THE EFFECTS OF AUTHENTIC LEARNING ACTIVITIES ON ACHIEVEMENTS AND ATTITUDE TOWARDS NATURAL SCIENCE AMONG GRADE 7 LEARNERS IN KHOMAS AND OMUSATI EDUCATIONAL REGIONS

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ABSTRACT

Teaching and learning Natural Science for conceptual understanding requires appropriate and effective teaching approaches and inquiry-based learning activities. The problem of teaching and learning Natural Science for deeper understanding is global and Namibia is not an exception. The Ministry of Education, Arts and Culture's reports on the National Standardised Achievement Tests (SATs) results of Grade 7 Natural Science showed that learners scored under basic achievement category over the past years. These poor SATs results might affect learners' academic achievements and attitude towards science subjects. It is therefore a concern that many teachers seem to teach Natural Science excluding authentic learning activities in their teachings. Therefore, this study investigated the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in Khomas and Omusati educational regions.

The study was a mixed research approach which used a case study and quasi-experimental designs. Data were analysed using SPSS and thematic data analysis. Eight schools and 221 learners participated. Schools and learners were randomly selected and assigned into experimental and control groups. The experimental group had 124 learners and 97 were in the control group. Experimental groups received authentic learning activities and control groups received traditional lectures. The pre-test and post-test were used. The experimental group's mean scores on the pre-test and post-test were 18.91 and 31.72 respectively, while the control group had 17.28 and 23.07. This indicated a significant difference in the performance of the experimental group at 0.05 significant level and proved that authentic learning activities improve learners' achievements in Natural Science. The STAQ-R was given to learners in the experimental group to establish whether authentic learning activities influence their attitude towards Natural Science. Respondents indicated that the self-directed effort factor among others, attracted them to Natural Science and positively influenced their attitude towards the subject. Focus-group interviews with 22 learners from the experimental group were randomly selected to gauge their views on authentic learning activities. Learners appreciated the use of authentic learning activities as the activities helped them to understand concepts of science better and they could easily remember what was taught. Based on these findings, the usage of authentic learning activities in schools to enhance learners' conceptual understanding, improve learners' achievements, and positively influence learners' attitude towards the subject should be advocated. Nonetheless, the study developed the CPSR domain model for the teaching and learning of Natural Science using authentic learning activities in classrooms to prepare learners for the 21st century.

The study recommended that curriculum developers in the Ministry of Education, Arts and Culture should incorporate more fun and enjoyable activities in the national curriculum, syllabus and other teaching and learning support materials where the use of authentic learning activities is required. Schools should procure appropriate authentic materials for the effective teaching and learning of concepts of science. In addition, Natural Science teachers should incorporate authentic learning activities in all their lessons.

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LIST OF ACRONYMS

LCE	Learner-Centred Education
NIED	National Institute for Educational Development
SATs	National Standardised Achievement Tests
SCET	Social Constructivist Epistemology Theory
SPSS	Statistical Package for Social Sciences
STAQ-R	Simpson Troost Attitude Questionnaire-Revised
UNAM	University of Namibia

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"*A sacrifice to be real, it must cost, must hurt, and must empty ourselves. The fruit of silence is prayer; the fruit of prayer is faith; the fruit of faith is love; the fruit of love is service; and the fruit of service is peace.*"

Mother Teresa of Calcutta (1910 - 1997)

"The love and peace be with you all"!!

DEDICATION

This study is dedicated to the following people, without whose support and inspiration this study would not have been a success;

- To my mother, Taimi Kaapangelwa Shamena-Iipinge and late father Junias Shapaka-Kasamane Uugwanga. Thank you *Meme gwaShamena* and *Tate Kasamane* for teaching me the importance of education and nurturing me a culture of perseverance.
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- To all the learners who travel long distances to schools, for their courage and determination as they often travel in harsh and unsafe conditions.

This dissertation is for you and I salute you all!

DECLARATION

I, Jafet Shikongo Uugwanga, hereby declare that *"The effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in Khomas and Omusati educational regions"* is my own work and is a true reflection of my own research, and that this work, or any part thereof has not been submitted for a degree at any other institution.

I, Jafet Shikongo Uugwanga, grant The University of Namibia the right to reproduce this dissertation in whole or in part, in any manner or format, which The University of Namibia may deem fit.

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Jafet Shikongo Uugwanga	Signature	Date

CHAPTER 1: INTRODUCTION

1.1 The background of the study

Teaching and learning Natural Science for conceptual understanding requires the appropriate and effective teaching approaches and inquiry-based learning activities (Ilter & Kilic, 2015). Therefore, the problem of teaching and learning Natural Science for deeper understanding is not only found in Namibian schools but also in other African and Western countries such as South Africa and Turkey, among others (Azri & Al-Rashdi, 2014; Shumba, Ndofirepi, & Gwiragi, 2012; Ultanir, 2012). In most countries, it is a concern that many teachers seem to teach Natural Science using the syllabus and a textbook only rather than including authentic learning activities in their teaching (Ates & Eryilmaz, 2011). Authentic learning activities promote learners' attitude to learn science and improve learners' achievements (Oguz, 2008).

Nakanyala (2015) and Nghipandulwa (2011), conducted studies on factors that affect the effective teaching of Physical Science and teachers' perceptions of the importance of practical work in Biology respectively. Both studies were done in Namibia and they found that teachers concentrated on teaching rules than employing innovative strategies and activities in teaching and learning science content. Amoonga and Kasanda (2011), Awe (2007) and Uugwanga (2015) also found that teachers in Namibian schools prefer to use the lecture method, which is teacher-centred. A teacher-centred method is not only used by many Namibian teachers, but is also used globally (Thompson-Krug, 2014; Safdar, Hussain, Shah, & Rifat, 2012). Although Awe (2007) argued that the lecture method contributes to better performance in examinations, learners are not fully equipped with varieties of opportunities that enable them to acquire scientific skills. Therefore, there is need to practice other constructive approaches such as authentic learning activities in teaching and learning concepts of science in order to foster learners' scientific skills and understanding. Thompson-Krug (2014) conducted a study on the effects of authentic learning experiences on learners' perceptions of science in Nebraska, United States of America and found that authentic learning activities can:

- improve learners' attitude towards learning regardless of subject;
- impact learners' interest in science more than traditional textbook teaching;
- prepare learners for real life and meet learners' needs;
- improve learners' academic achievements; and
- encourage teachers to adopt effective teaching methods (p. 251).

Based on the above mentioned benefits, authentic learning activities are also regarded as the most constructive teaching and learning activities in developed and developing countries such as Finland (Hyvonen, 2011) and South Africa (Titus, 2013). When one considers some reasons given, it is obvious that authentic learning activities have many positive effects on learners and teachers, as these activities foster meaningful learning instead of rote learning (Uugwanga, 2015) and have noticeable positive impacts on learners. In addition, authentic learning activities provide learners with opportunities to operate at the main domains of learning.

1.1.1 What is authentic learning?

Authentic learning is a pedagogical approach that allows learners to explore, discuss and meaningfully construct concepts and relationships in real contexts that involve real world problems and projects that are relevant to the learners (Iucua & Marina, 2014). Similarly, Rule (2006) defines authentic learning as a "relatively new term that describes learning through applying knowledge in real-life contexts and situations" (p. 1). According to Morales (2015), authentic learning allows for the construction of meaning grounded in real-life situations and the learners' own personal experience. Lombardi (as cited in Neo, Neo, & Tan, 2012, p. 51) define authentic learning as learning that "…focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice."

Therefore, using authentic learning approaches during teaching and learning of Natural Science enables learners to understand better as they connect the real activities to the real world (Pantiwati, Wahyuni, & Permana, 2017; Suryawati & Osman, 2018). Authentic learning approaches also enable learners to grasp science concepts meaningfully and reason scientifically when conducting an investigation (Suryawati & Osman, 2018). As a result, learners' performance in Natural Science is improved drastically as authentic learning allows learners to experience real-world problems while in a learning environment (Pantiwati et al., 2017).

1.1.2 Themes that support authentic learning in science classrooms and beyond the school

Rule (2006) identified four themes that support authentic learning within and beyond the science classroom. According to Rule (2006), the themes are:

- the activity involves real-world problems that mimic the work of professionals in the discipline with presentation of findings to audiences beyond the classrooms;
- use of open-ended inquiry, thinking skills and metacognition;
- learners engage in discourse and social learning in a community of learners; and
- learners direct their own learning in project work (p. 2).

By looking at the four themes stated above, there are key concepts in each theme. These concepts are discussed below.

1.1.2.1 Authentic learning involves real-world problems

When Natural Science teachers prepare their lesson plans for teaching, they should consider practicing authentic learning tasks that target the real-world problems. In addition, the authentic learning tasks should promote learners' participation and involvement with the possibility of being able to contribute to the society beyond their classroom settings (Moodley & Aronstam, 2016; Rule, 2006). In fact, to enable the Natural Science learners to address the real-world problems, they should be allowed and taught how to investigate the real problems within their own lives and communities before they fully engage themselves in solving some global problems (Moodley &

Aronstam, 2016). In so doing, authentic learning tasks encourage and promote lifelong learning rather than passive learning (Rule, 2006).

1.1.2.2 Authentic learning promotes inquiry and thinking skills

Natural Science pedagogy should involve authentic learning activities that promote theoretical inquiry and also encourage learners to demonstrate higher levels of critical thinking (Lau, 2011; Moodley & Aronstam, 2016; Rule, 2006). In Natural Science teaching, authentic learning tasks should reflect the scientific process of acquiring knowledge that enables learners to construct ideas through scientific inquiry (Magaji & Sa'eed, 2017). Learners should be exposed to authentic learning where they are expected to acquire conceptual understanding that enables them to think and reason scientifically so as to overcome their daily obstacles. This implies that authentic learning fosters Natural Science learners to be critical thinkers who are able to make good decisions in life and who can work freely with other learners. Similarly, authentic learning enables Natural Science learners to inquire into scientific information by generating hypotheses and testing them to arrive at acceptable results.

1.1.2.3 Authentic learning occurs through a discourse in a community of learners

In teaching Natural Science, authentic learning tasks should accommodate group work whereby learners are encouraged to work together as a team which enables them to solve problems (Moodley & Aronstam, 2016). In addition, authentic learning projects should allow learners to interact with their community members when they embark on field work such as Natural Science investigation. Thus, according to Rule (2006), authentic learning enables learners to communicate openly with the community through a diversity of languages, cultures, and social mores.

1.1.2.4 Authentic learning empowers learner-directed learning

In authentic learning, a learner-directed learning concept is interchangeable to a self-directed learning concept and/or learner-centred approach whereby learners are empowered to take responsibility and ownership of their own learning (Fettling, 2015; Hew, Law, Wan, Lee, & Kwok, 2016). This implies that authentic learning prepares Natural Science learners for self-study as opposed to learners depending on their teachers to remind them when to study and do their homework. According to Smith (2016), authentic learning should promote learner-directed learning in science classrooms so as to encourage learners to be "ready to learn; setting learning goals; engaging in the learning process; and evaluating learning" (p. 17). Smith's sentiments denote that authentic learning should empower learners to set themselves tangible goals that they can achieve through learning. Similarly, Rajan (2015) stated that learner-directed learning "develops learners' learning skills and professional skills through the teaching and learning process" (p. 204). According to Rajan, authentic teaching and learning fosters Natural Science learners to acquire academic and professional skills that enable them to cope with school work as individuals and succeed in their personal careers after school.

1.1.3 Learning domains enhanced by authentic learning activities

Authentic learning activities provide learners with opportunities to operate at all four domains (*cognitive, affective, psychomotor and conative*) of learning (Safdar et al., 2012). The learning domains are:

- ***Cognitive domain***

For the cognitive domain, the use of authentic learning activities enables learners to remember and retrieve the recent learned science work (Wilson, 2017). In authentic science class, learners acquire knowledge to enable them to remember and recall the information taught and learned; acquire comprehension skills to enable them to understand the meaning of different scientific concepts; acquire application to enable them to interpret the collected data; acquire analysis skills to enable them to distinguish between the diagrams and charts; and acquire synthesis skills to enable them to evaluate the value of science activities taught in class (Clark, 2015; Wilson, 2017). In other words, teaching science to the learners using authentic learning activities develops learners' intellectual skills to enable them recall or recognise specific scientific facts, procedural patterns, and scientific concepts that serve in the development of their intellectual abilities and skills (Clark, 2015; Manickavasagam & Surwade, 2017). In brief, the cognitive domain emphasises that a learner's thinking capacity, reasoning skills and intellectual abilities are increased for better performance when teachers practise authentic activities in their science classes.

- ***Affective domain***

For the affective domain, the use of authentic learning activities enables learners to actively and positively participate in discussions and debates (Wilson, 2017). In authentic science class, learners acquire skills that enable them to receive the full attention of the teachers and other learners; respond to the feelings of being motivated to learn and contribute in science class with satisfaction; value their commitments and accept that their beliefs and attitude towards science can be positively justified for better achievements; organise and conceptualise their mind-sets according to the priorities when executing science activities; capable of making reasonable judgements, conclusions and/or generalisations based on their scientific enquiry with adequate facts (Clark, 2015; Manickavasagam & Surwade, 2017; Wilson, 2017). In brief, the affective domain emphasises that teaching science to the learners develops and/or stimulates their attitude, emotions and feelings that enables them to participate in science class with self-confidence.

- ***Psychomotor domain***

For the psychomotor domain, the use of authentic learning activities enables learners to perform their work physically, quickly, better and more accurately (Clark, 2015). In an authentic science class, learners develop the skills and techniques that enable them to express, create, mime, design and interpret science activities precisely and scientifically (Wilson, 2017). In other words, at home learners imitate exactly how the teacher was connecting the electric circuit in the science class; learners do a science project, for instance, they draw the electric circuit diagrams correctly by following the instructions or directions given to them on paper (Clark, 2015; Dalto, 2014). In brief, the psychomotor domain emphasises that a learner's motor-skills are developed to enable them to perform specific science activities easily within and outside the classroom setting for better results.

- ***Conative domain***

For the conative domain, the use of authentic learning activities enables learners to develop self-control, commitment, conceptual understanding and self-determination to actually perform at the highest disciplinary standard (Atman, 2014; Revees, 2017). In an authentic science class, a learner's passion and confidence to further their education in science related subjects is awakened; a learner's engagement in science related processes and/or self-goal oriented actions and willingness is developed through the teaching and learning process (Dalto, 2014; Manickavasagam & Surwade, 2017). In short, the conative domain emphasises that teaching learners authentic activities enhances their passion for learning science subjects and/or concepts.

Therefore, teachers should use authentic learning activities in teaching science to determine the learners' existing ideas and measure their attitude regarding the subject matter (Oguz, 2008). Authentic learning is a new pedagogical strategy that prepares learners for real life situations to enable them to face the real world's problems (Azri & Al-Rashdi, 2014). Despite the opportunities and/or benefits that learners can gain from the use of authentic learning activities, there are also some factors that hinder the use of authentic activities in science.

1.1.4 Criticisms of using authentic activities in science pedagogy

Despite the fact that the use of authentic learning activities provide learners with opportunities to operate at all four domains of learning as highlighted above by Atman (2014), Clark (2015), Dalto (2014), Manickavasagam and Surwade (2017), Revees (2017) and Wilson (2017), some researchers criticise the use of authentic learning activities. Kilickaya and Miller, (as cited in Azri and Al-Rashdi, 2014, p. 252), claim that authentic learning activities have "no value", they only "add a burden on teachers" and are "too difficult and time consuming to select, edit and prepare." Similarly, Flowerdew and Peacock (as cited in Peñamarí and Benavent, 2011, p. 90) also argue that an "authentic text may not be authentic for a specific class, just because a text is authentic does not mean it is relevant" and "authentic texts are often too difficult linguistically."

Similarly, Peat and Taylor (2006) conducted a research on how well to teach Biology using authentic activities with the first year Biology learners at the University of Sydney. They found that authentic materials might be expensive to buy and to collect. Authentic materials referred to the teaching and learning aids and/or resources which are regarded as beneficial tools in the teaching and learning process. In other words, authentic materials are real-life or genuine materials such as magazines, newspapers, posters, television shows, computer videos, camera, electric circuit, magnifying glass and so on. All the above criticisms were raised based on the research that was conducted internationally and it is worth noting that no similar research has been conducted in Namibia. This would have given a clear guidance upon this study as to whether the study would fill the gap existing in related literature or address the issues based on other researchers' recommendations from the Namibian context.

1.2 Motivation for the study

Since the researcher has been a science teacher for 12 years, he didn't think of what else could be used to promote learners' interest to study Natural Science. For a long time, the researcher only used science textbooks as the only teaching tools and sources of information during the teaching and learning process. One day, the researcher decided to change his teaching strategy to one of his three Grade 7 Natural Science classes. That time, he was going to teach "states of matter" and he decided to collect real objects (balloons, ice cubes, dice, water, candles, empty bottles, stones, woodblocks, Bunsen burner, stick matches, etc.). These were then used during his lesson. The main aim of using real objects was to observe the learners' understanding of the topic taught and the learners' reaction and participation during the lesson. During the lesson, some learners were very excited, the reason was that they were learning while seeing and touching the real objects at the same time. After the lesson, these learners went to tell other Grade 7 science learners how engaging and interesting the lesson was.

After school, some of the other Grade 7 learners came to the researcher's office (as he was then the Head of Department for Mathematics and Science) and informed him that they also wanted to be taught the same activities with the real objects like other learners. The next day, the researcher went to teach the learners as per their request, and thereafter, these learners were also enjoyed the new method of teaching used. Based on the researcher's observation on the learners' reaction and participation during the lesson presentations in the three Grade 7 classes taught using the new method, the researcher concluded that the use of authentic learning activities in science pedagogy might make science lessons fun, interesting, and exciting leading to the learners' improved performance.

The questions that came to the researcher's mind after teaching the Grade 7 learners with real materials were:

1. Why can't the Ministry of Education, Art and Culture through the National Institute for Educational Development (NIED) directorate advocate the use of authentic learning activities in every day's teaching and learning in schools in line with Learner-Centred Education (LCE)?
2. What effects if any, does authentic learning activities have on learners' achievements?
3. What will be the learners' attitude towards the learning of science if the use of authentic learning activities is made compulsory in Namibian schools?
4. Is there any research done so far on authentic learning activities in Namibian schools or elsewhere?

Subsequently, what came to the researcher's mind was that the only best way to find solutions to these questions was to conduct an empirical study. It is against this background that the researcher was interested to undertake a study to investigate the effects of authentic learning activities on Grade 7 learners' achievement and attitude towards Natural Science.

1.3 Statement of the problem

The National Standardised Achievement Tests (SATs) results of Grade 7 Natural Science in Namibia have shown that learners scored under basic achievement category over the past few years. In 2010, learners who wrote the Natural Science's SATs scored 51% with 54% in 2012 while 58% and 59% were obtained in 2014 and 2015 respectively (Ministry of Education, Arts and Culture, 2016). At a regional level, it was noted in the Ministry of Education, Arts and Culture's report of 2016 that Omusati region was one of the regions that had been performing below 60% while the Khomas region had performed above 60% in Natural Science. However, the performance of many schools in the Khomas region was unsatisfactory in three basic competencies, namely: identifying a reflex arc from a diagram; describing the influence of drugs on the nervous system; and classifying elements into metals and non-metals (Shaakumeni, 2012). This means that the majority of learners did not master the three basic competencies mentioned above.

The unsatisfactory SATs results of Grade 7 learners in Natural Science was the main concern of this study and it was presumed that this might affect learners' academic achievements and attitude towards science related subjects at the next grade levels (Hoepfner, 2014). It was also presumed that the learners' unsatisfactory performance in Natural Science was caused by lack of meaningful teaching and learning activities

(United Nations Educational, Scientific and Cultural Organisation, 2015) or the learners' attitude as learners might not have had interest in the subject (Ivowi, 2001).

Uugwanga (2015) argues that most teachers are still using teacher-centred methods in their teaching. Uugwanga also concurs with Hoepfner (2014) who reveals that teachers are not making use of a variety of teaching strategies in their teaching and this affects learners' performance. According to Oguz (2008), authentic learning activities in science promote learners' attitude to learn science and increase learners' academic achievements. Therefore, this study aimed at investigating the effect of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in Khomas and Omusati educational regions. The researcher selected Khomas and Omusati educational regions mainly because of their accessibility and his acquaintance with these regions.

1.4 Research objectives

The main objectives of this study were to:

1. Determine the effect of authentic learning activities on achievement scores among Grade 7 learners in the Khomas and Omusati educational regions.
2. Find out whether authentic learning activities influence Grade 7 learners' attitude towards Natural Science in the Khomas and Omusati educational regions.
3. Investigate what Grade 7 learners in the experimental group thought about the effect of authentic learning activities in Natural Science.

1.5 Research questions

In order to achieve the objectives of this study, the following research questions were used:

1. What are the effects of authentic learning activities on achievement scores among Grade 7 learners in the Khomas and Omusati educational regions?
2. Does authentic learning activities influence Grade 7 learners' attitude towards Natural Science in the Khomas and Omusati educational regions?
3. What does the Grade 7 learners in the experimental group think about the effects of authentic learning activities in Natural Science?

1.6 Hypotheses of the study

The following two null hypotheses were tested in this study.

1.6.1 Null hypothesis (H_o): There is no significant difference between the achievement scores of the Grade 7 learners who are exposed to authentic learning activities and those who are not.

Alternative hypothesis (H_1): There is a significant difference between the achievement scores of the Grade 7 learners who are exposed to authentic learning activities and those who are not.

1.6.2 Null hypothesis (H_o): The authentic learning activities have no influence on the Grade 7 learners' attitude towards Natural Science after exposing them to authentic learning activities.

Alternative hypothesis (H_1): The authentic learning activities have some influence on the Grade 7 learners' attitude towards Natural Science after exposing them to authentic learning activities.

1.7 Significance of the study

This study is significant to various stakeholders in education. First, the study might guide the Natural Science teachers in the Khomas and Omusati educational regions on how to use authentic learning activities and provide them with useful information that promote learners' attitude and achievements. Second, the study might add new evidence on which authentic learning activities and strategies are suitable to Namibia's rural and urban schools' settings to improve learners' results. Third, the study might positively change the viewpoints of the policymakers and educators in Namibia to consciously encourage the use of authentic learning activities to improve learners' achievements in science subjects. Fourth, the results of this study might be used as evidence to help researchers in the field of science education to fill the gap which this study might not fill and add value to the current lack of literature on the effect of authentic learning activities in Namibia. Finally, the results of this study might be a source of information that may encourage educational stakeholders to supply and/or improvise necessary authentic learning activities to supplement what textbooks provide in order to improve the quality of teaching and learning, particularly in Natural Science.

1.8 Limitations of the study

One of the limitations was that some learners might have responded to the questions in dishonest ways which might have influenced the outcomes of the study. However, the researcher assumed that all the responses given by the learners were an expression of their true reflections since the learners were encouraged to be honest at all costs. This limitation could have been avoided by informing the learners before the commencement of data collection that there would be no correct or wrong answers. Another limitation was that by using the attitude Likert scale to determine the level of the learners' attitude towards Natural Science, the respondents might have chosen or ticked the answers without properly reading and understanding the questions. This might have been avoided by informing the respondents to read the statements carefully with understanding before they chose or ticked their possible answers. The unavailability of both printed and electronic literature on or related to authentic learning activities in Namibia was another limitation. This might have been prevented if there was extant research or studies conducted on authentic learning activities locally and/or regionally.

1.9 Delimitations of the study

This study focused on government primary schools since private primary schools have been performing above the basic achievement in SATs. The study was also confined to the Khomas and Omusati educational regions because the researcher's accessibility and acquaintance with these regions. The study targeted ten primary schools altogether (six schools in the Khomas region and four schools in the Omusati region) in order to minimise the number of case study sites. Two of the six schools in the Khomas region were used as the piloting schools and these did not form part of the main study sample. These schools were studied in terms of performance and resources and they were far apart from each other so as to avoid data contamination. Only Grade 7 learners were included in the study for the reason that Natural Science's SATs were only administered to Grade 7 learners.

1.10 Definition of terms

This section defines the terms that were mostly used in this study. These terms are as follows;

Authentic learning: This refers to a pedagogical approach that allows for the construction of meaning grounded in real-life situations and the learners own personal experiences (Morales, 2015). In this study, authentic learning refers to the learning process that the Grade 7 Natural Science teachers employ in their classrooms in order to enable their learners to explore and construct concepts for better understanding and academic achievements.

Authentic learning activities: This refers to the teaching intervention constructed in real-world contexts to improve learners' outcomes (Luo, Murray, & Crompton, 2017). In this study, authentic learning activities refer to the real teaching and learning activities that the researcher designed and used in teaching Grade 7 learners in the experimental group to determine their effect on learners' achievement scores and attitude towards Natural Science.

Achievement: This refers to the performance of an individual in any given task to assess the basic skills (Ates & Eryilmaz, 2011). Achievement in this study refers to the academic performance of Grade 7 learners in the given pre- and post-tests on "electricity".

Performance: This refers to the "academic accomplishment of a given task measured against present known standards of accuracy, completeness and speed" (Cobb, as cited in Haimbodi, 2012, p. 14). In this study, performance refers to the scores/marks of the Grade 7 learners in the pre- and post-tests on "electricity".

