium Chloride
1.2 Hydrogen + Oxygen → Water
1.3 Potassium + Sulfur →Potassium Sulfide
1.4 Hydrogen + Nitrogen → Ammonia
1.5 Hgo →Hg and O_2
1.6 SO_2 O_2 →SO_3

Activity 6

1. The acid of our reaction was hydrochloric acid. Write its chemical formula
2. What is the name and formula of the metal oxide we used?
3. Now, let us try to predict the products of the reaction. We know that water will be one of the products.
4. Write what remains on the base (MgO) after we have taken away the H (to make water). (Remember we need two H to make one H_2O)
5. Now put the remaining fragments together. Place the metal first and remember that 2HCl will leave 2Cl after the 2H has been given to O to make water. One Mg and 2Cl makes $MgCl_2$
6. Now let us put it all together, first the reactants, then products

   $2HCl + MgO \rightarrow MgCl_2 + H_2O$

7. Let us check quickly if the reaction is balanced.

a) How many H atoms on the left hand side and on the right hand side?

- Are they balanced?
- 2H atoms on the right and left hand side.
- Yes they are balanced.

b) How many Cl atoms on the left hand side and on the right hand side?

- Are they balanced?
- 2 Cl atoms on the right and on the left hand side.
- Yes they are balanced.

c) How many O atoms on the left and on the right hand side?

- Are they balanced?
- 1 O atom on the left and right hand side
- Yes they are balanced.