Attitude: refers to the psychological mind-set of an individual's experience and temperament about an object, fact or situation (Ilter & Kilic, 2015). Attitude in this study refers to the way Grade 7 learners behaved or reacted towards the use of authentic learning activities in Natural Science.

Science pedagogy: This refers to the systematic process of presenting science facts, skills, concepts, ideas and techniques to the learners (Kuuskorpi, 2014). In this study, science pedagogy refers to the process of how Grade 7 teachers teach Natural Science to their learners.

Primary school: This refers to "a school or part of a school in which basic education from the level of the first grade to the level of the seventh grade is provided" (Government Gazette of the Republic of Namibia, 2001, p. 6). In this study, primary school refers to the senior phase in which Grade 7 learners and teachers in the Khomas and Omusati educational regions belong.

1.11 Synopsis of the chapters

This study is divided into six chapters as indicated below;

Chapter 1: Introduction. This chapter introduces the study based on the background of the study, motivation for the study, statement of the problem, research objectives and hypotheses of the study, the significance of the study, limitations and delimitations of the study as well as the definition of the key terms.

Chapter 2: Literature review. This chapter reviews relevant literature based on the SCET theory in relation to the use of authentic learning activities in science classrooms. It further discusses relevant literature related to the use of authentic learning activities and its effects on learners' achievements. The model for teaching and learning Natural Science using authentic learning activities was designed and discussed.

Chapter 3: Research methodology. This chapter provides the participants' demographic information and discusses the research methods used in this study. It further describes the population, sample and sampling procedures. The chapter also explains the research instruments that were used to collect data and data collection procedures. Data analysis methods and ethical considerations are also included in this chapter.

Chapter 4: Data presentation, analysis and interpretation. This chapter presents and interprets the data analysed from the pre-and post-tests, STAQ-R and semi-structured interviews. The themes that emerged from the participants' interviews are discussed.

Chapter 5: Discussion of findings. This chapter discusses the findings that were presented in Chapter 4 in relation to the themes that emerged from the objectives of the study.

Chapter 6: Summary, conclusions and recommendations. This chapter summarises the key findings from the data presented and discussed in Chapters 4 and 5 respectively. It further draws conclusions of the study and provides some recommendations.

1.12 Summary

This chapter provides the background of the study based on authentic leaning domains and criticisms on using authentic leaning activities in science pedagogy and rationale of the study. The statement of the problem, research objectives and hypotheses that guided this study were identified. It also discussed the study's significance, limitations as well as delimitations of the study. The definition of key terms that are frequently used in this study is given and it concludes with the synopsis of all the chapters. The next chapter presents a discussion of related literature review.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The review of related literature is "an analysis on works previously done on a subject matter, analysis done based on credible sources – valid research or proper intellectual analysis" (Ishak & Fauzan, 2015, p. 5). In research, a critical analysis can be done on theories, criticisms, ideas or findings and these can be found in credible sources such as books, magazines, journals, conference proceedings and reports (Derntl, 2014; Ishak & Fauzan, 2015). In short, the review of relevant literature is an "extensive critical review of the extant literature on the research topic" as stated by Clare & Hamilton, (as cited in Ishak & Fauzan, 2015, p. 5). According to Silverman, cited in Iipinge (2010), the aim of the literature review is to "provide a set of explanatory concepts. These concepts offer ways of looking at the world which are essential in defining the research. …without a theory, there is nothing to research" (p. 25).

Therefore, the literature review was done in line with the study's theoretical framework on how learners construct and acquire knowledge to understand the real world. The literature was also drawn from various credible sources that addressed the effect of authentic learning activities on learners' achievements and attitude in teaching and learning of science. Furthermore, the literature on the meaning and originality of authentic learning; the components, characteristics, types of authenticity and the importance of authentic learning; the pedagogical strategies that support authentic learning towards self-directed learning; certain aspects of authentic learning environment; teachers' and learners' roles in authentic classroom; themes that support authentic learning in classroom and beyond; skills developed when engaging in authentic learning; authentic learning for the 21st century; authentic pedagogy at primary education level; teaching science concepts for authentic learning; challenges of teaching and learning science concepts; the meaning and learners' attitude towards Natural Science; teaching science towards authentic scientific inquiry; and authentic assessment of learners' learning were also reviewed.

2.2 Theoretical framework for this study

A theoretical framework is the "blueprint" theory of ideas that guide and support a study. In other words, it is the worldview of the heart rather than the mind that provides the structure to define how the researcher understands and plans his/her study (Grant & Osanloo, 2014). Therefore, the theoretical framework that underpinned this study is attributed to the theory of Berger and Luckmann's (1966) and Wittgenstein's (1956) Social Constructivist Epistemology Theory (SCET) in which the term constructivist epistemology was used first by Piaget in 1967 (Mutekwe, Ndofirepi, Maphosa, Wadesango, & Machingambi, 2013). The theory focuses on the learning of knowledge-based meaning and understanding of reality (Andrews, 2012; Mutekwe et al., 2013). The next section provides the brief overview of SCET and its relevance to the current study.

2.2.1 An overview of Social Constructivist Epistemology Theory and its relevance to the current study

The Social Constructivist Epistemology Theory is viewed through the researcher's lens in terms of social constructivism as an epistemology. Mutekwe et al. (as cited in

Mutekwe, 2017, p. 197) define social constructivism as an "epistemology that foregrounds the social construction of knowledge through interactive teaching and learning activities in the classroom." Alanazi (2016) states that constructivism is a theory that was founded by Jean Piaget and is "considered one of the most influential constructivist theories in education" (p. 1). In support, Vygosky's (1978) social constructivist theory believes that learners' cognitive development and attitude are moulded by the social environment in which they live. In other words, learners' cognitive development and attitude can affect their achievements and performance in whatsoever way. Thus, social constructivism is a theory of knowledge (epistemology) that examines how learners learn by actively developing and constructing their knowledge to enable them to achieve and understand the real world.

The Social Constructivist Epistemology Theory is filtered through the researcher's lens in relation to the teaching and learning of Natural Science using authentic learning activities in science classrooms. The SCET emphasises the significance of how learners construct knowledge to understand and view the real world outside the science classrooms (Shumba et al., 2012). The theory stresses the importance of learners' thinking and focuses more on learning and creating meaning than the teaching and presentation of information (Andrews, 2012). According to Shumba, Ndofirepi, and Gwiragi (2012), SCET is about how "knowledge is constructed in the mind of the learners" (p. 14).

The core expression of SCET is that teaching learners using authentic learning activities, enables them to construct and understand the real meaning of new information and concepts of science presented to them (Mutekwe et al., 2013; Shumba et al., 2012). It is important to mention that social constructivism emphasises that learners should actively participate in the authentic teaching and learning process and play an active role than their teachers. Therefore, in teaching Natural Science, learners are expected to actively participate in the lessons only when authentic learning activities are used. In actual fact, social constructivism focuses on three aspects, namely; learn, knowledge and reality (Galbin, 2014; Mogashoa, 2014). This implies that in authentic science classrooms, learners are encouraged to actively participate in learning of science concepts in order to acquire and construct knowledge in their mind as they learn. Thereafter, learners would be able to transform and apply the learnt knowledge into reality beyond science classrooms.

For the learners to learn better and understand the concepts of science presented to them well, they should be taught properly with the appropriate teaching and learning activities. Making use of authentic learning activities in science classes enables learners to think deeply as they are allowed to create meaning and construct knowledge within their mind. With authentic learning activities, learners are expected to connect the real meaning of the objects used in the science class during the lesson presentation with what they mostly see in the real world. In tune with the constructivist theory, the use of authentic learning activities allow learners to be active in their learning and provide them with higher order thinking skills (Oguz, 2008) that enables them to positively change their attitude towards their learning. The use of authentic learning activities in schools must be strongly supported as it offers learners opportunities to create knowledge to become life-long learners with lasting knowledge-based meanings and understandings of the reality and the natural world. Moreover, use of authentic activities also allows teachers to plan their teaching activities more effectively and positively.

2.3 The characteristics of authentic learning environment in relation to practical work

The meaning of authentic learning is defined in chapter 1, section 1.1.1. Authentic learning prepares learners for life outside the school (Pearce, 2016). Therefore, authentic work should equip learners with essential life skills and provide them with abilities to fully engage in their own learning that require them to solve real-life problems beyond the school (Du & Han, 2016; Iucua & Marina, 2014; Kuuskorpi, 2014). The teaching of Natural Science as a subject also requires practical work unlike the teaching of social and/or language subjects. According to Koller, Olufsen, Stojanovska, and Petrusevski (2015), practical work refers to "any type of science teaching and learning activity in which learners, work either individually or in small groups, are involved in manipulating and/or observing real objects and materials as opposed to virtual objects and materials as those obtained from digital video disc, a computer simulation, or even from a text-based account" (p. 87). It is quite interesting to note that learners can be involved in observing real objects which are authentic. Therefore, it is important to teach Natural Science in an authentic learning environment that draws learners' attention. In this case, the researcher refers to the word 'environment' as a 'classroom' or 'laboratory' where science teaching and learning mostly take place. Scholtz (2007) outlines nine characteristics of an authentic learning environment. According to Scholtz (2007), an authentic learning environment should:

- provide authentic contexts that reflect the way knowledge will be used in real life;
- provide authentic activities;
- provide access to expert performances and the modelling of processes;
- provide multiple roles and perspectives;
- support collaborative construction of knowledge;
- provide reflection to enable abstraction to be formed;
- provide articulation to enable tacit knowledge to be made explicit;
- provide coaching and scaffolding by the teacher at critical times; and
- provide for authentic assessment of learning within the tasks (p. 44).

Considering the characteristics outlined above, it means that authentic learning environment plays an important role in teaching and learning of Natural Science concepts as compared to practical work. Practical work is also referred to as ‘laboratory work’ or ‘field work’ where most of the observations and measurements of real objects normally take place compared to ‘authentic work’ (Millar, 2015). Millar (2015) further states that practical work is necessary in science teaching as it develops the learners’ “understanding of science concepts and explanations” (p. 11).

Jokiranta (2014) highlights three main objectives of practical work in science, namely:

- to help learners develop their knowledge of the world and their understanding of some of the main ideas, theories and models that science uses to explain it;

- to help learners learn how to use some piece(s) of scientific apparatus and/or to follow some standard scientific procedure(s); and
- to develop learners' understanding of the scientific approach to enquiry (e.g. of how to design an investigation, assess and evaluate the data, process the data to draw conclusions, evaluate the confidence with which these can be asserted) (p. 2).

From the above objectives, one can easily notice that practical work is not interchangeable with authentic activities although both aim to encourage teachers to make Natural Science interesting (Needham, 2014) and help learners to develop their knowledge in order to understand scientific concepts. However, authentic activities provide learners with abilities and skills that enable them to solve real-world problems that affect the society during classroom practice and beyond school.

2.4 Components of authentic learning activities

The most common components of authentic learning activities in Natural Science pedagogy involve real world problems; learners' open-ended inquiry, thinking skills and metacognition; learners' engagement in the discourse and social learning in their communities and learners' enhancement through making right choices that direct their own learning into relevant project work (Rule, 2006). Knobloch (2003) identify three components of authentic learning, namely: construction of knowledge, disciplined inquiry and value beyond the school.

Construction of knowledge promotes learners' higher-order thinking to acquire deeper learning to solve problems (Iucua & Marina, 2014). Disciplined inquiry engages learners in cognitive work that involves in-depth understanding of prior knowledge and integration (Ilter & Kilic, 2015). Value beyond the school refers to the communicated, performed or acted knowledge to deal with everyday issues such as economical and industrial problems that have meaning to the real world after school (Frey, Schmitt, & Allen, 2012). It is important to teach Natural Science by engaging learners into authentic learning components that enhance their cognitive skills to think deeper when solving real problems in real contexts.

2.5 Characteristics of authentic learning activities

According to Lombardi (2007)**,** there are ten characteristics that can be considered as a useful checklist to guide science teachers when using authentic learning activities during teaching and learning process that reflect the real world. The researchers Collins, (2011); Har, (2013); Lau, (2011); Reeves, Herrington, & Oliver, (2002) found that each authentic learning activity should be well applied in teaching and learning process and should have the following characteristics: real-world relevance; provide ill-defined problems; comprise complex tasks; require examination of tasks from multiple perspectives and roles; provide opportunity to collaborate; provide opportunity to reflect; can be integrated and applied across different subject areas; are seamlessly integrated with assessment; create polished products; and allow competing solutions and diverse outcomes. The detailed explanation of each characteristic is given below.

2.5.1 Authentic activities have real-world relevance

Authentic learning activities are prepared equally and practically with the real-world situation rather than simply de-contextualised and/or classroom-based activities (Nasab, 2015). This implies that learners are taught with authentic learning activities that are prepared with the aim of reaching and creating tangible, meaningful and useful outcomes. As a result, the outcomes are easily accessed and shared with the society and therefore, learners as the products of the authentic learning activities are viewed as significant and useful to enable them to address the challenges that the society is confronted with which are relevant to the real-world (Simpson, 2016). This implies that when authentic learning activities are relevance to the real-world, this seems to positively influence the learners' attitude towards Natural Science as learners contextualise what they are taught and put the same into perspective.

2.5.2 Authentic activities provide clarity to ill-defined problems

The ill-defined problems refer to the science tasks and/or activities that are not clearly defined and/or that lack some degree of self-exploration. Therefore, authentic learning activities preparing learners to define and explain the tasks and sub-tasks needed to complete the activity openly by using various interpretations rather than bounded to the simply existing set of rules (Herrebosch, 2016). The use of authentic learning activities equips learners to discover their own abilities and uniqueness in solving problems. As a result, learners would be achieving and completing the major activities rather than only carrying out the minor activities in the journey of their life-long learning (Nasab, 2015). For this study, this means that authentic learning activities have a positive effect on the learners as they encourage other learners to develop a sense of common understanding that enables them to solve critical problems amicably in their life-long learning (Simpson 2016), and this seems to positively influence learners' attitude towards Natural Science.

2.5.3 Authentic activities are comprised of complex tasks to be investigated by learners

Authentic learning activities are numerous and equal to a significant amount of time provided for their completion (Jan, Agostinho, & Rees, 2007). According to Reeves, Herrington, and Oliver (2002), this means that the authentic activities that are given to the learners should be complex and require ample time allocation, for example: days, weeks and/or months rather than minutes or hours to complete. It is important to note that authentic learning activities should be challenging and require significant investment of time and intellectual resources (Simpson, 2016). Moreover, authentic learning activities require learners to do some quite intensive research and use their thinking capacities to finalise the given activities and/or projects. When learners are provided with the opportunity to investigate complex tasks, it means that learners would better understand science concepts that lead to better performance in Natural Science.

2.5.4 Authentic activities require examination of tasks from multiple perspectives and roles

Authentic learning activities provide learners in the Natural Science classes with the opportunity to examine and scrutinise the tasks from different theoretical and practical perspectives using a variety of resources (Reeves et al., 2002). The use of authentic learning activities requires learners to use different roles that are applicable to them for a broader perspective and well explained context rather than allowing them to use a limited number of resources that provided them with irrelevant and inappropriate evidence (Simpson, 2016). This characteristic enables Natural Science learners to examine the authentic learning activities from various angles and roles. Then, learners would be able to make the right decision and provide concrete and relevant solutions.

2.5.5 Authentic activities provide the opportunity to collaborate

Authentic learning activities provide Natural Science learners with opportunities to integrate with each other and participate in completing the task both inside the classroom and beyond the school environment (Har, 2013). The use of authentic activities enables Natural Science learners to work together as a team to tackle the task rather than work on the task as an individual learner. Collaboration in authentic environment gives Natural Science learners opportunities to motivate each other to think critically (Simpson, 2016), conceptualising ideas and acting together as a team to find agreeable solutions.

2.5.6 Authentic activities provide the opportunity to reflect

Authentic learning activities are enhancing Natural Science learners to make proper choices and reflect on their learning experiences both individually and socially (Collins, 2011). The use of authentic learning activities provide Natural Science learners with an opportunity to reflect on the knowledge and skills that they will have acquired in an authentic environment and share them with their peers and the community they serve (Simpson, 2016).

2.5.7 Authentic activities can be integrated and applied across different subject areas

Authentic learning activities encourage Natural Science learners to co-operate the learned content across with the contents of other subject areas and lead them to the desire outcomes beyond the specific learning objectives (Kinash, 2015). The use of authentic learning activities allow Natural Science learners to use their acquired subject knowledge and integrate them with other different subject areas of interest rather than apply them in a single well-defined field or domain of learning (Simpson 2016).

2.5.8 Authentic activities are seamlessly integrated with assessment

Authentic learning activities should contain learners' assessment activities that reflect how the quality of tasks is judged within and based on the real world rather than deploy artificial assessment (Abedi, 2010). The use of authentic learning activities in Natural Science classroom must also be integrated with authentic assessments that reflect the real world (Simpson, 2016).

2.5.9 Authentic activities create polished products

Authentic learning activities provide Natural Science learners with an opportunity to demonstrate certain relevant skills that they acquire to create and/or prepare a valuable end-product rather than an unfinished product that cannot stand on its own (Sparks, 2013). The use of authentic learning activities enable Natural Science learners to create something new (original) and useful to an extent that later it can be presented to the real world (Simpson, 2016).

2.5.10 Authentic activities allow competing solutions and a diversity of outcomes

Authentic learning activities allow Natural Science learners to provide a variety of outcomes that require many answers rather than a one right answer generated from the way of rote learning (Scott, 2015). The use of authentic learning activities give Natural Science learners the opportunity to compete for solutions with other learners by using their diversity of outcomes in a meaningful manner than provide/accept one solution.

In addition to the characteristics of authentic learning activities discussed above, Herrington (as cited in Lau, 2011. P.4) provides the characteristics that authentic learning environment should have, namely: "an authentic context that reflects the ways knowledge is used in real world; authentic activities; access to expert performances and modelling of process; multiple roles and perspectives; collaborative construction of knowledge, reflection, articulation, coaching and scaffolding; and authentic assessment." Be that as it may, it means that when the authentic learning environment is well-organised and authentic learning activities are well-planned, learners' performance in Natural Science and their attitude towards the subject is likely to be positively improved (Simpson, 2016).

2.6 Types of authenticity to consider during teaching and learning process

It makes sense to emphasise that authentic activities are needed in the teaching and learning process since they help Natural Science learners to connect the learning environment with the real world. Authentic activities help Natural Science learners to understand the complexity of the real world outside the classroom (Hui & Koplin, 2011). Similarly, Iucua and Marina (2014) state that "authenticity in teaching involves features such as being genuine, becoming more self-aware, being defined by one's self rather than by others' expectations, bringing parts of oneself into interaction with learners" (p. 414). According to Breen, (as cited in Al Azri and Al-Rashdi, 2014, p. 250), there are four types of authenticity one could consider when intent to use authentic activities in teaching and learning process. These are:

- text authenticity,
- learner authenticity,
- task authenticity, and
- classroom authenticity.

Below is the detailed explanation of each of the abovementioned type of authenticity.

Text authenticity: According to Al Azri and Al-Rashdi (2014), the authenticity of text refers to the qualities of the texts or writings that are used in the teaching and learning process. The context in which the Natural Science concepts are taught and/or learned must present originality as a mean of quality source of information that aims to help learners to acquire conceptual understanding authentically (Herrebosch, 2016).

Learner authenticity: The authenticity of learners refers to the “ability of learners to interpret the meaning present in the text just like the native speakers do in the real world” (Al Azri & Al-Rashdi, 2014, p. 250). For instance, when Natural Science learners are taught authentic texts and clearly understand the real meaning of science concepts during the class practice, then these learners can demonstrate and apply their learned conceptual understanding practically in the real world.

Task authenticity: The authenticity of the tasks refers to the tasks or activities that are well-chosen by the teachers and are meaningful to the learners (Iucua & Marina, 2014). The well-chosen activities should enhance and promote Natural Science learners’ participation to enable them to use authentic language during their learning.

Classroom authenticity: The authenticity of the classroom refers to the way the Natural Science classroom is set up. It is crucial to teach learners science concepts in an authentic learning classroom (Ilter & Kilic, 2015). Authentic Natural Science classrooms should contain the real science work and/or displays that attract learners’ attention and stimulate their thinking capacities. As such, it enables learners to experience and learn Natural Science content much better as that will serve them beyond the classroom.

2.7 Pedagogical strategies that support authentic learning towards self-directed learning at primary level

In order for the teaching and learning process to be effective in every Natural Science classroom, teachers should apply appropriate pedagogical strategies that promote learners’ conceptual understanding and critical thinking. Dabbagh and Bannan-Ritland, (as cited in Hodgkinson-Williams and Deacon, 2013), classified pedagogical strategies into three broad categories that teachers need to apply when teaching learners using authentic learning activities. The three pedagogical strategies are shown in Figure 1 and they are: exploratory strategies, dialogical strategies and supportive strategies.

Exploratory strategies are defined by Barufaldi (2009) as learning “approaches to teaching and learning that encourage learners to examine and investigate new material with the purpose of discovering relationships between existing background knowledge and unfamiliar content and concepts” (p. 1). According to Hodgkinson-Williams and Deacon (2013), these strategies help learners to enhance their self-directed learning. Knowles (as cited in Hew, Law, Wan, Lee, and Kwok, 2016, p. 679) defines self-directed learning as a “learning process in which learners take the initial responsibility for their learning by diagnosing their own learning needs, setting or formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes”.

According to Kan’an and Osman (2015), self-directed learning is the learning that “occurs in one’s daily life experiences and it is very essential for survival” (p. 791). Self-directed learning is essential for learners’ survival in the sense that it transforms learners from being passive to being active learners. In brief, self-directed learning is a process of self-transferring knowledge, a way of teaching learners to teach themselves through a self-continuous teaching and learning process rather than depending on their teachers.

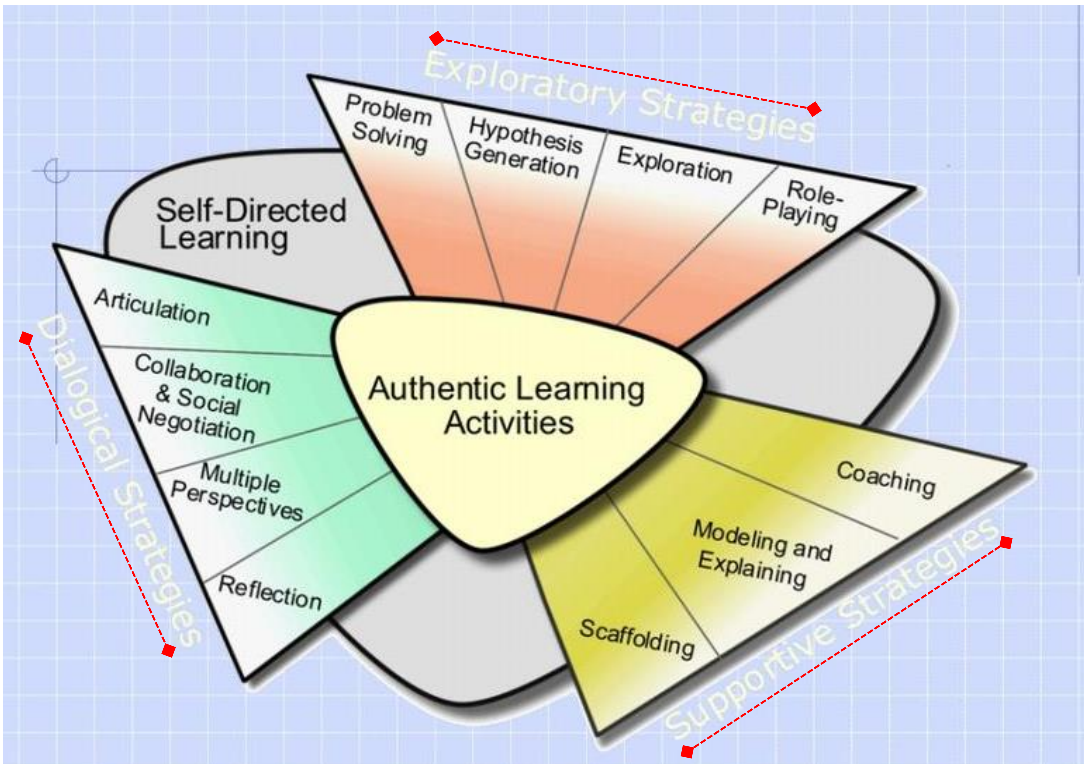

Figure 1: Pedagogical strategies that support authentic learning activities towards self-direct learning (Adopted from Dabbagh, 2005, p. 16).

The three pedagogical strategies that were proposed by Dabbagh and Bannan-Ritland, as cited in Hodgkinson-Williams and Deacon (2013) are discussed below with reference to how they can be applied in Natural Science classroom using authentic learning activities.

2.7.1 Supportive strategies

With supportive strategies, learners are equipped with the knowledge of scaffolding, modelling, explaining and coaching. As shown in Figure 1, modelling and explaining are combined. This is to ensure that when Natural Science teachers teach using authentic learning activities, learners are able to learn and reflect on their academic achievements and see whether they have understood what teachers taught them (Kan'an & Osman, 2015). For this reason, supportive strategy also informs the learners on whether or not to improve their academic achievements.

In most cases, there are some learners in Natural Science classrooms who come from different societies with different prior knowledge, experiences and understanding of learning science (Festile, 2017). Therefore, the supportive strategies seem to be the suitable ways of supporting these learners to acquire sufficient cognitive scaffolding (Hodgkinson-Williams & Deacon, 2013). According to Hodgkinson-Williams and Deacon (2013), the use of a supportive strategy in Natural Science classrooms helps learners to accommodate each other in the learning process and develop their understanding to enable them to engage deeply with science concepts. In addition, a supportive strategy enables learners to explain science concepts to each other and participate more in supporting others when learning science concepts with respect, empathy and compassionate (Stamp, 2016).

2.7.2 Exploratory strategies

Exploratory strategies are the approaches that encourage learners to undertake individual thinking and accommodate each other's ideas when investigating a Natural Science problem (Murphy, 2015). However, in teaching Natural Science, exploratory strategy allows learners to be involved in problem solving, hypothesis generation, exploring and playing the role in a critical and constructive manner (Hodgkinson-Williams & Deacon, 2013; Sedova, Sedlacek, & Svaricek, 2016).

2.7.3 Dialogical strategies

Dialogical pedagogy strategy is a dialogue between teachers and learners by means of communication as "to acquire and share ideas" (Doucet, 2015, p. 23). Lehesvuori (2013) defined dialogical strategy as "interactions where learners ask questions, comment on ideas that emerge in lessons, explain and state points of view, and are given more time for thinking" (p. 23). Similarly, Jay et al. (2017) describe dialogical pedagogy as a "dialogue through which learners learn to reason, discuss, argue, and explain in order to develop their higher order thinking as well as their articulacy" (p. 4). Hodgkinson-Williams and Deacon (2013) state that dialogical strategy is a conversation that enables learners to articulate, reflect, acknowledge multiple perspectives, collaborate and discuss the subject content learned in the classroom with the teachers. Dialogical strategy is therefore an approach which involves talking between the teacher and the learners in the Natural Science classroom, mostly when using authentic learning activities.

In Natural Science teaching, dialogical strategy creates an authentic teaching and learning environment whereby learners' prior knowledge is assessed in accordance with their current understanding of science concepts for the meaningful learning of science (Lehesvuori, 2013). Lehesvuori, Ratinen, Kulhomaki, Lappi, and Viiri (2011) provide the essential characteristics of dialogical teaching and briefly describe them as follows:

- *collective:* teacher and learners jointly participate in the learning as a group or as a class;
- *reciprocal:* teacher and learners listen to each other, share ideas and consider alternative views;
- *supportive:* learners can present their ideas freely without fear of being wrong;
- *cumulative:* teacher and learners develop their ideas, jointly constructing knowledge; and
- *purposeful:* the teacher plans and guides the discourse paying attention to educational goals in addition to the above (p. 142).

Since primary education is developed to lay a foundation of a child's education development, it "needs to be as strong as possible" (Banu, 2011, p. 3) so that learners will cope well with their studies at secondary and tertiary levels. Therefore, the notion of engaging learners in authentic learning activities at early grades should be advocated and encouraged (Machluf, Gelbart, Ben-Dor, & Yarden, 2017).

In a Natural Science classroom, learners should be exposed to authentic learning activities that create space to integrate learners' everyday experiences with the scientific processes during teaching and learning processes (Meyer & Crawford, 2011). In so doing, authentic learning activities allow learners to “solve complex and real-world problems through integration of scientific knowledge” (Machluf et al., 2017, p. 146). The integration of scientific knowledge in Natural Science pedagogy enables learners to apply and connect their learned school science to their everyday life science at an early stage of their education.

At primary school level, authentic pedagogy strategies encourage real life-long learning that allows Natural Science learners to participate in their own learning where their voices can be heard while the Natural Science teachers only facilitate the learning process (Christmas, 2014). According to Tortop (2013, p. 62), teaching science to the learners using authentic activities while at primary education level allows them to “apply science to daily life and motivate learners to investigate and increase their knowledge about science”. By exposing Natural Science learners to scientific and authentic learning activities at the primary schooling stage of their education, might positively change their attitude towards science and are likely to improve their achievements.

2.8 Types of authentic learning practices

The quality of teaching and learning process of any school subject is only realised when the teachers and learners participate in an authentic learning environment in which authentic learning activities are carried out. Morales (2015) identifies seven authentic learning practices that learners need to participate in. According to Morales (2015), learners should participate in simulation-based learning; learner-created media; inquiry-based learning activities; peer-based evaluation; working with remote instruments; working with research data; and reflecting and documenting achievements. Each of these learning practices is discussed below.

2.8.1 Simulation-based learning

In an authentic learning classroom, learners are required to practice simulation-based learning that energises them to actively and freely participate in authentic decision-making responsibilities (Lombardi, 2007; Morales, 2015). According to Morales (2015), simulation-based learning "helps in developing valuable communication, collaboration, and leadership skills that would help the learners to succeed as professionals in their fields of studying" (p. 7). This implies that in stimulation-based learning, Natural Science learners should be exposed to complex authentic learning activities in which learners are required to actively participate and simplify the given activities to provide positive feedback. In so doing, it increases the learners' understanding of science concepts and also improves learners' thinking and communication skills. When learners understand science content and are able to think and communicate scientifically, they also tend to succeed and do well in Natural Science.

2.8.2 Learner-created media

One of the benefits that learners gain when participating in learner-created media is that it enables them to use different types of technologies and programs when they engage in science projects (Lombardi, 2007). In addition, learners' may improve their "reading comprehension, writing skills and their abilities to plan, analyse, and interpret results as they progress" with their learning through learner-created media (Morales, 2015, p. 7). This implies that in learner-created media, Natural Science learners are expected to actively participate in designing and finishing authentic and viable science projects that add value to the learners' real life situations both while they are in school and after school.

2.8.3 Inquiry-based learning activities

In this type of authentic learning practice, the learners are introduced to key concepts, and certain skills while the teacher observes the learners' progress and makes sure that learners are on the right track and understand what is going on and provides feedback (Lombardi, 2007; Morales, 2015). In inquiry-based learning activities, the Natural Science teacher facilitates the learning process. Inquiry-based learning activities enable Natural Science teachers to ask learners questions that stimulate their thinking capacity on how to go about to solve the problem under investigation (Sedova et al., 2016).

2.8.4 Peer-based evaluation

The peer-based evaluation provides learners with an opportunity to analyse and critique other classmates' written activities and provide constructive criticisms and positive feedback based on what they have assessed (Morales, 2015). In so doing, Natural Science learners are equipped with knowledge and skills on how to approach certain issues in their own societies and how to address and solve them.

2.8.5 Working with remote instruments

Natural Science learners should be taught how to work with authentic remote instruments to enable them to interpret the results at an early stage. To engage learners in working with remote instruments, learners are expected to interpret and apply the studied theory into practice by improvising appropriate but authentic learning materials during their theoretical learning process (Morales, 2015). This means that in working with remote instruments, Natural Science learners produce evidence-based (actual) results using authentic learning materials and also interpret and present them in the same manner as if they were in the real laboratory set up. In so doing, this enhances the learners' conceptual understanding that leads them to improve their academic performance and also positively influence their attitude towards Natural Science.

2.8.6 Working with research data

Exposing learners to working with research data as part of authentic learning practice allows them to use their own collected data or data that were collected by other learners to conduct their own studies (Surr, Loney, Goldston, Rasmussen, & Anderson, 2016). This practice encourages Natural Science learners to carry out scientific research by investigating the real problem that subsequently provides real results that can be analysed, interpreted, discussed and published (Morales, 2015). During the process of authentic learning or at the end, Natural Science learners may gain new knowledge and/or clear understanding of what needs to be observed; how to conduct the research, get the results, discuss the results and publish them.

2.8.7 Reflecting and documenting achievements

In this authentic practice, Natural Science learners are encouraged to share their science projects to enable them to judge and review their learning achievements so that they can improve their performances (Lombardi, 2007; Morales, 2015). Learners are also expected to take a record of their work which they were engaged in during authentic learning process and document them. In so doing, it helps them to retrieve their work when they need them and reflect back to them in order to improve their future projects. This denotes that reflecting and documenting achievements as an authentic learning practice helps and encourages Natural Science learners to reflect on their own performance throughout the learning process (Iucua & Marina, 2014). For the learners to perform better through the authentic learning process, they need teachers to play their roles as discussed in the next section.

2.9 Teachers' roles in an authentic science classroom

In an authentic Natural Science classroom, a teacher is not necessarily there to teach and/or talk while learners are listening and paying attention to them (Rafi, 2015), but merely to try to provide learners with meaningful real-life learning knowledge (Christmas, 2014). Moreover, the teacher's role in the authentic Natural Science classroom is to facilitate and guide the learning process (Christmas, 2014). In authentic Natural Science classrooms, learners take responsibility for their learning that reflects the real-world and requires them to know real objects and engage in authentic learning activities rather than engaging in rote learning activities (Iucua & Marina, 2014).

According to Iucua and Marina (2014), teachers need to “create the authentic tasks that provide learners with reasons and rationales for learning” (p. 411). Iucua and Marina’s sentiments suggest that science teachers should create authentic learning environments that encourage learners to think critically, reason scientifically and explore the real-world independently (Lau, 2011). Clough (as cited in Wilcox, Clough, and Kruse, (2015) identifies the crucial roles of teachers when teaching science through authentic scientific inquiry. According to Clough (as cited in Wilcox et al., 2015, p. 63), “science teachers should:

- structure and scaffold activities so that learners must access and employ previously studied science ideas;
- ask questions that spark ideas and reduce learners frustration;
- use materials and equipment that are no more complex than necessary scaffold to more complex materials when needed;
- require learners to apply science reasoning to problems;
- make learners responsible for communicating their laboratory work in a clear manner;
- have learners make decisions and assess progress;
- refrain from summative evaluations of learners’ ideas and interpretations; and
- encourage learners to collaborate with one another in their decision making.”

The above-mentioned roles for teachers are some of the various functions that Natural Science teachers need to apply in Natural Science classrooms when teaching authentically. In the end, the learners’ scientific skills and knowledge are developed

(Magaji & Sa'eed, 2017). Overall, teachers in authentic Natural Science classrooms should make sure that learners are proactive and use hands-on activities during the teaching and learning process.

2.10 Learners' roles in an authentic science classroom

In order to prepare learners for the real world, teachers need the teach learners to understand the real meaning of the universe in an authentic science classroom. In an authentic Natural Science classroom, learners should fully participate and engage in meaningful activities that interact with their own environment and that of the outside world (Christmas, 2014). Learners should use learning materials that stimulate their conceptual understanding and relate to their own real life experiences (Herrington & Herrington, 2008; Kovač & Kovač, 2011). Learners fully participate in their learning activities, monitor their learning progress and take responsibility for their own learning with the assistance of their teachers as facilitators (Rafi, 2015). During the learning process, Natural Science learners should engage in hands-on activities that encourage them to think critically and solve real-world problems logically.

2.11 Skills developed when engaging in authentic learning classroom

According to Parker, Maor, and Herrington (2013), using authentic learning approaches in science classrooms "help foster critical skills such as critical thinking and problem solving" within the learners (p. 237). In the same vein, Morales (2015) identifies the skills that learners can develop while participating in an authentic learning environment. These skills include:

- judging the validity and reliability of new information;
- flexibly work across disciplines and cultural boundaries to develop creative solutions to the problem under investigation;
- through practice, learners will develop patience to follow and complete more complex problems; and
- develop the ability to recognize relative patterns in unfamiliar contexts (p. 3).

From the above-listed skills, it can be noted that authentic learning 'activities' and 'environment' are important in teaching Natural Science as they help to empower learners with relevant skills to solve complex 'social issues' and 'academic problems'.

2.12 Moving towards authentic learning for the 21st century

The notion of teaching Natural Science to enable learners cope with 21st century technologies is supported by Neo et al. (2012) who state that "moving into 21st century teaching, more relevant, authentic and applied teaching and learning strategies need to be incorporated into learning environments to innovate the learner learning process" (p. 50). Therefore, teaching and learning Natural Science for the 21st century requires learners to learn by doing Natural Science rather than listening to the teacher lecturing about Natural Science. According to Lombardi (2007, p. 1) "learning-by-doing is generally considered as the most effective way to learn". By moving towards authentic learning, teachers need to acquire skills on how to manage teaching and learning resources and control the Natural Science classroom. In so doing, authentic learning enables teaching and learning activities to take place in terms of reviewing and refining them (see Figure 2). Figure 2 shows that the real-world project-based activities play a crucial role in achieving authentic learning education for the 21st century as they encourage learners to solve real-world problems.

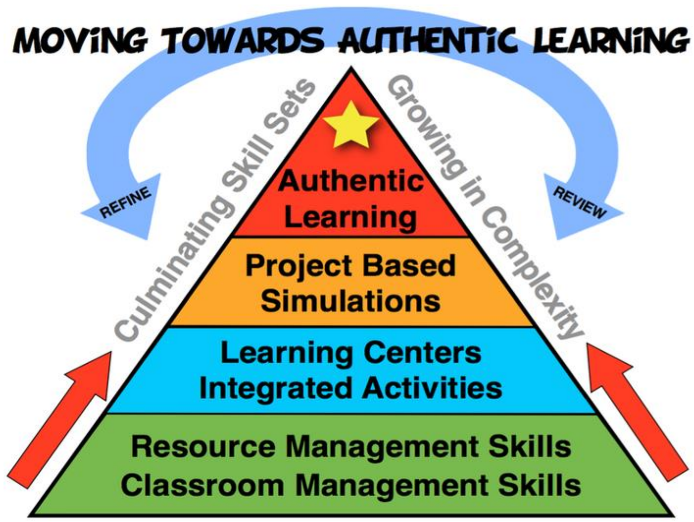

Figure 2: Hierarchy of instructional skills development towards the 21st century (Adopted from Revington, 2016, para. 17).

Figure 2 demonstrates that for the teachers to use authentic learning activities in the teaching and learning process optimally, they require a complex set of skills set (Revington, 2016). This means that Natural Science teachers need to know and/or master the resources (materials) they would use and understand how they work. Natural Science teachers also need to have some management skills to enable them to manage the classes and facilitate learners when using authentic learning activities. Figure 2 illustrates further that teachers should integrate learner-centred activities focus on project-based stimulation in which learners would acquire knowledge and skills over an extended period of time through investigation as a response to authenticity (Parker, Maor, & Herrington, 2013).

Since the 21st century is a technology based era, Natural Science teachers should therefore link their pedagogies with learners' needs through technologies in order to "construct more interactive, engaging and learner-centred environments that promote the 21st century skills and encourage self-directed learning" (Parker et al., 2013, p. 227). According to Parker et al. (2013), the use of real-world activities supported by latest technologies is likely to change the learners' attitude towards Natural Science as they learn better and improve the quality of education for the 21st century.

One can suggests that Figure 2 makes sense as it shows that moving towards authentic learning for the 21st century aligns well with the needs of today's participatory learners (Lombardi, 2007). Lombardi (as cited in Iucua and Marina, 2014) introduced the basic elements of an authentic learning experience that focuses on teaching authentic learning for the 21st century. These basic elements are:

- instructors are encouraged to design activities for their learners that match as nearly as possible the real-world tasks of professionals in the field;
- the challenges learners are asked to undertake should be complex, ambiguous, and multifaceted in nature, requiring sustained investigation;
- reflection, self-assessment, and performance review are fully integrated into the exercise. The real-world challenge comes with its own criteria for success. Learners

are held accountable for achieving the milestones that practitioners would have to meet under genuine working conditions;

- teamwork is as essential to the authentic learning experience as it is likely to be in modern workplace settings. Groups of learners have to draw on multiple sources and negotiate among multiple perspectives - including those of the stakeholders (business partners, clients, customers, citizens) who will be impacted by their performance; and
- an authentic learning exercise highlights a learner's capacity to affect the world beyond the classroom and to make contributions that are valued by peers, mentors, and prospective employers (p. 411).

In the light of these elements, Natural Science learners are encouraged to work as a team in order to assist each other in completion of given tasks. In so doing, learners empower themselves to be successful employers or employees who can contribute positively to the real-world's demands beyond the classroom.

2.13 Importance of authentic learning activities in science pedagogy

According to Al Azri and Al-Rashdi (2014, p. 249), "authentic activities are the most important activities a teacher can and must use in class in order to make his/her teaching go smoothly and be effective in transmitting the necessary knowledge to all learners". Authentic learning activities are important in teaching Natural Science as they help learners to become more active inside and beyond the classroom environment (Kuuskorpi, 2014). This means that applying authentic learning activities promote learners' critical thinking and so that they become more proactive when they engage in any platform where they can discuss and interact with each other socially and/or academically.

Through authentic learning activities, learners acquire scientific concepts and knowledge-based understanding in a meaningful way (Frey et al., 2012). In addition, it develops learners' thinking skills through scientific inquiries that enable them to be effective life-long and knowledgeable learners (Rule, 2006). Therefore, employing authentic learning activities in teaching Natural Science may positively contribute to the learners' thinking and scientific skills that they will apply in their life.

Fernandez (2017, p. 3) reiterates that "there is a need to introduce authenticity in science instruction, in the sense that learners must be engaged in work that parallels the work of the professional scientific community". For authenticity to be effective and possible, Natural Science teachers must be knowledgeable and skilled in how to implement and facilitate the authentic learning activities in the teaching and learning of Natural Science. Therefore, the well facilitated authentic learning activities tend to encourage learners to like Natural Science, as a result the learners' academic achievements are likely to improve.

2.14 Teaching science concepts for authentic learning towards scientific inquiry

Teaching Natural Science for conceptual understanding requires authentic learning activities that enable learners to be proactive in their learning. Teaching science concepts authenticity in Natural Science classrooms should involve group activities rather than using textbooks only that leads to rote learning.

According to Mehta and Kulshrestha (2014), today's science teaching "should not only serve the academic purpose but also develop social and cooperative skills that enable learners to withstand against all oddities and challenges being faced by them beyond school" (p. 2). Therefore, teaching Natural Science for authentic learning enables learners to "meet the demands and face the challenges ahead of them at working environment when they start working" (Mehta & Kulshrestha, 2014, p. 1). Importantly, teaching science concepts authentically improve learners' understanding of a subject matter, promote their academic achievements and develop learners' positive attitude towards learning Natural Science (Lacap, 2015; Newell, Tharp, Vogt, Moreno, & Zientek, 2015). Similarly, teaching science concepts for authentic learning boosts learners' feelings and confidence as they work in groups; and it's through group discussions that learners are able to clarify and understand the science concepts and help each other in the learning process (Altun, 2015; Mehta & Kulshrestha, 2014). This means that through teaching science concepts for authentic learning, it enables learners to take responsibility of their own learning by solving real-world problems and making right decisions.

According to Warner and Myers (2017), teaching science for conceptual understanding should focus on questioning, critical thinking and problem-solving. In so doing, this might help Natural Science learners to develop the necessary skills that will help them become successful, active and lifelong learners in the classroom and outside.

Speaking of teaching science towards authentic scientific inquiry, Waight and Abd-El-Khalick (2011, p. 38) state that authentic scientific inquiry entails “enacting and replicating scientific practice in the science classroom”. This notion fosters collaboration and greater participation of learners in Natural Science classrooms for acquisition of deeper conceptual and scientific understanding. Roth, as cited in Yang, Park, Shin, and Lim (2017) describe authentic scientific inquiry as the “activities that scientists practice every day” (p. 3937). For scientists to practice their activities on a daily basis, they need to fully understand the elements of scientific inquiry.

According to Yang et al. (2017, p. 3937), the elements of scientific inquiry are: “skills of scientific inquiry; knowledge about scientific inquiry; and an educational approach for teaching science contents”. Therefore, learners should be taught Natural Science using authentic learning activities in order for them to possess skills and scientific knowledge that enable them to reason scientifically and think critically (Lau, 2011; Moodley & Aronstam, 2016; Yang, Park, Shin, & Lim, 2017; Warner & Myers, 2017) to become future scientists. On the contrary, teaching Natural Science through authentic scientific inquiry hinders teaching and learning processes.

Wilcox et al. (2015) outline seven common myths that hinder teaching and learning processes that enable learners to acquire scientific skills and knowledge when teachers teach them science concepts. The seven myths according to Wilcox et al. (2015) are:

- teaching science through authentic scientific inquiry means learners discover science ideas on their own;
- teaching science through authentic scientific inquiry is achieved merely through hands-on activities;
- teaching science through authentic scientific inquiry is chaotic;
- teaching science through authentic scientific inquiry is not an efficient use of time;
- teaching science through authentic scientific inquiry is only for some learners;
- teaching science through authentic scientific inquiry can't be used to teach advanced science concepts; and
- teaching science through authentic scientific inquiry does not promote college and career readiness (p. 63–65).

In the light of the outlined myths above, it is important to encourage and motivate Natural Science teachers to apply authentic scientific inquiry strategies when teaching science in order to reject such misconceptions (Adofo, 2017). Overall, teaching Natural Science through authentic scientific inquiry enables Natural Science teachers to facilitate authentic activities through teaching and learning process while learners take full responsibility for their own learning.

2.15 Authentic assessment of learners' learning

According to Mueller (2016, p. 2), authentic assessment is a "form of assessment in which learners are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills". Similarly, Gulikers, Bastiaens, and Kirschner (2014) define authentic assessment as an "assessment that requires learners to demonstrate the same competencies, or combinations of knowledge, skills and attitude, that they need to practice in their professional life" (p. 5).

In spite of the given definitions above, the focus remains on the fact that assessment is only authentic when it "directly examines learners' performance on worthy intellectual tasks as they appear in real-life" (Otchoun, 2010, p. 40). It is also noteworthy to state that in authentic assessment, learners are assessed according to specific setup criteria (rubrics) that they should know in advance. However, it should be noted that learners are not only assessed on the information they will have acquired during the teaching and learning process, but also through their conceptual understanding and scientific application of essential knowledge and skills in learning Natural Science.

Trow (2002) conducted a research on the effects of authentic assessment in elementary school science in Washington Township, New Jersey and found that authentic assessment has positive effects on the learners and teachers since it "improved learners' performance; encouraged learners to accept the need for and value for the questions; created opportunity for the learners to express their ideas in a more open format; and guided teachers to make positive changes in their instructional and assessment choices" (p. 24–25).

It is important to stress that authentic assessment encourages learners not to fear their teachers as they mostly work side-by-side with them when assessing and evaluating their learning activities (Neufeld, 1994; Trow, 2002). This concludes that teachers are not only using authentic assessment to assess learners' performance in real contexts but also to evaluate learners' knowledge, skills and attitude which are very crucial goals in any science curriculum (Azim, 2012). Therefore, Natural Science teachers should assess and evaluate learners' learning activities authentically and assist learners where necessary to enable them to perform better in the subject.

2.16 The proposed four-domain model for teaching and learning science using authentic learning activities

Before independence, the Namibian education system was predominantly teacher-centred (Amakali, 2017), whereby teachers were actively involved in the teaching while learners passively and exclusively listened to the teachers (Rafi, 2015). In 1993, three years after independence, Namibia embraced the idea of Learner Centred Education (LCE) approach. This is an "approach to teaching and learning that comes directly from the National Goals of *equity* (fairness) and *democracy* (participation)" (Ministry of Basic Education, Sport and Culture, as cited in Kapenda, 2007, p. 200). Since then, many workshops and trainings have been conducted to encourage teachers to make use of LCE in their daily teachings. Some aspects of the LCE approach are that: learners are expected to participate in group work; apply their knowledge in meaningful ways and bridge the gap between what they learned in the classroom and the real world (Kapenda, 2007; Ministry of Basic Education, Sport and Culture, 1999).

According to Kapenda (2007), the LCE approach "is a very old concept in the education setting…, its origin could be traced back to 4th and 5th century during the work of Greek and Chinese philosophers, such as Socrates and Confucius respectively" (p. 199). In order to meet the challenges of the 21st century, the Namibian education system should be changed and/or reformed in terms of its teaching and learning approaches so as to address these challenges, learners' needs and expectations. Considering the discussion on the Social Constructivist Epistemology

Theory in relation to this study and what the study has established the four-domain model as the appropriate and effective model which should be used when one intends to use authentic learning activities in teaching and learning science. The model addresses four key domains which are: Critical-thinking (C), Problem-solving (P), Scientific-inquiry (S), and Real-world (R) (CPSR model).

The CPSR model promotes learners' active participation in learning science concepts in order to acquire and construct knowledge in their minds as they learn. With the CPSR model, learners would clearly understand science concepts, apply the acquired knowledge and view the real world outside the science classrooms. Therefore, the use of authentic learning activities in schools should be advocated as it enhances learners' conceptual understanding and provide them with the real meaning of science concepts.

The CPSR model is specifically designed for the teaching and learning of Natural Science using authentic learning activities in classrooms; that is, inquiry-based learning activities (Ilter & Kilic, 2015).

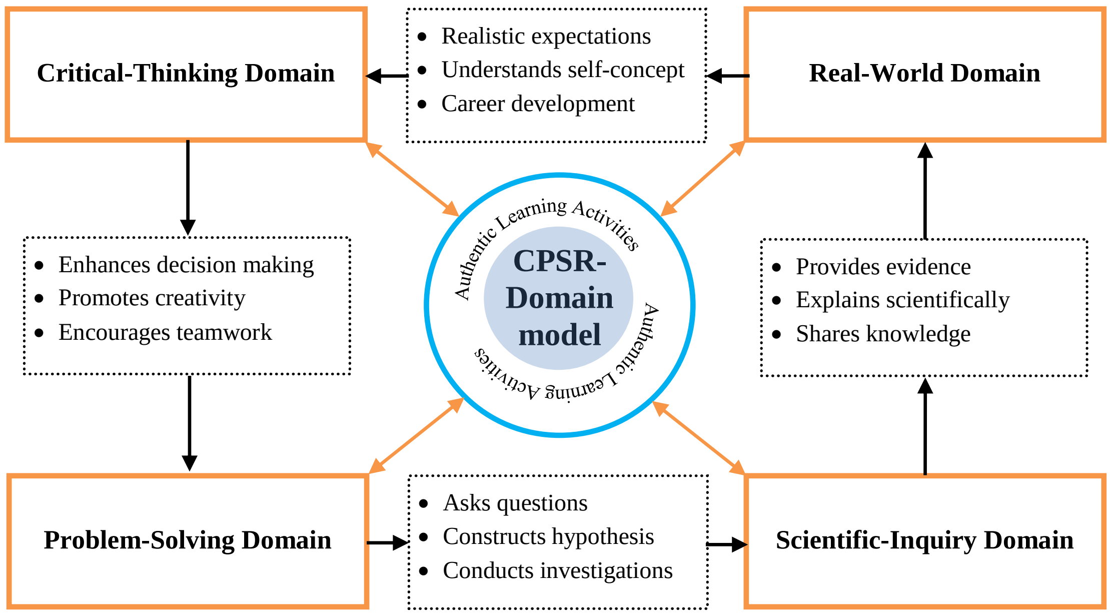

Figure 3: The CPSR model for teaching and learning science using authentic learning activities

The following is a detailed explanation of how important each domain of the proposed CPSR model is to the learners during the teaching and learning of science concepts using authentic learning activities.

- ***Critical-thinking domain***

In education, critical thinking "is seen as an important competency for academic and career success" (Halim & Mokhtar, 2015, p. 1). According to Liu, as cited in Halim and Mokhtar (2015), critical thinking is one of the higher order thinking skills that plays a central role in problem solving. Similarly, Christmas (2014) suggests that critical thinking is the reflective thinking which is “the ability and tendency to gather, evaluate and use information effectively” (p. 55). In critical thinking, learners acquire skills to conceptualise, apply, analyse, synthesise, and/or evaluate information generated by observing, experiencing, reflecting, reasoning or communicating (Kahlke & White, 2013). The use of authentic learning activities in the critical thinking domain equips learners to make good decisions, promotes learners’ creativity, and encourages leaners to think critically and work freely in a team.

- ***Problem-solving domain***

Problem-solving is an ongoing process that provides learners with opportunities to use their newly acquired knowledge in meaningful and real-life activities (Fredericks, 2005). In addition, problem solving is regarded as an approach that develops learners’ higher order thinking skills, such as summarising, analysing and making inferences and deductions during their learning time (Carr, 2007). In other words, learners need to acquire higher levels of thinking in order to enable them to overcome their daily obstacles by generating hypotheses and testing these hypotheses to arrive at satisfactory solutions. The use of authentic learning activities in the problem-solving domain encourages learners to ask questions, equip learners to construct hypotheses, and inspire learners to conduct investigations with a view to get solutions.

- ***Scientific-inquiry domain***

Scientific-inquiry refers to the ability that learners possess to think and act when asking questions, conducting investigations using suitable instruments and techniques to collect data (Lederman et al., 2014). Similarly, scientific inquiry refers to the activities through which learners develop their knowledge and understanding of scientific ideas to enable them think critically and logically about the relationships between evidence and explanations to communicate, reason and argue scientifically (Moe, 2011; Nargund-Joshi & Liu, 2013). In other words, scientific inquiry is the cornerstone of how learners learn and understand the natural world through conducting scientific investigations. The use of authentic learning activities in scientific-inquiry domain promotes learners to provide evidence-based results, explain their findings scientifically, and share their knowledge with peers systematically.

- ***Real-world domain***

Real-world domain is perceived as the foreseen opportunity that learners should prepare for. During the teaching and learning process, learners should apply their acquired knowledge to learn through doing, to realise their learning abilities to adapt and change their lifestyle, and to form the habits required to perform successfully in their lives beyond school (Pearce, 2016). According to Scott (2015), *real-world* refers to the learning that actively facilitates and engages learners to use classroom-based knowledge and skills to address the challenges beyond school.

Therefore, the use of authentic learning activities in real-world domain inspires learners to make realistic expectations, awaken learners to understand self-concept, and enable learners to choose the right careers. In other words, authentic learning activities equip learners with necessary life skills that enable them to connect to the real-life situations and provide learners with problem solving skills that they should use during their professional and entire personal lives after school.

2.17 Summary

In this chapter, the relevant works based on the SCET's theory were reviewed. The chapter also discussed several aspects that are crucial and related to the teaching and learning of Natural Science using authentic learning activities in class. The aspects include the types of authenticities, pedagogical strategies that support authentic learning activities, skills to be developed when engaging in authentic learning and teaching science towards authentic scientific inquiry for the 21st century. The appropriate and effective model that should be used when one intends to use authentic learning activities in teaching and learning science was also proposed and discussed. In the next chapter, the researcher describes the research methodology and procedures used to collect data from the participants for this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This section outlines the methodology that this study used. It discusses the research approaches and design, the population and sample and how the participants were selected. It further explains the research instruments and procedures that were used to collect data and discusses the data analysis procedures and research ethics adopted for this study.

In many cases, the use of ‘research design’ and ‘research approach’ creates confusion when learners, researchers and scholars try to interpret the two concepts. This study also attempts to provide clear definitions and make a distinction between the two mentioned concepts.

3.2 Research design

Joseph (2011) defines research design as a “blueprint for conducting a study that increases the probability that the study findings are a true reflection of reality” (p. 22). Anney (2014) indicates that if a study is conducted without a research design(s) its findings will not be trustworthy because the study will not have addressed the critical and real issues investigated by the research question(s). Williams (2007) states that a research design is a strategy of inquiry used to conduct studies for qualitative, quantitative and mixed research approaches which are meant to address specific research questions. In the same vein, Creswell (2014) describes a research design as a type of inquiry within the qualitative, quantitative, and mixed methods approaches that provide specific direction for procedures in a research design.

According to Durrheim (as cited in Mafuwane, 2011), research designs are “strategic frameworks for action that serve as a bridge between research questions and the execution, or implementation of research strategy” (p. 68). A research design is what the researchers use during investigations in order to facilitate the most valid and accurate possible answers to research questions (Gustafsson, 2017). The researcher believes that the research designs are research techniques that normally guide researchers on how and what to use to conduct inquiries in order to answer the research questions. In this study, two research designs namely: the case study and the quasi-experimental designs were used and are discussed in detail below.

3.2.1 Case study design

A case study is one of the most frequently used strategies in qualitative research although it is not completely understood by some researchers (Gustafsson, 2017). Yin (as cited in Hollweck 2015) defines a case study as “an empirical inquiry that investigates a contemporary phenomenon (the ‘case’) in depth and within its real-world context” (p 109). The current study used a case study design to gain an in-depth understanding of what Grade 7 learners in the experimental group thought about the effects of authentic learning activities during teaching and learning of Natural Science.

The case study was found to suit this study because it is “an intensive, holistic description and analysis of a bounded phenomenon such as a program, an institution, a person, a process, or a social unit” (Merriam cited in Yazan, 2015, p. 148). In this case study, the authentic learning activities as an intervention program was used during the teaching and learning process and its effect on achievements and attitude towards Natural Science among Grade 7 learners was assessed.

A case study allowed the researcher to solicit learners’ views on the effect of authentic learning activities through semi-structured interviews. Yin (2014) and Merriam and Tisdell (2015) views of a case study concur with the views of Hyett, Kenny, and Dickson-Swift (2014) who argue that a case study is “an investigation and analysis of a single or collective case, intended to capture the complexity of the object of the study” (p. 2). In other words, a case study aims to explore the real-life context in contemporary and/or multiple bounded systems in-depth over a period of time.

3.2.1.1 Advantages and disadvantages of case study design

A case study is a research method used in both qualitative and quantitative research. A case study design has many benefits in research, some of which are that it focuses on real-life situation(s) and tests the participants’ views directly in relation to phenomena as they unfold in practice (Hietala, 2017). It provides a detailed analysis and relevant data in the individual case and plays an important part in advancing a field’s knowledge base (Krusenvik, 2016). In addition, a case study design provides insight and illuminates meanings that expand the readers' experiences and investigates casual processes in the real-world rather than in artificially created settings (Starman, 2013).

A case study design does not only focus on real-world situation, but it also handles and combines multiple kinds of data collection methods such as documents, interviews, questionnaires and observations (Vissak, 2010). According to Widdowson (2011), a case study design is useful for both generating and testing hypotheses and it has higher internal validity. Moreover, a case study is an appropriate research design to use when the researcher tends to seek answers to descriptive or explanatory questions. In this study, the questions were based on how the Grade 7 learners view the use of authentic learning activities related to a lesson on electricity which the researcher taught them.

A case Study does not only consist of benefits, but it has limitations as well. According to Raeburn, Schmied, Hungerford, and Cleary (2015), a case study lacks scientific credibility, therefore its findings also lack generalisation and researchers can lack discipline as they sometimes allow detailed descriptions and illustrative quotes to dominate their findings. Hietala (2017) asserts that with a case study, it is difficult to assess confidential data as the interviewee may not be totally honest and it is time-, money- and labour-intensive and it often causes much stress. Raeburn et al. (2015) indicate that case studies have been criticised as unappreciated and underutilised methods of data collection and their results are considered to be weak, soft, feminine and unscientific.

Furthermore, it was also found that it is difficult to publish a case study paper in certain top journals as it is considered to contain bias towards verification and lower external validity (Krusenvik, 2016). Again, the process of data analysis during case-writing is intuitive, primitive and unmanageable in any rational sense which leads to unreliable and invalid conclusions (Vissak, 2010). In other words, findings from case studies may be too long, too detailed and/or too involved for busy policymakers and practitioners to read and use (Hietala, 2017; Krusenvik, 2016). Similarly, it is also important to mention that collecting and analysing the case study data are highly labour-intensive activities even to the skilled researchers (Raeburn, Schmied, Hungerford, & Cleary, 2015).

3.2.2 Quasi-experimental design

Nugent (2013) defines a quasi-experimental design as an experiment in which participants in the study are assigned to either control groups or experimental groups in a non-random manner. The pre-test and post-test non-equivalent control group design was used in this study (Creswell, 2014; Page, 2012) to pre-test the learners' knowledge of electricity then post-test them to determine the effect of authentic learning activities intervention. According to Krebs (2013), a quasi-experimental design is a "study in which the treatment cannot be applied at random to the experimental units" (p. 459). In order to determine the effects of authentic learning activities on learners' achievements in Natural Science, the quasi-experimental design was used as it involved the selection of two groups in which learners' achievements were tested and there were no random selection involved in the process of assigning individuals to groups.

In quasi-experimental design, the researcher can manipulate the independent variables but cannot randomly assign subjects to control and experimental groups (Vargas, Duff, & Faber, 2017). Levy and Ellis (2011) assert that the quasi-experimental design is also "known as 'field-experiment' or 'in-situ experiment' and is a type of experimental design in which the researcher has limited leverage and control over the selection of study participants" (p. 155). This implies that in the quasi-experimental design, the experiment can take place on site with the researcher observing the participants to determine the effects of the authentic learning activities.

3.2.2.1 Advantages and disadvantages of quasi-experimental design

The quasi-experimental design is useful in generating results for general trends especially where pre-selection and randomisation of groups is often difficult (Shuttleworth, 2008). This design is not only useful in generating results but it also "offers opportunities to study the effectiveness of interventions implemented at scale in real-world settings" (Bor, Geldsetzer, Venkataramani, & Bärnighausen, 2015, p. 497). It can also be often carried out using existing data and it tests causal hypotheses (Bor et al., 2015; White & Sabarwal, 2014). In this study, the two null hypotheses on learners' achievement scores and attitude were effectively tested to provide rich data as Levy and Ellis (2011) meant when they suggested that quasi-experiments provide rich data for the advancement of research.

The quasi-experimental design has weaknesses too. Dutra and Reis (2016) state that the quasi-experimental design "reduces potential for widespread, with less conclusive results; its validity is limited; and there is a great potential for bias" (p. 2235). In Quasi-experimental design, the researcher "does not control treatment assignment" (Bor et al., 2015, p. 497). This study aimed to collect quality data in determining the effects of authentic learning activities on achievements and attitude among Grade 7 learners towards Natural Science.

However, White and Sabarwal (2014) affirm that "lack of quality data is often a key barrier to using quasi-experimental methods" (p. 11). Therefore, the researcher had to ensure that he collected rich and quality data to avoid discrepancies that could lead to misinterpretations of the quasi-experimental design's results. Based on what White and Sabarwal (2014) affirmed, quasi-experiments also "lack control over extraneous variables generated by random allocation" (Holgado-Tello, Chacón-Moscoso, Sanduvete-Chaves, & Pérez-Gil, 2016, p. 1). It is for this reason that the researcher did not assign participants to groups randomly.

3.3 Research approach

Various researchers express or define a research approach in different ways. For example, Thomas (2010) indicates that a research approach is the master plan that directs how a research study is to be conducted in order to address given research problems. Other researchers such as Ponce and Pagán-Maldonado (2015) define a research approach as a "research plan that guides the researcher in conducting the study" (p. 118). MacMillan and Schumacher (as cited in Mafuwane, 2011) state that a research approach is a "plan for selecting subjects, research sites, and data collection procedures to answer the research question(s)" (p. 68). In the light of the above-given definitions of a research approach, one can safely state that a study can be undertaken and/or conducted using a qualitative, quantitative or mixed research approaches. This study used a mixed research approach (qualitative and quantitative); as such, it is appropriate to understand the meaning of a 'mixed research approach'.

3.3.1 Mixed research approach

A mixed method research approach is an approach of inquiry that combines both qualitative and quantitative forms of research (Creswell, 2014) in a single study (Gay, Mills, & Airasian, 2011). The researcher decided to undertake a mixed research approach as it gave him significant opportunities to gain a deeper understanding of the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners.

The use of a mixed research approach was more useful as compared to the use of a single research approach (Halcomb & Hickman, 2015). According to Creswell, Fetters, and Ivankova (as cited in Mafuwane, 2011), a mixed research approach is "more than simply collecting both qualitative and quantitative data; it implies that data are integrated, related, or mixed at some stage of the research process" (p. 70). Based on the above-mentioned meanings of a mixed research approach, Figure 4 shows seven steps that are involved in the process of conducting a mixed research approach study.

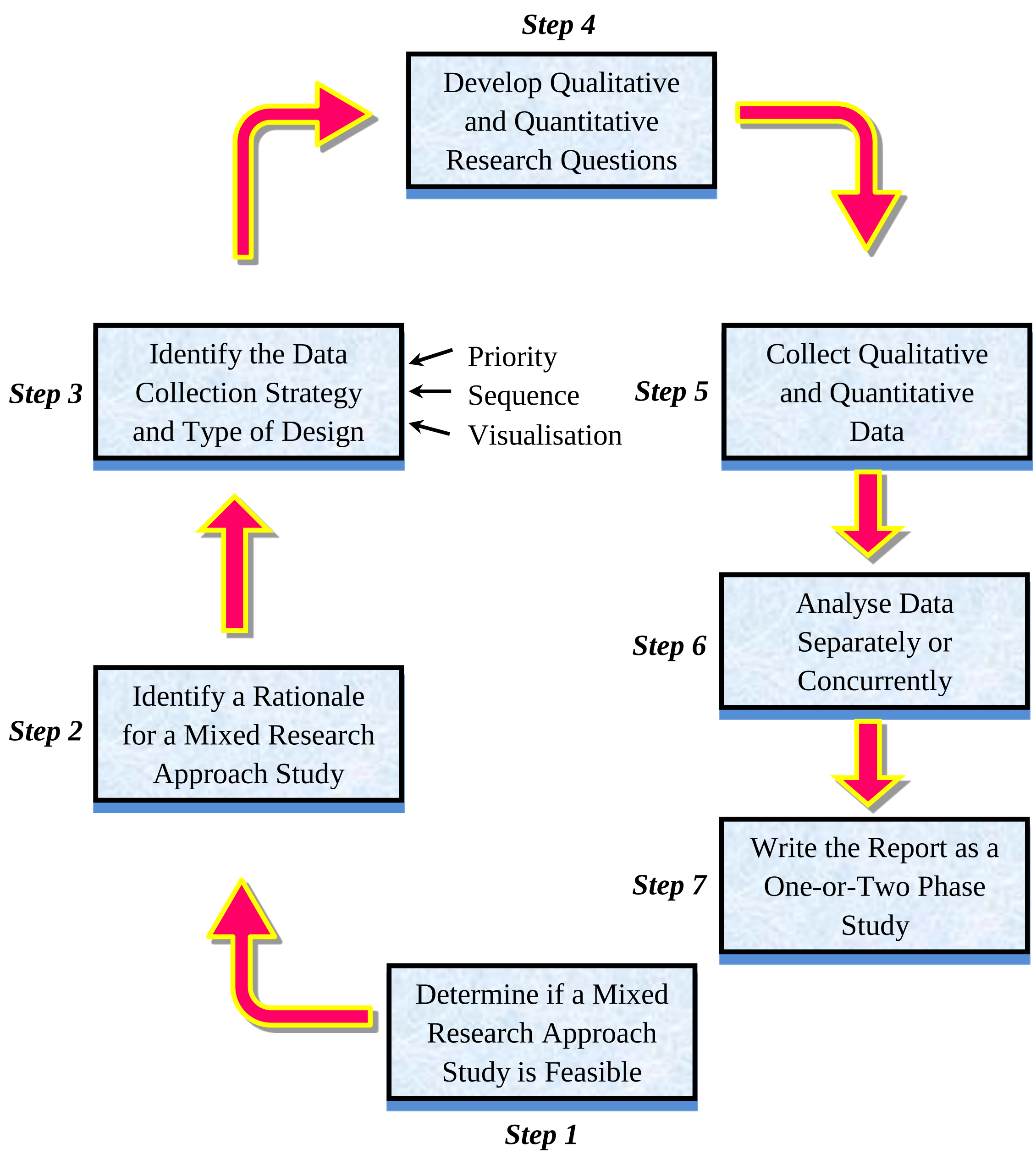

Figure 4. Steps in the process of conducting a mixed research approach study (Adapted from Mafuwane, 2011, p. 72)

The researcher conducted his study within the framework of the afore-illustrated Figure 4 in order to provide a holistic and comprehensive view of the issues being investigated.

3.3.1.1 Advantages and disadvantages of a mixed research approach

The researcher had the view that a mixed research study sought to collect comprehensive data and produce significant results other than make use of one research approach. Tashakkori and Teddlie (as cited in Malina, Nørreklit, and Selto, 2011) argue that a mixed research approach "enables the researcher to simultaneously answer confirmatory and exploratory questions, and therefore verify and generate theory in the same study" (p. 64). Similarly, the approach adds value to the study by increasing the validity in the findings, informing the collection of the second data source, and assisting with knowledge creation (McKim, 2017). The mixed research approach does not only increase validity in the findings, but it also gives a "voice to study participants and ensure that study findings are grounded in participants' experiences" as asserted by Wisdom and Creswell (2013, p. 3).

A mixed research approach requires a high level of skill to find points of intersection and discrepancies when analysing the data sources concurrently or in sequence; and considerable time and resources are needed in order to implement this approach in order to research comprehensively (Gay et al., 2011; Wisdom & Creswell, 2013). In other words, the researchers should possess the necessary knowledge and skills to master the full range of research techniques to enable them to use the mixed research approach (Gay et al., 2011). According to Wisdom and Creswell (2013), mixed methods studies are "complex to plan and conduct, as they require careful planning to describe all aspects of the research" (p. 4). As stated in section 3.3.1 a mixed research approach is a combination of qualitative and quantitative research methods, each research method is defined and discussed separately.

3.3.2 The qualitative research approach

Creswell (2014) defines a qualitative approach as a means through which individuals or groups use for exploring and understanding the meaning of individuals or groups ascribe to a social or human problem. Gay, Mills, and Airasian (2011) refer to the qualitative approach as the “collection, analysis, and interpretation of comprehensive narrative and visual (i.e. non-numerical) data to gain insights into a particular phenomenon of interest” (p. 7). According to Rahman (2017), the qualitative approach is a “type of research that produces findings that are not arrived at by statistical procedures or other means of quantification” (p. 103). Based on the descriptions given about qualitative research, the current study used the qualitative approach as part of the mixed research approach to collect primary descriptive, narrative and visual data (Creswell, 2014) and probe deeply to gain a clear understanding of the Grade 7 learners on “electricity” during investigation (Gay et al., 2011; Uugwanga, 2015). It was through the qualitative approach that the learners in experimental group were given opportunities to express their views on how they felt and experienced the practicality of being taught through authentic learning activities.

3.3.2.1 Advantages and disadvantages of the qualitative research approach

The researcher argues that the qualitative research approach gives opportunities to engage the participants in the study and allows for direct contact with them in order to have an exhaustive analysis on the phenomena being investigated. According to Rahman (2017), the qualitative research approach "produces the thick (detailed) description of participants' feelings, opinions, and experiences; and interprets the meanings of their actions" (p. 104). Rahman (2017) further states that the qualitative research approach has a "flexible structure as the design can be constructed and reconstructed to a greater extent" (p. 104). In term of scientific inquiry, the qualitative approach raises more issues through broad and open-ended inquiry for understanding behaviours of values, beliefs, and assumptions (Choy as cited by Salvador, 2016).

The qualitative research approach does not only guarantee some advantages, but it also has some disadvantages as well, as maintained by Silverman (as cited in Rahman, 2017) who urges that the qualitative research approach "sometimes leave out contextual sensitivities, and focuses more on meanings and experiences" (p. 104). Therefore, the results produced from a qualitative study may be given low credibility by policy-makers. In terms of analysing qualitative data, Flick (as cited in Rahman, 2017) states that "analyses of the cases take a considerable amount of time and one can generalise the results to the larger population in only a very limited way" (p. 105). The time-consumption involved in analysing a Case Study is mainly due to the process of coding, breaking down themes into categories and transcribing verbatim. In the same vein, Choy (as cited in Salvador, 2016) urges that using the qualitative research approach, is time-consuming even during the interviewing process and intensive categorising process, therefore, skilful interviewers are required.

3.3.3 The quantitative research approach

The quantitative research approach is used for testing objective theories by examining the relationship among variables (Creswell, 2014). Gay et al. (2011) refer to the quantitative approach as the "collection and analysis of numerical data to describe, explain, predict, or control the phenomenon of interest" (p. 7). According to Bryman (as cited in Rahman, 2017), the quantitative research approach is "a research strategy that emphasises quantification in the collection and analysis of data..." (p. 105). The researcher used the quantitative research approach to collect numerical data from learners in the experimental group. For numerical data collection, the questionnaires were deployed to find whether authentic learning activities had any influence on learners' attitude towards Natural Science.

3.3.3.1 Advantages and disadvantages of the quantitative research approach

In the quantitative research approach, a smaller sample of participants is normally pulled out from a larger population. Due to the larger sample, which is randomly selected, the quantitative research findings are likely to be generalised to a whole population or a sub-population (Pushkina, 2017; Rahman, 2017). The benefits of the quantitative research approach are not only important for generalising the findings but the use of the statistical software such as Statistical Package for Social Sciences (SPSS) in data analysis also means that there will be less time-consumption (Pushkina, 2017; Queirós, Faria, & Almeida, 2017; Rahman, 2017). In addition, the "employment of measuring variables can be emphasised as quantifiable results usually seem to be more objective" (Pushkina, 2017, p. 22). Another strength of the quantitative research approach was pointed out by

Choy (as cited in Salvador, 2016) who suggests that researchers can facilitate numerical data for groups and extents to which respondents either agree or disagree.

Rahman (2017), states that the "quantitative research paradigm overlooks the respondents' experiences and perspectives in highly controlled settings because there lacks a direct connection between researchers and the participants when collecting data" (p. 107). According to Pushkina (2017), the quantitative research approach "does not clarify deeper meanings and explanations and cannot account for how the social reality is shaped and maintained or how people interpret their actions and others" (p. 22). In other words, the quantitative research approach ignores an important human element (Pushkina, 2017) and lack of resources for a large scale research can stress the researchers (Choy, as cited in Salvador, 2016).

3.4 Population

Gay et al. (2011) define population as the "larger group from which the sample will be selected" (p. 113). Similarly, a population is "group of individuals' persons, objects or items from which samples are taken for measurement" (Mugo, 2002, p. 1). However, Best and Kahn (as cited in Simasiku, 2014) asserts that "a population is a group of individuals who have one or more characteristics in common that are of interest to the researcher" (p. 101).

The targeted population of this study consisted of seven hundred and sixteen (716) Grade 7 classes altogether (one hundred and eighty (180) classes in the Khomas region and five hundred and thirty-six (536) in the Omusati region) in the public senior primary schools offering Natural Science with twenty-one thousand four hundred and eighty (21 480) learners altogether; whereby five thousand four hundred (5 400) learners were in the Khomas region and sixteen thousand and eighty (16 080) learners were in the Omusati region.

3.5 Sample and sampling procedures

A sample is defined by Gay et al. (2011) as the "individuals selected from a population for a study" (p. 12). According to Mugo (2002), a sample is a "finite part of a statistical population whose properties are studied to gain information about the whole" (p. 1). On the other hand, a sampling procedure is defined by Al Kindy, Shah, and Jusoh (2016) as the "act, process or technique for selecting a sample to permit the researcher to collect smaller quantity of data that represents the overall population" (p. 896). In the same vein, Sharma (2017) suggests that sampling is a "technique (procedure or device) employed by a researcher to systematically select a relatively smaller of representative items or individuals (a subset) from a pre-defined population to serve as subjects (data source) for observation or experimentation as per objectives of his or her study" (p. 749).

For this study, sampling was a two-stage process. The first stage involved selection of four schools in each region. Then the second stage involved selection of one (1) Grade 7 class in each selected school. A sample of eight (8) Grade 7 Natural Science classes (four Grade 7 classes in the Khomas region and four classes in the Omusati region) were randomly selected from the targeted population. Two (2) Grade 7 Natural Science classes in the Khomas region were also randomly selected and used for piloting the research instruments and not for the main study. A total number of two hundred and twenty-one (221) learners participated in this study but only two hundred and thirteen (213) learners wrote both the pre- and post-tests. Eight (8) learners from the total number of two hundred and twenty-one (221) learners did not write both tests (they either wrote a pre-test or a post-test) but they attended Natural Science classes and completed the STAQ-R.

Therefore, the eight (8) learners were not part of the pre- and post-tests' results but they formed part of the STAQ-R's results. Then, from the total number of one hundred and twenty-four (124) learners in the experimental group twenty-two (22) learners were interviewed. Simple random sampling (Creswell, 2014) was also used to select four (4) schools per region (two (2) schools for experimental group and other two (2) schools for control group) but the leaners were not randomly assigned to groups. The criterion for the selected the schools was that these schools needed not to have been adjacent to one another to avoid the possibilities of data contamination. In this case, when two (2) schools were found to be adjacent to one another, simple random sampling with replacement was used.

Creswell (2014) defines simple random sampling as a procedure in quantitative research for selecting participants. It means that each individual has an equal probability of being selected from the population, ensuring that the sample will be representative of the population. Similarly, Gay et al. (2011) states that simple random sampling is the "process of selecting a sample in such a way that all individuals in the defined population have an equal and independent chance of selected for the sample" (p. 131).

3.5.1 Advantages and disadvantages of simple random sampling

Simple random sampling is easy to conduct; the strategy requires minimum knowledge of the population that is to be sampled (Gay et al., 2011). It provides a "fair way of selecting a sample from the given population since every member is given equal chance of being selected" (Sharma, 2017, p. 750). Since every member had an equal opportunity of being selected, the selection of the sample was unbiased and it was reasonable to generalise the results from the sample to the population of the study (Sharma, 2017).

Simple random sampling needs names of all population members. This may either over- or under-represent sample members, and it is difficult to reach all the selected in the sample (Gay et al., 2011; Sharma, 2017). According to Henderson (2015), simple random sampling often doesn't have a complete list of the population. In addition, not all the elements might be equally accessible, and it is possible, purely by chance to pick an unrepresentative sample.

3.6 Participants' demographic information

The participants' demographic information, their ages, gender, and the schools' profiles are presented below.

3.6.1 Ages of the learners in the control and experimental groups

Table 1 presents the number of the learners per age group in the control and experimental groups.

Table 1: Number of learners in the control and experimental groups by age group

Ages	Control Group		Experimental Group	
	Frequency	Percent	Frequency	Percent
10-12	5	5.2	7	5.6
13-15	88	90.7	107	86.3
16-18	4	4.1	10	8.1
Total	**97**	**100.0**	**124**	**100.0**

Table 1 indicates that the 13-15 years age group had eighty-eight (88) (90.7%) learners in the control group and one hundred and seven (107) (86.3%) learners in the experimental group. The 13-15 years age group had a higher number of learners compared to the 10-12 years and the 16-18 years age groups. Further, the 16-18 years age group had four (4) (4.1%) learners in the control group as compared to seven (7) (5.6%) in the experimental group.

3.6.2 Gender of the learners in the control and experimental groups

Table 2 provides the number of learners by gender in the experimental and control groups.

Table 2: Gender of the learners in the control and experimental groups

	Control Group		Experimental Group	
Sex	**Frequency**	**Percent**	**Frequency**	**Percent**
Male	45	46.4	69	55.6
Female	52	53.6	55	44.4
Total	**97**	**100.0**	**124**	**100.0**

As shown in Table 2, there were more female learners numbering fifty-two (52) (53.6%) in the control group than in the experimental group which had fifty-five (55) (44.4%). Overall, Table 2 indicates that there were one hundred and fourteen (114) (51.6%) male learners who participated in this study as compared to one hundred and seven (107) (48.4%) female counterparts.

3.6.3 Schools' profiles

Eight (8) schools participated in this study, namely; Schools C_1, C_2, X_1 and X_2 in the Khomas region and Schools C_3, C_4, X_3 and X_4 in the Omusati region. The X schools were the experimental schools while the C schools were the control schools. Table 3 shows the eight schools' profiles.

Table 3: Schools' profiles

School Name	Region	Range of Grades	Year Established	School Location	Number of HoDs	Number of Teachers	Number of Learners	Number of Classrooms	Number of Science Labs	Number of Science Kits
C_1	Khomas	0-7	1986	Urban	6	47	1458	38	0	1
C_2	Khomas	0-7	1969	Urban	5	48	1274	32	0	0
C_3	Omusati	1-7	1993	Rural	0	7	114	8	0	1
C_4	Omusati	0-7	1984	Rural	0	8	195	8	0	2
X_1	Khomas	0-7	1988	Urban	5	39	1416	41	0	2
X_2	Khomas	0-7	1999	Urban	4	36	1172	37	0	1
X_3	Omusati	1-7	1979	Rural	0	6	137	7	0	2
X_4	Omusati	0-7	1913	Semi	1	18	694	20	2	0

Table 3 shows that only school X_4 had two (2) science laboratories where learners were able to conduct science experiments. Schools C_1, C_3, C_4, X_1, X_2 and X_3 were in possession of science kits. School C_2 and school X_4 did not have any science kits. Science kits usually contain science apparatus and chemicals such as iron fillings, electrical circuit components, beakers, bromothymol blue solutions, test tubes, magnifying glasses, thermometers, sodium chloride, methylated spirit, copper sulphate, litmus paper and Bunsen burners. These apparatus were used when teaching and learning science concepts practically. All the schools had electricity. Teaching and learning science practically is an effective way of practicing science authentically.

3.6.4 Learners in the Khomas and Omusati regions

The study was undertaken in two regions, Khomas and Omusati. Table 4 shows the number of learners who participated in this study in each region. A total number of two hundred and twenty-one (221) learners (ninety-seven (97) in control group and one hundred and twenty-four (124) in experimental group) participated in this study but only two hundred and thirteen (213) learners wrote both the pre- and post-tests.

There were eight learners from the total number of two hundred and twenty-one (221) learners who only wrote either the pre-test or the post-test but attended Natural Science classes where the topic of electricity was taught using authentic learning activities and they also completed the Simpson Troost Attitude Questionnaire-Revised (STAQ-R). As a result, the eight (8) learners are neither part of the statistics shown in Table 4 nor part of the pre- and post-tests' results presented in Section 4.3. However, they formed part of the STAQ-R's results presented in Section 4.4. Then, from a total of one hundred and twenty-four (124) learners in the experimental group only twenty-two (22) learners were interviewed.

Table 4: Number of learners who wrote the pre-test and post-test by region (N= 213)

Region		Number of learners	Percent
	Khomas	125	58.7
	Omusati	88	41.3
	Total	**213**	**100.0**

Table 4 indicates that two hundred and thirteen (213) learners wrote the pre- and post-tests in this study. One hundred and twenty-five (125) learners (58.7%) were from the four (4) schools in the Khomas region whilst eighty-eight (88) learners (41.3%) were from the four (4) schools in the Omusati region.

3.6.5 Learners in the control and experimental groups

The schools and learners were split into control and experimental groups as indicated in Section 3.6.3. The total number of learners in the control and experimental groups are given in Table 5.

Table 5: Number of learners in the control and experimental groups (N= 221)

Group		Frequency	Percent
	Control	97	43.9
	Experimental	124	56.1
	Total	**221**	**100.0**

Table 5 shows that ninety-seven (97) (43.9%) of the learners were in the control group while one hundred and twenty-four (124) (56.1%) were in the experimental group. The control group had fewer learners because about half of the learners at school C_2 did not take part in the study because their parents/guardians did not grant permission for them to participate.

3.7 Research instruments

Eng (2013) defines research instruments as the tools that the researchers use to collect information (data) to answer his or her research question(s). In other words, research instruments are the measurement tools used to collect data on a topic of interest from the participants and/or respondents (Bastos, Duquia, González, Mesa, & Bonamigo, 2014). The questionnaires, semi-structured interviews and a pre- and post-tests are the research instruments that were used to collect data from the participants.

3.7.1 Questionnaires

Gay et al. (2011) defines a questionnaire as a "written collection of survey questions to be answered by a selected group of research participants" (p. 186). According to Malhotra (2009), a questionnaire is a "formalised set of questions for obtaining information from respondents" (p. 176). Malhotra's definition of a questionnaire is supported by Mcleod (2014) who said that a questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from the respondents. In other words, a questionnaire is a set of questions on a given topic that can be completed by an interviewer or by the person being asked the questions (Gbenga, 2015).

The Simpson Troost Attitude Questionnaire-Revised (STAQ-R) (Simpson & Troost, 1982) was adapted and given to all the learners in four experimental groups on the last (eighth) day of data collection at that particular group school. The aim of the STAQ-R was to find out whether authentic learning activities influence learners' attitude towards Natural Science. Each questionnaire had two sections. Section A asked learners' biographical information while section B had closed-ended items regarding the learners' attitude towards Natural Science. Each item had a five points Likert Scale (Strongly Disagree, Disagree, Undecided/Uncertain, Agree, Strongly Agree). The permission to use STAQ-R was granted by Professor Ronald D Simpson on 19th November 2016 (Appendices P and Q).

3.7.1.1 Advantages and disadvantages of questionnaires

Gbenga (2015) avers that questionnaires "are practical; large information can be collected from a large number of people in a short period of time; the results of questionnaires can be quickly and easily analysed through the use of a software; and quantitative data obtained through questionnaires can be used to create new theories" (p. 16). By collecting data through the use of questionnaires it means that respondents can respond anonymously, which may produce more honest answers (Bastos et al., 2014). In addition, Sansoni (2011) states that questionnaires are cheap to produce and administer; they can yield data not available by other means; and have high external validity if validated properly e.g. generalisability.

Some scholars do not prefer to use questionnaire during data collection simply because questionnaires require more time for delivering data to the statistics analyser software, processing and analysing information (Kalantari, Kalantari, & Maleki, 2011). According to Gbenga (2015), with questionnaires, it is “inadequate to understand some forms of information e.g. emotions, behaviour, attitude, etc.; it is difficult to determine the truthfulness of respondents; and it limits information gathering and expression of opinions” (p. 17). The response rates can be poor as people may lack the motivation to complete or return the questionnaires (Bastos et al., 2014). In addition, Sansoni (2011) states that questionnaires are often criticised because of the ‘crude’ level of measurement; they often never validate; and they can be fraught with bias unless they are well designed.

3.7.2 Semi-structured interviews

Alshenqueeti (2014) states that a semi-structured interview is a more flexible version of a structured interview that “allows depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the interviewee’s responses” (p. 40). A semi-structured interview is not only meant and known for face-to-face session, but it can “quickly produce rich and detailed data sets” (O’Keeffer, Buytaert, Mijic, Brozović, & Sinha, 2016, p. 1912) in an efficient and effective manner. A semi-structured interview is a form of data collection instrument which involves unstructured and generally open-ended questions that are few in number and intended to elicit views and opinions from the participants (Bastos et al., 2014; Creswell, 2014).

Based on the above-mentioned definitions, semi-structured interviews were used to conduct a 20–25 minutes face-to-face focus group interview with six (6) learners who were selected randomly from each experimental group per region to find out their views on authentic activities after being taught a topic on "electricity". The topic on "electricity" was chosen because it is broader, and learners were familiar with it. As it was, learners had quite reasonable background knowledge and ideas of what electricity was about, and during the interviews, they were able to express themselves on how they were taught the topic on electricity through authentic activities. The face-to-face focus group interview was conducted on the last (eighth) day of day collection after the learners had completed the STAQ-R.

3.7.2.1 Advantages and disadvantages of semi-structured interviews

According to Queirós, Faria, and Almeida (2017), semi-structured interviews are useful as they can be "adjusted to get detailed and insightful information on a given domain; need only fewer participants to provide useful and relevant insights; and can be performed in informal environments" (p. 379). Similarly, van Teijlingen (2014) indicates that semi-structured interviews are well suited for exploring attitude, values, beliefs, and motives; could be good in sensitive areas; non-verbal indicators assist in evaluating truthfulness / validity and urgency; facilitate getting every question answered; ensure the respondents are working on their own; and can potentially increase rate (p. 21). Keller and Conradin (2018) are of the opinion that semi-structured interviews' questions are prepared ahead of the interview session and this allows the interviewer to know what to ask prior to the interview, unlike conducting an interview without questions.

Semi-structured interviews do not only have strengths but have weaknesses as well, and according to Queirós et al. (2017), semi-structured interviews are "time-consuming and relatively costly; have longer verification process to extract compared information; the participants should be carefully chosen to avoid bias; and the results cannot be generalised" (p. 379).

In the same vein, van Teijlingen (2014) points out that when using semi-structured interviews, "the equivalence of meanings and difficulties may arise; preferred social response; non-response / particular groups being unrepresented; invasion of privacy; unique characteristics of interviewee; and prejudices, stereotypes, appearances and/or perceptions of researcher may alter response" (p. 22). Keller and Conradin (2018) state that semi-structured interviews need to be conducted by skilled researchers; they should be carefully planned to avoid prescriptive questions; and researchers should ensure confidentiality all the time.

3.7.3 Pre- and post-tests

Sunday and van Wyk (n.d.) define pre- and post-tests as a "measurement of the learning received during the research as a result of comparing what the researcher knew before in a pre-test and after the research experience in a post-test" (p. 12). The pre- and post-tests are widely used primarily for comparing groups and/or measuring change resulting from experimental treatments (Dimitrov & Rumrill, 2003).

The pre-test was used to test learners' existing knowledge of the topic of 'electricity' before they were taught about it and the post-test assessed learners' achievements on "electricity" after being taught using authentic learning activities as opposed to those who were exposed to traditional lectures. All learners were given the same pre-test to write on the first day of conducting the research at each school to test their existing knowledge level of the topic of 'electricity', followed by the interventions (experimental group received authentic learning activities and control group received traditional lectures) for five days and then the same post-test was given to the learners on the second last (seventh) day of conducting the research at each school to measure the effects of authentic learning activities on their achievements.

This means that the pre-test and the post-test was actually the same test that was administered to the two groups (experimental and control groups) at two different stages in the study. It should be noted that by using this practice, learners' performance on the post-test might actually be influenced by familiarity with the test due to the short interval between the two administrations. Both the pre-test and post-test and interventions were constructed, conducted and presented by the researcher.

3.7.3.1 Advantages and disadvantages of pre- and post-tests

McKirnan (2014) states that the pre-measure that assesses the baseline variable allows the researcher to assess the change within the groups being studied. In so doing, the researcher can find the matched pairs of participants or physical samples and assign each to different groups rather than using random assignment. In addition, the pre-measure also assesses whether the groups are equivalent at baseline or not (McKirnan, 2014). It allows the researchers to compare the measurement results of the dependant variable after and before the experimental treatment and take fair action (Dimitrov & Rumrill, 2003).

The measuring of the participants' pre and post knowledge of course-related concepts "provides valuable information that can be used to measure the participants' learning, suggest areas for teaching improvement, and improve course delivery"

(Simkins & Allen, 2000, p. 9). Simkins and Allen (2000) further argue that “it is quite flexible” to use pre- and post-test control group design and it can be used “in a wide variety of courses” (p. 8). Moreover, Bardenhorst (2014) emphasises that pre- and post-test “reduces the chances of spurious effect of confounding variables that may influence an effect of either dependant variable or independent variable” (p. 3).

According to McKirnan (2014), a pre- and post-test is “highly susceptible to confounds if using observed or self-selected groups” (p. 17). The pre- and post-test is time-consuming, costly and difficult to administer (Gouldthorpe & Israel, 2016; Harperin & Heath, 2017), as the solid instruments that assess participants’ knowledge have to be carefully developed.

The monitoring and assessment of the participants’ measurement process needs skilled researchers and the participants should be present during the whole process (Gouldthorpe & Israel, 2016). In the absence of the pairs of responses, whereby the pre-test is compared to the post-test, the “comparisons cannot be made, and the available data are reduced” (Gouldthorpe & Israel, 2016, p. 2). In other words, when there are missing or incomparable data, “it makes the pre-test and post-test comparison invalid” (Howard cited in Gouldthorpe & Israel, 2016, p. 2).

3.7.4 Intervention

The intervention or treatment was given to the experimental group by means of instruction. The authentic learning activities as the intervention program were used during the teaching and learning process. Two types of lessons (one lesson as a traditional lecture that was presented to the control group and another lesson involved authentic learning activities was presented to the experimental group) were prepared by the researcher each day in advance and were taught for five days. Authentic learning activities' lessons were focused on Natural Science topic of electricity. During the intervention, learners were exposed to the real simple electrical circuits with bulbs, conductor wires, switches and batteries unlike those in the control group.

Learners were also exposed to practical activities in which they practised how to connect the electrical circuit in series and parallel and after practice learners were then given a task to draw a complete electric circuit in parallel and in series using three cells, conductor wires, a switch and three bulbs. Thereafter, learners also observed how the two connections work and discussed it as part of group work activities. The researcher also presented the lessons using the posters to sum up and in conjunction with what was portrayed by the simple electrical circuits. In addition, learners were given summaries and homework based on the lessons presented. On day seven, the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners were assessed.

3.8 Pilot study

Gay et al. (2011) define a pilot study as a "small-scale trial of a study conducted before the full-scale study" (p. 121). Similarly, a pilot study can be defined as a "small study to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study" (Hassan, Schattner, & Mazza, 2006, p. 70). In other words, a pilot study is a mini version of a research that is normally conducted specifically to pre-test the research instruments for the main study (Dikko, 2016; Gumbo, 2014; van Teijlingen & Hundley, 2002).

A pilot test for this study was conducted at the two pilot schools in the Khomas region from 31st of August 2018 until 10th of September 2018. These pilot schools were not part of the sampled schools, but they had similar characteristics with those schools that participated in the main study (Simasiku, 2014). The research instruments that were tested are pre- and post-test items such as questionnaires and semi-structured interviews questions. The two simple electric circuits (one in series and one in parallel) that the researcher designed were also tested to see if they were working properly.

The pre- and post-tests items included 47 questions (45 multiple-choice questions weight 45 marks and two short questions weight 10 marks) for control and experimental learners was used to measure the learners' achievements on the "electricity" topic. In the pre- and post-test items, question number 2, 3, 14, 23, 31, 38, 39, 41 and 44 were found either vague, inappropriate, too difficult for the learners or not syllabus-related. Subsequently, these questions were refined in order to acquire the anticipated results. A questionnaire of 50 statements and semi-structured interview comprising 11 questions both for experimental learners on their attitude and views respectively were unchanged during the piloting of instruments.

For the topic 'simple electric circuits', some learners struggled to connect the electrical components together, while other learners were unable to see what was connected. It was due to the fact that the two boards that the researcher designed were too small, soft and of poor quality; the connecting wires were not properly fixed to the bulb holders; and the screw nuts used were a bit loose. Thereafter, the simple electrical circuits were improved as the researcher found bigger and stronger boards on which the screw nuts and connecting wires were also properly fixed. The main aim of conducting a pilot study first was to inform the researcher which questions needed to be refined, revised and rectified just to avoid bias and ambiguous items. The pilot test was conducted also in order to test the instruments for readability, validity and reliability (Gay et al., 2011).

3.8.1 Readability

Readability refers to the "ease with which a text or document can be read" (King & Burge, 2015, p. 1). Therefore, testing questions for readability, it means that the questions / items must be well understood by the outside readers (Janan & Wray, 2013). In simple words, readability is the process of matching the reader and the text, whether the reader can follow the arguments of/in the written text (Janan & Wray, 2013; Waller, 2011). Atvars (2017) and Crossley, Allen, and McNamara (2011) state that in order to determine the readability level of the research questions / written texts on whether they are easy or difficult to read, understand and/or match, the readability formulas can be used, although, these days there are "computer tools such as Coh-Metrix that can be used to objectively measure readability and other text characteristics" (Leander, 2016, p. 3).

According to Bailin and Grafstein as cited in Zamanian and Heydari (2012), readability formulas "can return a numerical score, giving the user the sense of knowing the precise level of difficulty of a text" (p. 50). Similarly, Leander (2016) asserts that "readability is a very convenient tool" and it is "very easy to apply to estimate the difficulty of" written texts (p. 4). Langeborg (2010) argue that readability formulas are "highly validated through many studies" and "they are also objective" (p. 5).

Zamanian and Heydari (2012) conducted a literature study on the readability of texts as a state of arts and found that readability formulas "consider only sentence length and word difficulty" (p. 47), and ignored the key aspects such as "cohesion, complexity of ideas and required schemata" (Zamanian & Heydari, 2012, p. 47). Furthermore, Zamanian and Heydari (2012) argue that readability formulas consistently do not measure the text comprehension, as a result, they "cannot prove to be valuable tools for producing, revising and selecting written materials" (p. 47). So, the readability of the research instruments of this study was tested under Section 3.8 in order to enable them to collect the desired results.

3.8.2 Validity

Validity is defined by Gay et al. (2011) in qualitative research, as the "degree to which qualitative data accurately gauge what we are trying to measure" (p. 391). Equally, Heale and Twycross (2015) define validity as the "extent to which a concept is accurately measured in a quantitative study" (p. 66). On the other hand, in quantitative, research, it refers to whether one can draw meaningful and useful inferences from scores on particular instruments (Creswell, 2014).

In other words, validity is the extent to which an instrument measures what it purports to measure (Bolarinwa, 2015). And if the instruments are not valid, then the results cannot be accurately interpreted and applied but only highly misleading (Faust, 2012). For this study, the researcher designed the interview questions and pre- and post-tests himself while the Simpson Troost Attitude Questionnaire-Revised (STAQ-R) was adapted and adjusted according to the nature of this study.

The researcher gave these research instruments to the supervisors, my colleague at work (senior researcher and a PhD holder) and the Senior Education Officer for Natural Science and Health Education to check the appropriateness and suitability of the items in order to maintain an audit trail for transparency (Newman, Lim, & Pineda, 2013). The researcher also gave the research instruments to his colleague who is a researcher to check if there was bias and any ambiguous items. After having received the research instruments from the reviewers, the corrections and adjustments were made to make sure that the research instruments would collect valid data as the researcher has anticipated.

3.8.3 Reliability

Gay et al. (2011) define reliability as the "degree to which a test consistently measures whatever it is measuring" (p. 164). According to Bolarinwa (2015), reliability is an extent to which a research instrument produces the same results on repeated trials. In other words, reliability refers to whether scores to items on an instrument are internally consistent, stable over time and whether there was consistency in test administration and scoring (Creswell, 2014).

To contextualise between validity and reliability, De Souza, Alexandre, and Ghirardelli (2017) raise important points in their argument when they assert that "an instrument that is not reliable cannot be valid; however, a reliable instrument, can, sometimes be invalid; thus, high reliability does not ensure an instrument's validity" (p. 4). In this study, the researcher valued and appreciated the comments and suggestions from reviewers. This was to ensure that if these research instruments would be used repeatedly to collect data for a similar study, the same results would be yielded.

3.9 Data collection procedures

Awaisu (2013) defines data collection as the "process by which the researcher collects information needed to answer research questions or problems" (p. 2). Patil and Yogi (2011) state that data collection is the "term used to describe a process of preparing and collecting data" (p. 263).

Before the researcher embarked on the data collection journey in the Khomas and Omusati Regions, he sought permission from the Executive Director (formerly known as Permanent Secretary) in the Ministry of Education, Arts and Culture and the two Regional Education Directors of the two regions involved in this study. Armed with permission from these officials, the researcher visited the participant schools and requested for permission to carry out this study. This was done in writing with the support of the approval letters from UNAM's Ethical Clearance Committee, the Office of the Executive Director of Ministry of Education, Arts and Culture, and the Regional Directors of Education in the two regions under study. At each school, the main purpose of the study was well explained to the school principals and the participants.

A pre-test of 40 minutes long was given to the learners at the eight schools for the main study. After the pre-test; the researcher taught learners at Schools C_1, C_2, X_1 and X_2 in the Khomas region and Schools C_3, C_4, X_3 and X_4 in Omusati region. At control groups (Schools C_1, C_2, C_3 and C_4), the researcher used the lecture methods; whilst at experimental groups (Schools X_1, X_2, X_3 and X_4), the researcher used authentic learning activities. Five lessons (one lesson per day) on the topic of 'electricity' of 40 minutes each per school were taught.

The topic of 'electricity' was chosen because this content is normally taught in the second term (the initial proposed time for data collection) as indicated in the Grade 7 scheme of work (Elphick & Machenzie, 2015). Unfortunately, the data collection was undertaken during the third term and only two schools (Schools C_1 and X_2) were found to have not taught the topic of 'electricity' in the second term and at these schools the researcher followed the normal timetable.

At Schools C_2, C_3, C_4, X_1, X_3 and X_4 they had already taught the topic of 'electricity' in the second term and an arrangement and agreement was made between the school principals, learners' parents/guardians, learners and the researchers for the researcher to teach the learners after school hours or during the afternoon study sessions. At Schools X_3 and X_4, the learners were taught during the slots for non-promotional subjects with the permission of the non-promotional subjects' teachers.

Although, the topic of 'electricity' was taught to the learners at some schools during the second term, the researcher acknowledged all the threats to the validity of the findings. This means that the findings from both schools were equally seen and treated through the same lens. It is worth noting that the schools that participated in this study were paired (e.g. C_1 with X_1; C_2 with X_2; C_3 with X_3 and C_4 with X_4) the during data collection period based on their analogous profiles. The aim of pairing the schools was not to compare them in any aspect but for logistics purposes such as the allocation of teaching time on the schools' timetable and the reduction of the researcher's travelling costs. However, these schools were not adjacent to each other, a scenario which prevented the possibilities of learners communicating with each other across the schools under study, a thing that might have led to data contamination. Learners in the paired schools wrote the pre-test on the same day. They were then taught the topic 'electricity' for five days and they wrote the post-test for a 40 minute duration on the same day. Then, learners' pre- and post-test papers were marked in order to compare their achievement scores.

On the last day of data collection, all the learners in the experimental group completed the STAQ-R to find out whether authentic learning activities influenced their attitude towards Natural Science. Thereafter, twenty-two learners from the experimental group were interviewed for about 20–25 minutes to investigate what they had to say about authentic activities. At Schools X_1 and X_2, learners were interviewed during their break time in their classes while at Schools X_3 and X_4, the interviews took place in the school library during the learners' free periods. A voice recorder was used to record the interviews in order to increase the validity and credibility of the study and also to avoid the possibility of biases during the transcription period (Kalu & Bwalya, 2017).

3.10 Data analysis

Marshall and Rossman (as cited in Vosloo, 2014) define data analysis as the "process of bringing order, structure and meaning to the mass of the collected data" (p. 355). Millers (2018), describes data analysis as the "process of inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, suggesting conclusions and supporting decision-making" (https://www.quora.com/What-are-the-steps-of-a-data-analysis-process).

The qualitative data from the interviews was transcribed verbatim to verify and increase its trustworthiness (Creswell, 2014; Gay et al., 2011). During the transcribing process, the researcher had to listen to the learners' voices on the voice recorder several times in order to get the gist and true message of what the learners were saying during the interviews. After transcription, thematic analysis was used to organise the text data into themes, broken down into categories, synthesised to get the similarities and differences and to find patterns (Creswell, 2014) to improve the trustworthiness of the research findings.

The quantitative data from questionnaires were analysed using the Statistical Package for Social Sciences (SPSS) (Version 25) in which a Chi-square test, exploratory factor analysis and t-test were run in order to find out if differences existed among the experimental and control groups. A Chi-square test was used to analyse the STAQ-R's data to count the frequency (%) of learners' responses regarding their attitude towards Natural Science after being taught on the topic of "electricity" using authentic learning activities.

The use of a Chi-square test in this study was only to count how many learners responded to each statement on a five point Likert Scale and not necessary to find out or test if there was a significance difference or there was no significant difference among the tested statements in the learners' responses in the four schools. The quantitative data from both pre- and post-tests' scores were analysed using a t-test to determine whether the learners' achievement scores from experimental and control groups were different at probability (*p*) level of 0.05. Exploratory factor analysis was used to cluster similar variables/items that were measuring learners' attitude into one factor.

3.10.1 Trustworthiness

Glaeser, Laibson, Scheinkman, and Soutter (1999) define trustworthiness as a "behaviour that increases the returns to people who trust you" (p. 3). Trustworthiness can also be referred to the "degree of confidence one has in the data" and overall findings (El Hussein, Jakubec, & Osuji, 2015, p. 1183). The trustworthiness of this study was established through credibility, confirmability, dependability and transferability during thematic analysis (Nowell, Norris, White, & Moules, 2017). The researcher organised the text data into themes so that they could be easily broken down into categories.

Furthermore, the synthetisation process was carried out in order to get the similarities and differences within the text data and to find patterns for better reporting. The report / presentation of the findings was written and given to the supervisors with the raw data to provide their expert review and verification. The aim was for the supervisors to see the authenticity of the report and/or whether all the key issues were addressed to answer the research objectives and also to remove unnecessary features. In so doing, it enabled the supervisors to provide reasonable feedback and the researcher to produce rich and thick descriptions of the findings that were entirely trustworthy.

3.10.2 Chi-square test

Gay et al. (2011) define the Chi-square test as an inferential statistic that is used to "compare group frequencies; that is to see if an event occurs more frequently in one group than another" (p. 234). According to McHugh (2013), the Chi-square test is a "non-parametric (distribution free) tool designed to analyse group differences when the dependent variable is measured at a nominal level" (p. 143). As stated in Section 3.10, a Chi-square test was only used to count how many learners responded to each statement on a five point Likert Scale after being taught on the topic "electricity" using authentic learning activities and not necessary to find out or test if there was a significant difference or there was no significant difference amongst the tested statements in the learners' responses in the four schools..

3.10.3 T-test

A T-test is an "inferential statistic used to determine whether the scores of two groups are significantly different from one another" (Gay et al., 2011, p. 234). Kim (2015) avers that a t-test is a "statistical test that is used to compare the means of two groups and it is one of the most widely used statistical hypothesis tests in pain studies" (p. 540). As indicated in Section 3.10, the t-test was used to determine whether the learners' scores from experimental and control groups were different at probability (p) level of 0.05.

3.10.4 Factor exploratory analysis

Gay et al. (2011) state that factor analysis "is a statistical procedure used to identify relations among variables in a correlation matrix and to determine how variables group together based on what they may have in common" (p. 368). They further indicate that factor analysis is "commonly used to reduce a large number of responses or questions to a few more meaningful groupings known as factors" (p. 368). As indicated in Section 3.10, exploratory factor analysis was used to cluster similar variables/items that were measuring the learners' attitude into one factor.

3.11 Research ethics

The Wellcome Trust (2014) defines research ethics as the "moral principles that govern how researchers should carry out their work" (p. 1). Research ethics are research policies, conditions and procedures that educate and guide the researcher to ensure a high ethical standard when conducting research (Center for Bioethics, 2003). In other words, research ethics are research codes of conduct that researchers have to abide by in order to protect human subjects in the research (Wendler, 2012; World Health Organisation, 2017).

It should be stated that the data collection process only commenced when the researcher had obtained clearance from the Ethic Committee of the University of Namibia followed by permissions granted by the Executive Director (formerly known as Permanent Secretary) in the Ministry of Education, Arts and Culture as well as Directors of Educations of the Khomas and Omusati regions, school principals, and learners' parents/guardians. The participants were asked to sign a consent form as an agreement to participate in the study. The participants were also assured of confidentiality, privacy and anonymity to the effect that no real names were going to be used (Gay et al., 2011). The researcher also assured participants that no harm, unpleasantness or any damage to the participants and the research setting during the data collection process was foreseen.

The researcher obtained informed consent from all the learners who participated in this study through their parents/guardians since they were minors and explained to them the main purpose and nature of the study. The researcher also made sure that participants' participation was a free will exercise (Creswell, 2014). The participants were also informed of their right to decline or withdraw from the study any time they wished to do so should they feel intimidated or pressured by the research setting.

All the raw, transcribed and recorded data was stored securely by the researcher at his house in a safe and lockable place where only the researcher had access for a duration of five years. Thereafter the data was to be burned to protect the participants' confidentiality. According to Turcotte-Tremblay and Mc Sween-Cadieux (2018), maintaining confidentiality is essential as it builds trust relationships between the researcher and participants whilst, breaching of confidentiality can harm the characters of the participants.

3.12 Summary

This chapter described the research approaches, designs and instruments used in this study. The selection of the samples and how the data was collected was explained. All the statistical procedures used to analyse data and research ethical issues were also discussed. The next chapter presents the research findings from the pre- and post-tests, questionnaires and semi-structured interviews.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

In the previous chapter, the research methodology and instruments that were used to investigate the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in the Khomas and Omusati educational regions were presented and discussed.

This chapter presents the research findings that were collected from the pre- and post-tests, questionnaires [The Simpson Troost Attitude Questionnaire-Revised (STAQ-R)] and semi-structured interviews. The interpretation of the data gathered which is aligned to the main objectives of this study was done. The analysis of data was done using the Statistical Package for Social Sciences (SPSS) (Version 25). The Chi-square, exploratory factor analysis and T-test statistical analyses were run in order to find out if differences existed among the experimental and control groups in this study.

4.2 Data presentation

Data for this study was collected in order to address the following research objectives:

1. To determine the effects of authentic learning activities on achievement scores among Grade 7 learners in the Khomas and Omusati education regions.
2. To find out whether authentic learning activities influence attitude towards Natural Science among Grade 7 learners in the Khomas and Omusati education regions.

3. To investigate what Grade 7 learners in the experimental group thought about the effects of authentic learning activities in Natural Science.

In order to determine the effects of authentic learning activities on the Grade 7 learners' achievement scores and find out whether authentic learning activities influence attitude towards Natural Science among Grade 7 learners in the Khomas and Omusati education regions. The following hypotheses were also tested.

H_o: There is no significant difference between the achievement scores among Grade 7 learners who are exposed to authentic learning activities and those who are not.
H_1: There is a significant difference between the achievement scores among Grade 7 learners who are exposed to authentic learning activities and those who are not.

H_o: The authentic learning activities have no influence on attitude towards Natural Science among Grade 7 learners after exposing them to authentic learning activities.
H_1: The authentic learning activities have influence on attitude towards Natural Science among Grade 7 learners after exposing them to authentic learning activities.

The next section presents learners' pre- and post-tests' results.

4.3 Pre- and post-tests' results

One of the study's main objectives was to determine the effects of authentic learning activities on achievement scores among Grade 7 learners in the Khomas and Omusati educational regions. To measure learners' achievement scores, they were given a pre-test and post-test on 'electricity', a Natural Science topic at Grade 7. Their results are presented in Sections 4.3.1 and 4.3.2 for the control and the experimental groups respectively. The hypothesis below was tested to find out whether the control group and the experimental group' achievement scores where statistically significant.

Null hypothesis (H_o): There is no significant difference between the achievement scores among Grade 7 learners who are exposed to the authentic learning activities and those who are not.

Alternative hypothesis (H_1): There is a significant difference between the achievement scores among Grade 7 learners who are exposed to authentic learning activities and those who are not.

An independent samples T-test was used to assess whether there was a significant difference in the learners' achievement scores from pre-test to post-test after the intervention using a significance level of $p<0.05$. The learners performance on the two tests are given in Appendices A, B, C and D.

4.3.1 Control group's performance on the pre- and post-tests

Table 6 shows the performance of the control group on the pre-test and post-test. The following hypothesis was tested.

H_o: There is no significant difference in the pre-test and post-test achievement scores of the control group.

H_1: There is a significant difference in the pre-test and post-test achievement scores of the control group.

Table 6: Control group's pre- and post-tests results

Paired Samples Statistics

Group	Tests	N	Mean	Std. Deviation	Std. Error Mean	$t_{calculated}$	df	Sig. (2-tailed)
Control Group	Pre-test	97	17.28	4.479	.455	-10.547	96	.000
	Post-test	97	23.07	6.888	.699			

$p<0.05$

As seen in Table 6, the control group's mean *(M)* score = 17.28 and Standard Deviation *(SD)* = 4.479 on the pre-test and *M* = 23.07 and *SD* = 6.888 on the post-test. Furthermore, the control group's scores between the pre-test and post-test indicate [$t(96) = -10.547$, p = 0.000, $t_{critical} = 1.985$]. Therefore, the results attribute that the H_o is rejected and the researcher concludes that there is a statistically significant difference in the control group's pre-test mean scores compared to the post-test mean scores. This attests to the fact that learners who were not exposed to authentic learning activities had also improved their achievement scores from pre-test to post-test through lecture method.

4.3.2 Experimental group's performance on the pre- and post-tests

Table 7 shows the performance of the experimental group on the pre-test and post-test. The following hypothesis was used.

H_o: There is no significant difference in the pre-test and post-test achievement scores of the experimental group.

H_1: There is a significant difference in the pre-test and post-test achievement scores of the experimental group.

Table 7: Experimental group's pre- and post-tests' results

Paired Samples Statistics

Group	Tests	N	Mean	Std. Deviation	Std. Error Mean	$t_{calculated}$	df	Sig. (2-tailed)
Experimental Group	Pre-test	116	18.91	6.089	.565	-30.382	115	.000
	Post-test	116	31.72	6.599	.613			

$p<0.05$

Table 7 shows the experimental group's mean *(M)* score of 18.91 and *SD* = 6.089 on the pre-test and *M* = 31.72, and *SD* = 6.599 on the post-test. The results further indicate the experimental group's pre-test and post-test scores [$t(115) = -30.382$, p = 0.000, $t_{critical} = 1.981$]. Therefore, the H_o is rejected and the researcher concludes that there is a statistically significant difference between the pre-test mean scores and the post-test mean scores of the experimental group. This confirms that learners who were exposed to authentic learning activities improved their achievement scores immensely from pre-test to post-test through the lecture method.

4.3.3 Control and experimental groups' performance on the pre-test

Table 8 shows the performance of the control and experimental groups on the pre-test to test the following hypothesis.

H_o: There is no significant difference in the pre-test achievement scores of the control and the experimental groups.

H_1: There is a significant difference in the pre-test achievement scores of the control and the experimental groups.

Table 8: Control and experimental groups' pre-test results

Group Statistics

Test	Groups	N	Mean	Std. Deviation	Std. Error Mean	$t_{calculated}$	df	Sig. (2-tailed)
Pre-test	Control	97	17.28	4.479	.455	-2.195	211	.029
	Experimental	116	18.91	6.089	.565			

$p<0.05$

Table 8 shows that the experimental group scored higher than the control group on the pre-test. The experimental group's mean score was 18.91 and standard deviation of 6.089. The control group's mean score was 17.28 and standard deviation of 4.479 on the pre-test. The mean scores of the two groups on the pre-test show [$t(211) = -2.195$, $p = 0.29$, $t_{critical} = 1.971$].

This means that both groups' mean scores were closer to each other and it seemed that learners in both groups had almost the same knowledge and understanding of the topic before intervention. Therefore, the study rejects the H_o and this concludes that there was a significant difference between the control and experimental groups before the intervention.

Therefore, in order to ensure that the post-test mean scores of the two groups were not due to the initial differences, learners in the experimental group were taught Natural Science on the topic of electricity using authentic learning activities while learners in the control group were taught using a normal teaching (lecture) method as an intervention. Thereafter, the same post-test was given to both groups to determine the effect of authentic learning activities on learners' achievement scores on the topic of electricity.

4.3.4 Control and experimental groups' performance on the post-test

Table 9 shows the performance of the control and experimental groups on the post-test based on the following sub-hypothesis.

H_o: There is no significant difference in the post-test achievement scores of the control and experimental groups.

H_1: There is a significant difference in the post-test achievement scores of the control and experimental groups.

Table 9: Control and experimental groups' post-test results

Group Statistics

Test	Groups	N	Mean	Std. Deviation	Std. Error Mean	$t_{calculated}$	df	Sig. (2-tailed)
Post-test	Control	97	23.07	6.888	.699	-9.332	211	.000
	Experimental	116	31.72	6.599	.613			

$p<0.05$

Table 9 indicates that the experimental group achieved higher scores *M* = 31.72, *SD* = 6.599 as compared to the control group *M* = 23.07, *SD* = 6.888 on the post-test. The post-test mean scores of the control and experimental groups indicate [$t(211) = -9.332$, p = .000, $t_{critical} = 1.971$]. Therefore, the H_o is rejected in favour of the H_1 and the researcher concludes that there is a statistically significant difference in the post-test achievement scores of the control and experimental groups. In other words, experimental group learners outperformed control group learners on the post-test. This means that authentic learning activities seem to have had a positive impact on learners' achievement scores on the topic of electricity.

The next section presents the results from the Simpson Troost Attitude Questionnaire-Revised (STAQ-R) on whether authentic learning activities influenced experimental group learners' attitude towards Natural Science. The STAQ-R was administered to the experimental group only to find out whether authentic learning activities have influence on their attitude towards Natural Science after being exposed to authentic learning activities.

4.4 Results from the Simpson Troost Attitude Questionnaire-Revised (STAQ-R)

The STAQ-R instrument was comprised of 50 multiple choice items (Appendix G) was administered to one hundred and twenty four (124) experimental group learners comprising sixty nie (69) male and fifty-five (55) female learners to assess views on whether authentic activities influenced their attitude towards Natural Science learning. Each item had a five point Likert Scale namely; 1 = Strongly Disagree, 2 = Agree, 3 = Undecided/Uncertain, 4 = Disagree and 5 = Strongly Agree. The STAQ-R was used to test the following hypothesis and learners' results per item are given in Appendix E.

H_o: The authentic learning activities have no influence on the Grade 7 learners' attitude towards Natural Science after exposing them to authentic learning activities.

H_1: The authentic learning activities have influence on the Grade 7 learners' attitude towards Natural Science after exposing them to authentic learning activities.

One of the study's objectives was to find out whether authentic learning activities had some influence on attitude towards Natural Science among the Grade 7 learners who were exposed to authentic learning. The results obtained from the STAQ-Revised questionnaire are presented in Sections 4.4.1, 4.4.2 and 4.4.3.

4.4.1 Learners' responses towards Natural Science

Tables 10 to 16 present learners' frequency responses on various items that assessed their attitude towards Natural Science. Learners' responses are presented separately in the tables but in the interpretations the 'strongly agree' and 'agree' are combined; the same was done for the 'disagree' and 'strongly disagree' responses to provide the extent of agreement or disagreement with each statement in Tables 10 to 16. It is worth noting that in the tables that follow the frequency counts of responses per item did not correspond with the total number of learners who completed the questionnaire, due to double entries by learners' or non-responses. These cases were treated as invalid data entries and recorded as zero frequency counts in data presentation for the purpose of fairness and consistency. However, the exact frequency counts of double entries and missing or non-responses are given in Appendix E.

Table 10: Learners' responses towards Natural Science on self-directed efforts items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I really like science.	(63) 50.8	(34) 27.4	(15) 12.1	(3) 2.4	(8) 6.5	(123) 99.2
I always try hard in science, no matter how difficult the work is.	(73) 58.9	(19) 15.3	(17) 13.7	(6) 4.8	(6) 4.8	(121) 97.5
I enjoy science.	(66) 53.2	(34) 27.4	(12) 9.7	(7) 5.6	(3) 2.4	(122) 98.3
I am confident that I can understand science.	(62)	(28)	(13)	(6)	(13)	(122)

	50.0	22.6	10.5	4.8	10.5	98.4
I like to learn more about science.	(80) 64.5	(34) 27.4	(3) 2.4	(3) 2.4	(3) 2.4	(123) 99.1
We live in a better world because of science.	(59) 47.6	(25) 20.2	(25) 20.2	(1) 0.8	(10) 8.1	(120) 96.9
I look forward to science activities in class.	(53) 42.7	(43) 34.7	(17) 13.7	(4) 3.2	(4) 3.2	(121) 97.5
I have good feelings towards science.	(52) 41.9	(39) 31.5	(20) 16.1	(6) 4.8	(6) 4.8	(123) 99.1
Most of my friends do well in science.	(56) 45.2	(30) 24.2	(19) 15.3	(7) 5.6	(5) 4.0	(117) 94.3
When I fail that makes me try much harder.	(72) 58.1	(31) 25.0	(9) 7.3	(4) 3.2	(6) 4.8	(122) 98.4
My best friend in this class likes science.	(42) 33.9	(42) 33.9	(24) 19.4	(6) 4.8	(6) 4.8	(120) 96.8
If I work hard enough, I can learn difficult science concepts.	(51) 41.1	(32) 25.8	(20) 16.1	(7) 5.6	(11) 8.9	(121) 97.5
I will continue studying science after I leave school.	(47) 37.9	(27) 21.8	(26) 21.0	(11) 8.9	(8) 6.5	(119) 96.1
My brothers and sisters like science.	(36) 29.0	(35) 28.2	(27) 21.8	(16) 12.9	(8) 6.5	(122) 98.4
Science will help me to understand the world around me.	(65) 52.4	(30) 24.2	(9) 7.3	(8) 6.5	(9) 7.3	(121) 97.7
We learn about important things in science class.	(88) 71.0	(25) 20.2	(4) 3.2	(1) 0.8	(5) 4.0	(123) 99.2
I really enjoy science lessons.	(67) 54.0	(35) 28.2	(12) 9.7	(3) 2.4	(3) 2.4	(120) 96.7
My mother likes science.	(24) 19.4	(32) 25.8	(41) 33.1	(15) 12.1	(10) 8.1	(122) 98.5
My family encourages my interest in science.	(35) 28.2	(38) 30.6	(26) 21.0	(14) 11.3	(8) 6.5	(121) 97.6
We do a lot of activities in science class.	(44) 35.5	(49) 39.5	(15) 12.1	(10) 8.1	(5) 4.0	(123) 99.2
I like to watch TV programs about science.	(51) 41.1	(23) 18.5	(20) 16.1	(14) 11.3	(15) 12.1	(123) 99.1
My science teacher makes good plans for us.	(51) 41.1	(42) 33.9	(13) 10.5	(10) 8.1	(5) 4.0	(121) 97.6
My friends like science.	(39) 31.5	(34) 27.4	(31) 25.0	(7) 5.6	(12) 9.7	(123) 99.2
Science is easy for me.	(62) 50.0	(29) 23.4	(21) 16.9	(8) 6.5	(3) 2.4	(123) 99.2

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

As seen in Table 10, the results indicate that more than 80% of the learners strongly agreed that they enjoyed science, liked to learn more about science (91.9%), when they failed that made them try much harder (83.1%), they learned about important things in science class (91.2%) and they really enjoyed science lessons (82.2%). It seems that most of the learners really enjoyed science itself and its lessons. They agreed that science was easy for them (73.4%) and they really liked science (78.2%). Science was not only easy for the learners because they liked it, they also agreed that they had good feelings towards science (73.4%), confident that they understood science (72.6%) and always tried hard in science no matter how difficult the work was (74.2%).

These learners were self-driven and motivated towards Natural Science. However, only two statements on self-directed efforts had more than 20% of the learners disagreeing with the statements. Hence, 20.1% of the learners disagreed that their mothers liked science and 23.4% of the learners disagreed that they liked to watch TV programs about science. Despite that 45.2% of the learners agreed that their mothers liked science, 33.1% of the learners were uncertain to the same statement. The statements: “I like to learn more about science”, “we learn about important things in science class” and “I really enjoy science lessons” had 4.8%, the lowest percentage of the learners who disagreed and with more than 82% of the learners who agreed to the same statements.

Overall, an average of 71.5% of the learners strongly believed that self-directed efforts factor encouraged them to try hard in science no matter how difficult the task was as compared to an average of 14.8% of the learners who were uncertain and 11.7% of the learners who strongly disagreed. Therefore, it seems learners' achievement scores in Natural Science were determined by the learners' attitude towards the subject.

Table 11: Learners' responses towards Natural Science on anxiety about science items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
If I could choose, I would not take any more science in school.	(13) 10.5	(13) 10.5	(27) 21.8	(20) 16.1	(46) 37.1	(119) 96.0
Science lessons are a waste of time.	(10) 8.1	(8) 6.5	(18) 14.5	(9) 7.3	(76) 61.3	(121) 97.7
I cannot understand science even if I try hard.	(15) 12.1	(12) 9.7	(17) 13.7	(25) 20.2	(53) 42.7	(122) 98.4
My family watches science programs on TV.	(37) 29.8	(23) 18.5	(24) 19.4	(15) 12.1	(25) 20.2	(124) 100.0
I do not like science.	(16) 12.9	(5) 4.0	(16) 12.9	(13) 10.5	(73) 58.9	(123) 99.2
A job as a scientist would be boring.	(14) 11.3	(20) 16.1	(30) 24.2	(20) 16.1	(39) 31.5	(123) 99.2
Learning science is not important for my future success.	(17) 13.7	(8) 6.5	(17) 13.7	(30) 24.2	(51) 41.1	(123) 99.2
Teachers encourage me to understand concepts in science classes.	(59) 47.6	(32) 25.8	(15) 12.1	(9) 7.3	(6) 4.8	(121) 97.6

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

Learning Natural Science should be an exciting experience for some learners and a cause of anxiety for others. Table 11 shows that 21.8% of the learners agreed that if they could choose, they would not take any more science in school because they did not understand science even if they tried hard. However, 53.2% and 62.9% of the learners strongly disagreed with the statements respectively. On the other hand, 68.6% of the learners disagreed with the statement that “science lessons are a waste of time”. They (47.6%) also disagreed with the statement that “a job as a scientist would be boring”. About seventeen (16.9%) of the learners agreed that they did not like science, 12.9% were not sure and 69.4% agreed with the statement.

In addition, the results show that 73.4% of the learners strongly agreed that teachers were encouraging them to understand concepts in science classes while 12.1% of the same learners disagreed and were uncertain with the statement. Even though, 12.1% of the learners were not sure whether teachers were encouraging them to understand concepts in science classes. Science teachers should encourage their learners to overcome anxiety and negative perceptions about Natural Science. According to Wrobbel (2004), science teachers should prepare authentic instructions that encourage learners to engage in substantive conversation where they can exchange their views openly with teachers and other learners about the subject matter and science teachers should create authentic learning environments that encourage learners to think critically, reason scientifically and explore the real-world independently (Lau, 2011).

Table 12: Learners' responses towards Natural Science on career awareness items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I will become a scientist in future.	(37) 29.8	(19) 15.3	(44) 35.5	(14) 11.3	(10) 8.1	(124) 100.0
I will study science if I get into a university.	(47) 37.9	(29) 23.4	(31) 25.0	(8) 6.5	(9) 7.3	(124) 100.1
I am sure I can do well in science.	(75) 60.5	(23) 18.5	(12) 9.7	(6) 4.8	(3) 2.4	(119) 95.9
Science is one of the most interesting school subjects.	(64) 51.6	(24) 19.4	(18) 14.5	(7) 5.6	(9) 7.3	(122) 98.4
Science classes will help prepare me for university.	(53) 42.7	(37) 29.8	(21) 16.9	(3) 2.4	(8) 6.5	(122) 98.3

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

Learners should be aware of their future careers at an early age. The results in Table 12 indicate that 45.1% of the learners agreed that they would become scientists in the future compared to 19.4% who disagreed while 35.5% were not sure. Even though, some learners did not want to become scientists in the future, 37.9% of the learners agreed that they would study science if they got to the university while 13.8% disagreed. Despite learners' choices about their future studies, 79% of the learners strongly agreed to the statements that "I am sure I can do well in science"; "science is one of the most interesting school subjects" (71.0%) and "science classes will help prepare me for university" (72.5%).

On the other hand, 9.7% of the learners were uncertain about their own science learning capabilities, while 16.9% of the learners were not sure whether science classes would help them prepare for university education. Close to 13% (12.9%) of the learners disagreed with the statement that science was one of the most interesting school subjects. With reference to Table 12, it seems that many learners were aware about their future careers as 45.1% of them wanted to become scientists. When learners are aware of their scientific future careers at an early stage of their education, it is likely to influence their attitude positively towards Science and might result in better achievements in the subject.

Table 13: Learners' responses towards Natural Science on motivating classroom items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I usually give up when I do not understand a science concept.	(16) 12.9	(19) 15.3	(23) 18.5	(22) 17.7	(44) 35.5	(124) 99.9
Our science classroom contains a lot of interesting equipment.	(44) 35.5	(37) 29.8	(10) 8.1	(20) 16.1	(11) 8.9	(122) 98.4
My best friend likes science.	(47) 37.9	(26) 21.0	(31) 25.0	(6) 4.8	(10) 8.1	(120) 96.8

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

In Table 13, only 28.2% of the learners agreed to the statement that "I usually give up when I do not understand a science concept" as compared to 53.2% of the learners who disagreed. More than sixty-five (65.3%) of the learners agreed that their science classrooms had a lot of interesting equipment and 25.0% of the learners disagreed and 8.1% of the learners were not sure about their classrooms' environment. More than 58.5% of the learners agreed to the statement that "my best friend liked science" while 12.9% of the learners disagreed and 25.0% were undecided. Learners' responses to the statements on motivating classrooms seem to indicate that the majority of the learners had positive attitude towards Natural Science because their science classrooms contain a lot of interesting equipment. The interesting science equipment seems to attract and motivate learners to like science subjects and not to give up when they did not understand the science concepts.

Table 14: Learners' responses towards Natural Science on the relevance of science items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I will miss studying science when I leave school.	(49) 39.5	(30) 24.2	(12) 9.7	(16) 12.9	(16) 12.9	(123) 99.2
Science is useful in solving everyday life problems.	(52) 41.9	(24) 19.4	(25) 20.2	(15) 12.1	(7) 5.6	(123) 99.2
My father likes science.	(30) 24.2	(24) 19.4	(44) 35.5	(13) 10.5	(9) 7.3	(120) 96.9

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

Table 14 results revealed that 63.7% of the learners strongly agreed that they would miss studying science when they left school. Whereas, 25.8% of the learners strongly disagreed and 9.7% of these learners, showed that they were uncertain. Furthermore, 61.3% of the learners agreed that science was useful in solving everyday life problems while 17.7% of the learners disagreed. However, 43.6% of the learners agreed that their fathers liked science while 35.5% of the learners were not sure.

Generally, learners agreed with the statements about the relevance of science. This means that learners had a positive attitude towards Natural Science as a subject and that they would miss science when they leave school and viewed science as a relevant subject in solving everyday life's problems.

Table 15: Learners' responses towards Natural Science on science is fun's items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I would enjoy working in a science-related career.	(44) 35.5	(27) 21.8	(37) 29.8	(12) 9.7	(3) 2.4	(123) 99.2
Scientists do not have time for fun.	(23) 18.5	(20) 16.1	(19) 15.3	(19) 15.3	(42) 33.9	(123) 99.1

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

The results in Table 15 show that 57.3% of the learners agreed that they would enjoy working in a science-related career and 34.6% agreed that scientists do not have time for fun.

Table 16: Learners' responses towards Natural Science on value of efforts' items

Statements	Respondents (N = 124)					
	(Frequency) %					Total
	SA	A	UN	D	SD	
I always try to do my best in school.	(87) 70.2	(20) 16.1	(7) 5.6	(2) 1.6	(5) 4.0	(121) 97.5
My science teacher is very good.	(79) 63.7	(26) 21.0	(6) 4.8	(2) 1.6	(10) 8.1	(123) 99.2
I consider our science classroom attractive and comfortable.	(27) 21.8	(40) 32.3	(27) 21.8	(15) 12.1	(14) 11.3	(123) 99.3
I will not pursue a science-related career in the future.	(11) 8.9	(21) 16.9	(33) 26.6	(25) 20.2	(30) 24.2	(120) 96.8

***Keys**: **SA**-Strongly Agree; **A**-Agree; **UN**-Uncertain; **D**-Disagree; **SD**-Strongly Disagree*

Table 16 results indicate that learners strongly agreed that they always tried to do their best in school and their science teachers were very good in teaching Natural Science with 86.3% and 84.7% respectively. Moreover, 54.1% of the learners agreed to the statement that they considered their science classrooms attractive and comfortable; while only 25.8% of the learners agreed that they would not pursue a science-related career in the future. Despite the fact that 84.7% of the learners strongly agreed that their science teachers were very good, 21.8% of the learners were not sure whether they considered their science classrooms attractive and comfortable while 24.2% of the learners disagreed that they would not pursue a science-related career in the future. In general, the learners were optimistic to all the statements.

4.4.2 Results from exploratory factor analysis

The learners' attitude towards Natural Science using authentic activities was measured using the STAQ-Revised instrument. Exploratory factor analysis was used using the Statistical Package for Social Sciences (SPSS) (Version 25). Learners' results obtained through factor analysis are shown in Table 17. According to Gay et al. (2011) factor analysis "is a statistical procedure used to identify relations among variables in a correlation matrix and to determine how variables group together based on what they may have in common" (p. 368). Gay et al. (2011) further states that factor analysis is "commonly used to reduce a large number of responses or questions to a few more meaningful groupings known as factors" (p. 368).

Table 17 shows seven key factors that were extracted after varimax rotation. The varimax rotation is a commonly useful orthogonal rotation method in factor analysis that clusters the variables (Example: I will become a scientist in future) into groups (Example: career awareness) and the group becomes a factor (Yong & Pearce, 2013). The seven factors were incorporated in the study to align with the 50 items which measured learners' attitude towards Natural Science. That is, the items that commonly measured learners' attitude were clustered into one factor.

Table 17: Factor extracted after varimax rotation with items revealed and each of their factor loadings

Factors and % of Variance	Item Number	Item	Load Factor
Self-directed Efforts 15.70%	39	I really like science.	.68
	43	I always try hard in science, no matter how difficult the work is.	.61
	11	I enjoy science.	.60
	38	I am confident that I can understand science.	.58
	30	I like to learn more about science.	.56
	40	We live in a better world because of science.	.53
	26	I look forward to science activities in class.	.52
	27	I have good feelings towards science.	.51
	37	Most of my friends do well in science.	.51
	25	When I fail that makes me try much harder.	49
	35	My best friend in this class likes science.	.49
	47	If I work hard enough, I can learn difficult science concepts.	.48
	34	I will continue studying science after I leave school.	.47
	41	My brothers and sisters like science.	.47
	46	Science will help me to understand the world around me.	.46
	05	We learn about important things in science class.	.45
	32	I really enjoy science lessons.	.44
	31	My mother likes science.	.43
	36	My family encourages my interest in science.	.43
	15	We do a lot of activities in science class.	.41
	20	I like to watch TV programs about science.	.37
	21	My science teacher makes good plans for us.	.36
	03	My friends like science.	.36
	14	Science is easy for me.	.31
Anxiety about Science 6.70%	45	If I could choose, I would not take any more science in school.	.60
	48	Science lessons are a waste of time.	.55
	22	I cannot understand science even if I try hard.	.51
	29	My family watches science programs on TV.	.46
	50	I do not like science.	.46
	28	A job as a scientist would be boring.	.45
	02	Learning science is not important for my future success.	.38
	10	Teachers encourage me to understand concepts in science classes.	.32
Career Awareness 5.05%	01	I will become a scientist in future.	.57
	04	I will study science if I get into a university.	.52
	23	I am sure I can do well in science.	.45
	08	Science is one of the most interesting school subjects.	.42

	12	Science classes will help prepare me for university.	.38
Motivating Classroom 4.60%	06	I usually give up when I do not understand a science concept.	.49
	07	Our science classroom contains a lot of interesting equipment.	.46
	19	My best friend likes science.	.43
Relevance of Science 4.55%	44	I will miss studying science when I leave school.	.59
	24	Science is useful in solving everyday life problems.	.42
	33	My father likes science.	.32
Science is Fun 3.87%	42	I would enjoy working in a science-related career.	.47
	49	Scientists do not have time for fun.	.33
Value of Efforts 3.59%	13	I always try to do my best in school.	.46
	16	My science teacher is very good.	.40
	17	I consider our science classroom attractive and comfortable.	.35
	18	I will not pursue a science-related career in the future.	.32
Load factor beyond cut-off 3.25%	09	We do a lot of interesting activities in science class.	

With factor analysis, the principal component analysis method was also used to load the factor of each variable and extract the percentages of variance of each factor. As seen in Table 17, there are seven factors identified with the represented items and their factor loadings. The seven identified factors with percentages of variance included were: self-directed efforts (15.70%), anxiety about science (6.70%), career awareness (5.05%), motivating classroom (4.60%), relevance of science (4.55%), science is fun (3.87%), and value of efforts (3.59%).

The results show that item number nine (9) was removed from clustering; in other words, it was not belong to any of the seven factors because its loading factor was beyond the cut-off of seven extracted factors in component matrix. Even if item number nine was removed, it had 3.25% of variance. Table 17 displays that seven factors had a total variance of 44.06% for the variables that measured the learners' attitude towards Natural Science, excluding variable number nine due to its load factor.

The results show that the self-directed effort had 15.70% of variance with 24 variables and factor loadings ranging from 0.31 to 0.68 and was the highest factor in explaining the variance compared to other factors. This implies that a self-directed effort factor mostly attracted learners to Natural Science and positively influenced their attitude towards the subject. For self-directed effort factor, learners seemed to be self-motivated towards the learning of Natural Science after they were exposed to authentic learning activities.

Despite learners' self-directed effort towards Natural Science, learners were also sceptical about Natural Science as the anxiety towards science factor was ranked the second highest with 6.70% of variance and factor loadings ranging from 0.32 to 0.60 in terms of measuring learners' attitude towards Natural Science as a subject. For instance, with reference to the variables, learners were grateful and confident that they would continue studying science after leaving school; though they were also worried that working as a scientist would be boring.

Despite the fact that anxiety about science factor was the second in the scale of learners' attitude towards Natural Science, learners were aware of their future. In other words, the career awareness factor concerned with learners' future interests had 5.05% of variance with factor loadings ranging from 0.38 to 0.57 and that also attracted and changed learners' attitude to like Natural Science.

Learners' viewed a motivating classroom and relevance of science with 4.60% and 4.55% of variance with factor loadings ranging from 0.43 to 0.49 and from 0.32 to 0.59 respectively. These were factors that also played equal roles on the learners' attitude towards Natural Science. This suggests that a science classroom that had a lot of interesting science equipment seemed to develop learners' interest in studying science after leaving school. However, 'science is fun', and 'the value of efforts' had 3.87% and 3.59% of variance with factor loadings ranging from 0.33 to 0.47 and from 0.32 to 0.46 respectively.

These were regarded as the factors that had no great effect neither influenced many learners' attitude towards Natural Science as they had the lowest role to play among other factors. In fact, few learners were of the view that scientists had no time for fun; therefore, these learners believed that they would not pursue a science-related career in the future. Nevertheless, the findings by factor analysis indicated that authentic learning activities positively influenced learners' attitude towards Natural Science.

4.4.3 Male and female learners' attitude towards Natural Science

The hypothesis (below) was tested using the T-test to find out if there was a significant relationship between the items which tested learners' attitude towards Natural Science and their gender at $p = 0.05$ and $df = 122$.

H_o: There is no significant relationship between learners' attitude towards Natural Science and their gender.

H_1: There is a significant relationship between learners' attitude towards Natural Science and their gender.

Table 18 shows the extent of how learners' attitude towards Natural Science interacted with their gender.

Table 18: Learners' attitude towards Natural Science by gender

Variable	Gender	N	Mean	Std. Deviation	Std. Error Mean	$t_{calculated}$	df	Sig. (2-tailed)
Attitude towards Natural Science	Male	69	115.16	18.090	2.178	1.344	122	.181
	Female	55	110.51	20.378	2.748			

$p<0.05$

Table 18 shows that the female learners' attitude were slightly lower (*M* = 110.51, *SD* = 20.378) than that of the male learners (*M* = 115.16, *SD* = 18.090). The learners' attitude were not significantly different between their genders [t(df = 122) = 1.344, p = 0.181]. The $t_{calculated}$ = 1.344 was less than the $t_{critical}$ = 1.980 at df = 122. Therefore, the study fails to reject the H_o and the researcher concludes that there is no statistically significant relationship between males and females with regards to their attitude towards Natural Science ($p<0.05$) after having been exposed to authentic learning activities.

The next section presents results from the semi-structured interviews.

4.5 Semi-structured interviews' results

This section presents the responses from 22 learners (six from school X_1, four from school X_2, six from school X_3 and six from school X_4) who were interviewed using focus-group discussions. These learners were given codes (Appendices A, B, C and D) as their names and they were MBO01, MBO02, MBO12, MBO13, MBO24 and MBO34 from school X_1; OPO25, OPO27, OPO32 and OPO33 from school X_2; JKO05, JKO12, JKO13, JKO14, JKO17 and JKO21 from school X_3; and OKO01, OKO05, OKO06, OKO11, OKO12 and OKO28 from school X_4. The interview questions focused on learners' thoughts regarding the effects of authentic learning activities in teaching and learning of Natural Science (Appendix F).

The researcher wanted to know from the learners what they thought of being taught through authentic learning activities.

Table 19 provides the responses from the learners on the question: "What do you think of being taught through authentic learning activities"?

Table 19: Learners' views on being taught through authentic learning activities

Respondents	Responses
MBO02	*Being taught in authentic is a good thing, because now we know how series are like and the bulbs. It is much better than being taught but you do not know how things are like.*
OPO27	*It's good to be taught in authentic because you learn to experience what is that thing if you like do not know, like did not experience it the teacher is just talking out of nowhere, you would not know how it look, you would not even get it right in your hand but if know and showing us authentically we will know what it is and catch it quickly into our head without negative thoughts.*
OPO33	*Just to add more about on what she said, some of us are visual learners and learn by seeing things, so, being taught visually is the best thing in the class and then you learn a lot about that thing.*

JKO05	*It's a new thing but it's good to learn something that we cannot, did not learn in my life. It's a good thing to us to learn it.*
JKO17	*To be taught in authentic, I thought maybe you can be able to understand things that you have never seen before so that you can know, ever we meet something like that you can know what it is.*
OKO06	*I understand more, better than not using authentic.*
OKO11	*By explaining authentic really helps me because first we do not really know the items by A's and you get to know more.*
OKO28	*It makes easier for the learners to understand the way the teacher is teaching.*

As seen from Table 19, learners MBO02, OPO27, OPO33, JKO05, JKO17, OKO11 and OKO28 appreciated the fact that they were taught through authentic learning activities during the teaching and learning process. For instance, learner MBO02 said "*being taught in authentic is a good thing, because now we know how series are like and the bulbs*" while learner OPO33 mentioned that "*some of us are visual learners and learn by seeing things, so, being taught visually is the best thing in the class and then you learn a lot about that thing*".

In addition, learners OKO06 and OKO28 stated that "*I understand more, better than not using authentic*" and "*it makes easier for the learners to understand the way the teacher is teaching*" respectively. From the learners' answers, it is clear that being taught the topic electricity using authentic activities, enabled the learners to learn a lot, know more about what exactly these teaching and learning materials were that they were being taught about (Iucua & Marina, 2014) and the learners could quickly comprehend what they were taught in the class (Suryawati & Osman, 2018). Furthermore, the learners' answers indicated that being taught through authentic learning activities helped learners to understand and remember the subject content that they were taught.

Table 20 gives the learners' responses to the second question: "What do you like most about being taught using authentic learning activities"?

Table 20: What learners liked most when taught through authentic learning activities

Respondents	Responses
MBO13	*I think my favourite part of being taught about authentic, it is a good thing. My favourite part is actually see part is actually see what the teacher is explaining to you, so at the end of the day you know what you were taught on.*
OPO27	*I, I, it's very nice because you will know what the teacher is talking about and you do not need to think about another thing or like the electricity that you have shown us, I have a lot of experience about that and it cannot get out of my head because I know everything. In the process, it's very easy to think when; the authentic is the most important thing.*
OPO33	*Like, aah, the way that I like about authentic learning is like aa, the presentation of the teacher. You just do not have to read from the teacher's mouth like the audio learners, aa, we have to be visually, we have to see about the topic while the teacher is talking about, so authentic is very important to the learners.*
JKO12	*Like, like Sir teaches us to connect the bulbs or to connect the cells in parallel or series.*
JKO13	*I like a circuit,* [so, how?] *because, because it teaches us how to make electrical, how to make, how to connect them.*
JKO17	*Sir, I want to say something, because in authentic you can be taught something and you get it so that you can make your own, you try to make your own, to know how to make and you can use your own thing like if you are not having a bulb, you can search a bulb from the lamp, from the torch so that you can make your own circuit.*
OKO11	*I like it most because you get to know the items even if, let me say you were in the store and just see the things and you do not know about it, you can take it for your own good and good for your future to study science.*
OKO12	*I think, aaa, is a good experience because a learner can really learn better by experiencing or visualising the items that the teacher can teach so that he or she can understand and improvise on.*
OKO28	*It gives the learners and teachers more information about how and why things should be used.*

In Table 20, learners MBO13, OPO27, OPO33 and OKO12 stated that when learners are taught using the authentic learning activities, they actually listened to the teacher's explanations and at the same time they saw the reality of what the teacher was teaching or talking about. Learners also pointed out that they understood science better when they visualised real teaching and learning materials than being taught without authentic learning activities.

Learners OPO27 and OKO28 remarked that teaching and learning using authentic activities enabled them to fully pay attention to how, why and what the teacher was teaching. Learner OKO11 commented that being taught using authentic activities, developed in him an interest to study science in the future while learners JKO13 and JKO17 mentioned that authentic activities enabled them to make their own circuits.

Table 21 provides responses from the learners on the question: "What do you dislike most about being taught using authentic learning activities"?

Table 21: What learners disliked most when taught through authentic learning activities

Respondents	Responses
JKO13	*I do not like the human being because some teachers told us that human being long, long, long, long ago. I do not like that. It's like monkeys.*
OKO06	*Some authentic things are also scarily and might damage learners' brains. Example: the skeletons.*
OKO11	*The thing I do not like about authentic, it might get accidentally fall and your science period will be already finished.*

OKO12	*Sometimes, aaa, authentic are dangerous because some teachers do not know how to use that material and the slightest mistake, he or she drops it or do mistakes or something can cause shock reactions and it might ruin the whole period, the class. Those physical damages can be dangerous can cause electrical explosion and the classroom lead to fire. That's why it's appropriate; the teachers need more training to use authentic materials in the class.*
OKO28	*Being taught in authentic can also be dangerous because the materials that the teacher brings to the class might be dangerous and has to be done by experienced person.* *Because of the teacher, the teacher has to practice before he jumps to the conclusions that he or she knows how to use it but as she teaches us there might be mistakes and cause troubles to the school and lose her job.*

Learners JKO13 and OKO06 mentioned that they did not like to be taught using authentic learning activities when the topic was about 'human anatomy'. Learner JKO13 remarked that "*I do not like the human being because some teachers told us that human being long, long, long, long ago. I do not like that. It's like monkeys*" while learner OKO06 said that "s*ome authentic things are also scarily and might damage learners' brains. Example: the skeletons*".

Learners JKO13 and OKO06 pointed out the disadvantages of using authentic learning activities as opposed to its benefits. Learners OKO11, OKO12 and OKO28 cautioned that when using authentic materials in teaching and learning electricity, the materials needed to be handled with care otherwise they might cause shock that might lead to fire and/or accidental fall. As a result, the whole lesson would be disturbed. The learners, therefore, suggested that teachers should be well trained, have experience and/or practical knowledge on how to use authentic learning activities in advance in order to avoid making mistakes and wasting teaching and learning time in the classroom.

Table 22 provides learners' responses on the question: "In general, did authentic learning activities help you understand the topic 'electricity' better"?

Table 22: Learners' views on whether authentic learning activities helped them to understand electricity

Respondents	Responses
MBO01	*Because you can see how the teacher is connecting the things, so, you learn more.*
OPO27	*It really helped me to understand because first when the teacher was explaining I did not really know what was parallel and series but when the teacher shows me the things how the bulbs when you take it off and how the things move, now I know how, why people put lights in parallel and not in series and so on, that's why and I learned a lot of stuffs in authentic way.*
OPO32	*Aa, for me, I also learned more because I did not know how many types of electricity do we have but now I know we have current electricity and static electricity, thank you.*
OPO33	*Authentic learning is like; Sir, you taught us a lot of things about electricity the first day that you came to us you already gave us a test that we did not even understand but the second day that you came to the class you brought posters that we can see visually and you also presented the things are combined with electricity.*
JKO05	*We learned something because we know how to connect two wires and know how to, if you take out one bulb the two or three bulbs are open, still on.*
JKO13	*Me, I think that we understand that topic because we learned first with our science teacher and again you explained us what we have to do and we know thoroughly.*
OKO01	*I think, I think it's a good thing because we learned about, we learned more about electricity and now I know how to identify the diagram in parallel and in series.*
OKO05	*It helped me because I did not know that in parallel circuit there are many conductors than series circuit.*
OKO06	*There is also more understandable to the learners.*
OKO11	*Let me say that, a good experience as I get to know that the parallel ones are connected with many wires and series are connected with few I never knew that.*
OKO12	*The information was good because now we can identify between a parallel circuit and series circuit. It has been a very good experience to know how parallel and series circuits are; and useful in our future because like when if a person want to become a scientist, he can, he can, he can improvise with some information he got from past school teacher and it's grateful for*

	the kids to known.
OKO28	*The pictures help the teacher to describe to the learners but what makes it very easy is how the teacher designed the parallel circuit for the learners to understand more about it. It has been really a good experience to learn more about it and it really helped me to figure out which electricity in series circuit and parallel circuit.*

Table 22 shows that, learners OPO27, OPO32, JKO05, JKO13, OKO01, OKO06, OKO11, OKO12 and OKO28 indicated that authentic learning activities helped them to understand the topic 'electricity' better. Learner OPO27 stated that "*I did not really know what was parallel and series but when the teacher shows me the things how the bulbs when you take it off and how the things move, now I know how*". In addition, learner OPO32 stated "*for me, I also learned more because I did not know how many types of electricity do, we have but now I know we have current electricity and static electricity*".

Judging from what learners OPO27 and OPO32 said, it seemed that learners only understood the topic 'electricity' better when the researcher taught them using authentic learning activities. According to learner OPO27, authentic activities taught her to understand and "*know how and why people put lights in parallel and not in series*". While learner OKO28 stated that authentic activities really helped him to figure out which electricity is in series circuit and parallel circuit. Learner OKO12 mentioned that authentic activities were useful in his future because when someone wants to become a scientist, he/she can use the information that he/she acquired from the previous school where authentic activities were used.

Table 23 gives learners' responses on the question: "To what extent did you find this exercise of using authentic learning activities? Make your choice from: A=not at all a challenge, B=minor challenge, C=somewhat of a challenge, D=significant challenge, and explain why".

Table 23: Extent to which learners view the use of authentic learning activities

Respondents	Responses
MBO13	*I do not think anything was challenging with the things we taught using authentic. It was really easy I would say, I do not think anything was difficult.*
OKO11	*Let me say that there were minor challenges because the parallel circuit real needs to much wires and if you sent home you do not know real where to get those and really needs more attention on it.*
OKO12	*Aaa, to me, it was a challenge because those are like how to connect a circuit, it was very tough because are, even though sometimes you are sent at home to make a series circuit and parallel circuit. It takes more time to understand the teacher about how to connect and how its diagram, how it should be and the way the parallel is; the most challenging is the parallel circuit especially to me because once like I get home and go and provide all materials to use and have also to use many wires, bulbs and all that. So, the parallel circuit has been a real challenge to me and I now know how to connect it.*
OKO28	*There are some challenges because when you connect in parallel circuit, has lot of circuits for me to understand it while series circuit makes it easier to make electricity because it uses more battery power, I mean less battery power.*

In Table 23, learner MBO13 stated that they experienced no challenges or difficulties in being taught using authentic learning activities. On the contrary, learners OKO11, OKO12 and OKO28 experienced some minor challenges during the use of authentic learning activities. Some of the challenges that were mentioned by the learners were that to design electrical circuit, one needed to pay more attention during the designing process as a lot of materials (example: conductor wires) were needed especially in parallel circuits. Learners also expressed their concerns that it took them time to understand what the teacher was talking about as he was also connecting the electrical circuit so that it can work. Thereafter, learners understood what an electrical circuit was and were able to know how to connect the electrical circuit by themselves as indicated by learner OKO12.

Table 24 provides responses from the learners on the question: "Did you get clear instructions to guide you through authentic teaching and learning activities? Explain how".

Table 24: Learners' views on whether they got clear instructions through authentic teaching and learning activities

Respondents	Responses
MBO13	*Me, I would say that the instructions were very clear and straight out.*
OPO25	*Ok, as Sir as the learner said it is better be taught in authentic method rather than be taught in audio. So, that means that we learn more, better than the teacher who is learning, talking and such stuff, so it is better than teaching with things, tools and such stuff in action rather than just being teaching by mouth.*
OPO33	*It was very clear because, Sir, as we did not understand, we also asked you and you also repeated the questions or the things that you were shown us already.*
JKO17	*Me, I think maybe if we are doing something like we were using circuit to make circuit to connect circuit, you can learn more and when you grownup you can be, maybe you can become a teacher and teach science you can make that thing of a circuit then you can be able to teach by your own.*
OKO01	*For me, it was real not tough, aaa, the big challenge that was challenging me was the diagram that's in parallel. That one has many connectors, and so I really do not get to connect it well.*
OKO06	*It was also easy for me to identify the parallel circuit but although it has many conductors, but I can also do, I can also try it and do it better.*
OKO11	*For me, it was extremely very clear because when before you came showing us those pictures I so shocked and surprised, because I came to get and take something from that, and it was really interested.*
OKO12	*It gave me a lot of information, for instance like parallel and series circuits. When you are trying to create those types of circuits, it is easy to improvise and visualise pictures of what your teacher taught you and you can just create in, in, in like if in series and parallel, you can just create in both of those, those forms, it real easy because it, it, it's very good and can also give, give you*

	some great technological skills on how to make electricity easier.
OKO28	*The drawings of circuit, three circuits in parallel circuit were gave me clear instructions to understand how to connect the parallel and series circuit. So, when you create, it makes easier for me to understand by looking at the pictures.*

In Table 24, learners MBO13, OPO33, OKO11 and OKO28 stated that the instructions given to them during the use of authentic teaching and learning activities were very clear and straight forward. As a result, learners had a clear understanding of electricity and were able to connect the parallel and series circuits; and to differentiate between them. Learner OPO25 mentioned that he learned more and better when taught using the authentic method rather than audio whereby a learner was only listening to the teacher without being engaged in practical activities.

Table 25 gives learners' responses on the question: "Did the use of authentic learning activities provide you with sufficient time to complete the task given to you"?

Table 25: Learners' views on whether authentic learning activities provided them with sufficient time to complete tasks

Respondents	Responses
MBO24	*I think it's a good thing, it's not time consuming and we finish the work on time.*
OPO27	*Authentic activity is, is really, like it would be enough time to do our other activity but even we do not do it, aa, is very easy you can even memorise it in your head, we can do it another day because it was very easy for the teacher to teaching us the thing and we can understand it and we experience it, so we know how it like so we can do it even another day because we can remember it how teacher was doing it and so on.*
OKO11	*Let me say, it does not give too much activities because it has a long process, some, let me say some has long process some has short.*
OKO28	*Authentic learning activities make it easier for me to understand the way the teacher show the diagrams because they, they give me, aaa, when I look at the pictures, I think that this is not easy to create.*

Learners MBO24 and OPO27 in Table 25 stated that authentic learning activities were not time consuming. According to learners MBO24 and OPO27, authentic activities provided them with enough time to finish their work. Learner OKO11 indicated that authentic learning activities would not provide learners with too many activities to do, therefore, learners completed their activities on time. On the other hand, learner OKO28 mentioned that authentic learning activities made it easier for him to understand the way the teacher was teaching by showing him the diagrams and as a result, he had completed his work on time.

Table 26 provides learners' responses on the question: "How much did the authentic learning activities help you to understand the subject content compared to the lecture method? Make your choice from: A=did not help me at all, B=helped me a little, C=helped me somehow, D=helped me a great deal, and explained how".

Table 26: Learners' views on how authentic learning activities helped them to understand the subject content

Respondents	Responses
MBO12	*I think it's helping very well because when you are using real things, it would encourage you more than just being taught without being explained but without showing people what to do or I think this is a great deal.*
OPO25	*Ok, authentic method is the best method or let me say the best plan to teach children because you can see and do things in action rather than the teacher talking in audio, you have to be like think about the things so is better than teaching authentic method. So, it's really a good deal and is better than just teaching, ok it is like a waste of time but then it's good to teach using authentic method.*
OPO33	*Aaa, it helped me with a great deal. Authentic activities helped me with a great deal like when you are taught theory, the teachers are just talking to you while you cannot even see, they are not even like bringing pictures for you that you see and understand, so if you write a test you will be like able to fail because you did not*

	even see drawings, so authentic activities are the best learning sources and they are 100% good.
JKO05	*It helps me because when the teacher is finished to write a summary on the chalkboard, she is asking us that do you understand or do not understand. Then, ask a question from us and if you are not understand you stay here and learn.*
JKO13	*It helped me, when the teacher is teaching, I am listening well.*
JKO17	*Me, I am saying, when the teacher is teaching after she has finish teaching writing the summary then after finishing she ask is there anybody who do not understand and if you do not understand then you must raise up your hand so that the teacher can come and help you where you do not understand.*
JKO21	*Somehow, authentic is better than not using real things.*
OKO06	*It was more understandable than not using authentic process and maybe you might also need help, might also need someone to help you from that, so you can also help the person and it, it will be more understandable than not choosing the person, so it will be much easier for you.*
OKO11	*Let me say that, it's a really great deal because I was impressed by those bulbs, those bulbs like if you, if you take the holder from that bulb the other still light, light up. I never knew it; I knew it if you remove one the rest will also go off.*
OKO12	*Indeed, aaa, authentic is better, is better because it helps the learners to, to, to see how to, to, to invent the, the parallel circuit and series circuit but when I am just like given on the chalkboard and drawing, it does not feel like make sense because a learner needs to visualise in order to give, to give, to give it his or her best.*
OKO28	*I think authentic activities should really be done by the teachers because it makes easier for the learners to understand the diagrams easily and make me feel comfortable when the teacher is teaching.*

In Table 26, learners OPO25, OPO33, MBO12 and OKO11 indicated that authentic learning activities helped them a great deal in understanding the subject content compared to the lecture method. Learner OPO25 also stated that authentic method was the best method through which to teach learners because learners were able to see and do activities practically rather than just listen to the teachers' talks, whereby learners were normally exposed to audio lessons. Learner JKO13 pointed out that authentic activities helped them a great deal as they were listening very carefully and understood better when the researcher was teaching, unlike being taught theoretically while learners cannot even see real things or pictures.

Learner OPO33 further indicated that authentic activities were the best learning source and they were 100% good to teach learners. According to learners OKO11, OKO12 and OKO28, authentic learning activities helped them a great deal and were impressed by the way the bulbs were connected, to be switched on and off. Learner OKO11 further remarked that he never knew before, that in a parallel circuit, when you remove one bulb, other bulbs would remain switched on unlike in a series circuit. Similarly, learners OKO12 and OKO28 emphasised that authentic activities should be used by teachers in their teaching as they helped learners to see or visualise real materials.

Table 27 gives responses from the learners on the question: "So far, to what extent has this authentic learning activities helped you better understand the topics taught? Make your choice from: A=helped a great deal, B=helped somewhat, C=helped a little, D=did not help at all, and explain".

Table 27: Learners' views on to what extent has authentic learning activities helped them to understand electricity

Respondents	Responses
OPO27	*It helped me a big deal because when we were in Grade 6, we were taught about electricity, it was not really easy because our teacher was just telling us and not showing us any example, just teaching us just that out of the blue. Then, Mr Uugwanga* (researcher) *came and taught us about electricity, he shown us the authentic way. It was very easy, I did not even know when he gave us the first test about parallel and series, now I know it 100% even to write it, is very easy now because teacher shown us how is like how the bulbs do in the circuit everything the lines the*

	crocodile clips and everything.
JKO12	*This topic helps me because when I grown-up I want to be working engineer or electrical, so, I want to learn more from electrical.*
JKO13	*It can help me a little because if I grown-up I do not want to be electrical and if I grown-up I want to be a teacher but not a teacher to teach Natural Science or whatever I just teach Social Studies.*
JKO14	*The topic tells me a lot because I am grown-up, I want to be a mechanic or electrician.*
OKO11	*For me is always a great deal, and it helps me much because I am always see those sparkles, but I never knew what, what, what causes now I know that it's static electricity, electricity that does not flow.*
OKO12	*Authentic process, processing, authentic processing materials good, is good because, aaa, it helps, it helps the learners to, to, to, to be, to be understandable on this type of predicament of having to connect the parallel circuit and the series circuit. It's also good because a learner can, can do, a learner have a sharp mind, a sharp mind because when you tell he or she build those type of circuits, she or he already knows how to visualise and improvise on how to, to make it and how to connect the series or a parallel circuit, so it is, it is, it is a good because it helps, it helps us learners to just keep on.*
OKO28	*So, authentic activities increase my understanding of electricity because the way the teacher is teaching with authentic; so maybe wish was easier but that thing would take for long because it help me to increase the, I mean, it helps me, it helps me.*

Table 27 shows that learners OPO27 and OKO11 responded by stipulating that authentic learning activities helped them a great deal to increase and better understand the topic 'electricity'. Learner OPO27 noted that they were taught on the topic 'electricity' in Grade 6, but they did not understand because the teacher only used the lecture method, "teaching them out of the blue" as there was nothing practically demonstrated or shown to the learners. With authentic activities, she found the topic very easy and understood it 100%. Learner JKO12 stated that authentic activities helped them a lot to understand electricity as he wanted to become an electrical engineer.

Learner OKO12 further mentioned that authentic activities helped learners with sharp minds to understand their predicaments. On the contrary, learner JKO13 mentioned that authentic activities helped her little because she wants to be a Social Studies teacher and not an engineer or a Natural Science teacher. With reference to what learner JKO12 said, it means that authentic learning activities had a positive influence and/or played an important role in learners' career choices.

Table 28 gives learners' responses on the question: "How can you describe your overall reactions and/or feelings by using authentic learning activities in science class? Make your choice from: A=it is helpful, B=it is fun, C=it is easy, D=it is difficult, E=it is difficult but helpful, F=it is boring, explain".

Table 28: Learners' overall reactions on using authentic learning activities in science class

Respondents	Responses
MBO01	*It is helpful because you will experience more and if you do not know how the things like cells look like you would experience more and if you do not know how the plants look like, the sunflower things you can go and look, the teacher will show you.*
MBO02	*I think it is very helpful because we get to see the things in reality, and you do not have to imagining.*
MBO12	*I think it's helpful because you are really experiencing how the things are been touched or may be what you seeing, so it is no very good if you go outside, aah, aah, I mean if you stay in the class so if you learning about something and you are outside, you better go outside because outside is more like, you can see everything or whatever you are doing you can see and touch. I think it is very useful.*
MBO13	*I think it is helpful for example if you learning something that's a poisonous tree and non-poisonous tree and we go outside and the teacher explain to us that this is the poisonous tree instead of just talking and tell us how it is, we might get the poisonous tree which you think is the non-poisonous.*
MBO24	*I think it's a good thing for us to go out and see how, what the teacher is telling us in the class with what is real outside.*
MBO34	*I would say that, seriously when you are in the class and the*

	teacher is explaining on the chalkboard, sometimes you will be trying to imagine what she said but I may get confuse, so, I am saying it is better if we are at a certain topic and that object is within the school we can go outside and then we can discuss it.
OPO25	*As the fellow learners say that authentic method is the best, it's fun, enjoyable and everything is very good. Nice method but and if like, like all the learners now they are like they can understand 100%, Sir, it's a very good method it they could do something to replace it Sir, it's good because we learn more with it.*
OPO27	*It's very, it's very easy for me because, aaa, we learn visually, we can memorise it very nice in the head and is very easy for me because, aaa, if, if, if, I, I, I'm very a slow learner, I cannot really capture things in my head just like that when the teacher is just explaining. It was very easy for me when Mr Uugwanga* (researcher) *was teaching us aaa, aaa, the, the, the authentic way. It was very easy for me.*
OPO32	*Authentic are, Sir, it's very easy because it helps us learners to learn more and understand all the things that the teachers are teaching us in authentic way.*
OPO33	*Aaa, the thing that I want to say is like are authentic activities were very good I think if it was the assessment test that we wrote in the Natural Science that Mr Uugwanga* (researcher) *taught us I think all the learners were supposed to get A, B and C, thank you.*
JKO05	*Electricity is good but is not good, is somehow because is shocking or is killing you.*
JKO12	*It's easy because I like that topic, so, it's not difficult to me learn.*
JKO13	*It is helpful because some topics in science is very, umh, is very, is very easy to me because authentic is just like when, when the topic that's electricity is, is, is easy because you mentioned the batteries, the bulbs and the, the, the cells and the switch. You mention the, and you, you draw the bulbs and cells in series and circuit in series and circuit in parallel and you do and then you, you, you will do, you do nice you teach.*
JKO17	*It's helpful, sometimes the teacher can make for you a circuit that you can know it and even when you make it some just you have to add some. They will ask you to draw, you can remember that the bulb was here, the switch was here if you want to draw a circuit in parallel, the bulbs, if you are told the bulbs must be three, you must make the bulbs like this but sometimes if you are told face-to-face like this then when it comes you do not know the thing.*
JKO21	*It's easy. When the teacher is teaching, you listen and see how it's working and how to connect and try to make your own connections.*
OKO01	*I think it was very fun and helpful because, aaa, when, when you, when you take the, the, the bulb from the, the, the, the bulb holder the switch, the, the, the, I mean the bulb were on still and I think that was a really good experience.*
OKO05	*It really helpful because it taught me to understand more than*

	lecture method.
OKO06	*It was really helpful and also fun because I never knew the different between parallel circuit and series circuit and by using authentic, I can now identify the different between parallel and series circuit.*
OKO11	*My experience was great, fun and good because I get, get to know the holders of the bulbs, I get to know the holders of the bulbs and it was really interesting, I was happy, I was really happy because it taught us a lot.*
OKO12	*In dependably, it has been easy because it has been, aaa, a great experience on how to connect parallel circuit and series circuit, aaa, it very good experience for the learners to, to really, really just, just share information with the teacher, with the teacher and, and, and during after classes lessons that learner will go home and try to visualise what the teacher was teaching and memorise and when he come back to school he will know that the teacher has been teaching him well and he will know that the teacher is, is, is, is aa, when he is teaching using authentic; it makes you, it makes he or she very, very, very, it makes, very, very easy for the learners.*
OKO28	*It's really fun because the way we understand it and the way we love it and have fun and if the teacher, teacher, the teacher teach us authentic activities, he, he tries to make it fun and funny for the learners to make it understandable for them because they love to have fun.*

Table 28 shows that learners MBO01, MBO02, MBO12, MBO13, JKO13, JKO17, OKO01, OKO05 and OKO06 responded that by using authentic learning activities in science class were helpful because they enabled them to see real materials such as bulbs, conductor wires and cells rather than imagining them. This was justified by learner MBO13 who said that authentic activities were *"helpful for example if you learning something that's a poisonous tree and non-*poisonous tree *and we go outside and the teacher explain to us that this is the poisonous tree instead of just talking and tell us how it is, we might get the poisonous tree which you think is the non-poisonous"* because learners have never seen or shown these trees before.

Learner MBO34 remarked that: *"I would say that, seriously when you are in the class and the teacher is explaining on the chalkboard, sometimes you will be trying to imagine what she said but I may get confused, so, I am saying it is better if we are doing a certain topic and that object is within the school we can go outside and then we can discuss it".* Learner MBO34 stated that it was important to be taught using authentic activities and then let learners have discussions about it in order to avoid confusions and in so doing, learners would also understand the topic much better than being taught without using authentic activities.

As observed from Table 28, learners OPO25, OKO01 and OKO28 indicated that using authentic learning activities in the science class was fun while learners OPO27, JKO12, JKO13, JKO21 and OKO12 indicated that it was very easy to understand the topic 'electricity' when they were taught with authentic activities; while learner OPO25 mentioned that the lessons were enjoyable.

Learner OPO27 stated that as a slow learner she could not really capture things in her head just like that when the teacher was just explaining but she could learn better visually when authentic activities were used. Learner OKO12 said that when taught with authentic activities, it was like information sharing in the class between the teacher and the learners. He further stated that when taught with authentic learning activities learners would easily visualise what the teacher was teaching them in class without even memorising what they were taught even if they were at home. The themes that emerged from the participants' interviews are presented and discussed below.

4.5.1 Theme 1: Conceptual understanding of electricity

Learners in their responses indicated that authentic learning activities were the effective teaching intervention. This indicates that during teaching the topic of 'electricity' using authentic learning activities, learners had a clear understanding of the topic unlike being taught without using authentic activities. With authentic activities, learners learnt a lot during the teaching and learning process and were able to comprehend what they were taught in the class. Learners indicated that they were not only able to contextualise and understand the Natural Science concepts well but also to remember the subject content that they were taught. When learners were taught electricity using authentic learning activities, they were able to differentiate between connecting the circuits in parallel and in series.

In addition, even the instructions that were given during teaching and learning process were very clear and straight forward to stimulate their conceptual understanding. Therefore, the learners' conceptual understanding of electricity was increased and enhanced (Suryawati & Osman, 2018). From the learners' responses, it is obvious that even if teachers teach learners Natural Science concepts but do not make use of authentic learning activities that would not help learners much to understand science concepts and comprehend what is taught. The use of authentic learning activities in teaching electricity also helped learners to follow the instructions easily and with understanding.

4.5.2 Theme 2: Explanations of key concepts on electricity

Judging from what learners said in their responses, it seems that these learners only understood the key concepts on electricity better when they were taught using authentic learning activities. This means that learners never knew before ‘how’ and ‘why’ people mostly prefer connecting lights in parallel than in series. Teaching Natural Science using authentic learning activities had created a platform whereby the key concepts on electricity were well explained to the learners and learners understood them perfectly. Based on the learners’ answers, authentic learning activities really helped them a great deal as learners could now be able to explain the connectivity of electricity to each other.

Learners had also indicated that they were impressed by the way the bulbs were connected especially when switched on and off. This means that authentic learning activities in teaching science concepts are self-explanatory as they help learners to figure out and understand for themselves with less explanation from their teachers. In short, authentic learning activities make teaching easier in terms of explaining the key concepts to the learners because learners see authentic materials such as bulbs, conductor wires, cells and were able to understand their primary functions rather than imagine them when being taught through the lecture method.

4.5.3 Theme 3: Capturing of learners’ attention

From the learners’ responses, authentic learning activities seem to capture their attention and stimulate positive attitude within the learners’ mind-set. Learners acknowledged that with authentic learning activities, they actually tended to listen very carefully to the teaching of science concepts. During teaching science concepts, learners were concentrating when they saw the real materials that were used to teach them about electricity. By visualising real teaching and learning materials it did not only captured the learners’ attention but also enabled them to understand science concepts better. This means that when learners listen to the teacher when teaching them using authentic learning activities, they fully pay attention and assimilate what the teacher would be teaching them with what they will have seen in reality.

When learners' attention is captured during teaching and learning process, they tend to carry out their tasks practically and complete them diligently and timeously. Learners also indicated that with authentic learning activities, they were able to see and do their activities perfectly rather than listening to the teacher's talk, through audio lessons. In addition, authentic learning activities were not only encouraging learners to pay attention but also to make the lesson more fun and enjoyable to them.

4.5.4 Theme 4: Interest to study science and career awareness

From the learners' responses, being taught using authentic learning activities, gave them an interest to study science in the future. Learners also stated that authentic activities were useful in their future careers because when someone wants to become a scientist, he/she can use the information that he/she acquired from the previous school where authentic activities were used. It means that using authentic learning activities helped learners to become aware of careers and able to make the right choice at an early age. With reference to what learners have indicated, it means that authentic learning activities had a positive influence and/or played an important role in learners' career choices and interest in studying science in future.

4.5.5 Theme 5: Transformation of learners' understanding of electricity

Being taught using authentic learning activities was an amazing practice in the learning process for the learners. From learners' responses, they expressed that they did not know how to connect an electrical circuit before. But when they were taught on the topic of electricity using authentic learning activities, the learners' understanding of electricity before this intervention was transformed.

According to the learners' responses, it took them time to understand how electricity works before they were exposed to authentic learning activities. But thereafter, learners understood what an electrical circuit was, and they were able to connect the electrical circuit by themselves. One learner noted that they were taught electricity in Grade 6, but they did not understand it because the teacher only used the lecture method. Then, her understanding of electricity was transformed after being exposed to authentic learning activities that allowed her to demonstrate electrical connections practically for better understand.

The overall results of this study indicate that there was a statistically significant difference in the pre-test mean scores of the control and experimental groups at the beginning of the study. Although the experimental group scored higher than the control group, their mean scores seemed closely similar before the intervention. The post-test results show that the experimental group significantly outperformed the control group. The STAQ-R's results show that the self-directed effort was the highest factor in explaining the variance compared to the other six factors and it mostly attracted learners to Natural Science and positively influenced their attitude towards the subject.

The semi-structured interview results showed that learners supported the use of authentic activities in teaching and learning of Natural Science. This concludes that authentic learning activities seemed to have a positive effect on the learners' achievement scores on the topic of electricity. In addition, authentic activities seemed to have positively influenced the learners' attitude towards Natural Science and it also enabled learners to see real teaching and learning materials rather than imagining them. On the whole, learners understood the subject content on 'electricity' since they were engaged in practical activities as compared to the lecture method.

4.6 Summary

This chapter presented data on the effect of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners. The data was collected from four schools in the Khomas educational region and four schools in the Omusati educational region. The pre- and post-tests, questionnaires and semi-structured interviews were used to collect data from the sample. The study objectives were used to organise and present data. The next chapter discusses the results of this study.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Introduction

The main aim of conducting this study was to investigate the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in Khomas and Omusati educational regions.

This chapter discusses the relevant research findings that were collected from the pre- and post-tests, questionnaires [The Simpson Troost Attitude Questionnaire-Revised (STAQ-R)] and semi-structured interviews according to the following themes:

1. The effects of authentic learning activities on the learners' achievement scores.
2. The influence of authentic learning activities on the learners' attitude towards Natural Science.
3. The experimental group' views on the effects of authentic learning activities in Natural Science.
4. The four-domain model for teaching and learning science using authentic activities.

5.2 The effects of authentic learning activities on the learners' achievement scores

The comparison of the mean scores of the control and experimental groups on the pre- and post-tests was done to find out how learners scored in both tests. Both groups were given the same pre- and post-tests. The findings from the pre-test indicated that the experimental group scored higher than control group. The findings are in line with the results reported by Ghanbari, Esmaili, and Shamsaddini (2015) and Ullah, Tabassum, and Kaleem (2018) who found that their control and experimental groups' mean scores on the pre-test were almost similar.

This means that both groups seemed to have almost the same knowledge and understanding of the topic on 'electricity' before the intervention. As far as the pre-test mean scores were concerned, learners in both groups were taught Natural Science on the topic of 'electricity' starting at same level. Learners in the experimental group were taught using authentic learning activities while learners in the control group were taught using a normal teaching (lecture) method as an intervention. Thereafter, the same post-test was given to both groups to determine the effect of authentic learning activities on learners' achievement scores on the topic of 'electricity' then the groups' post-test mean scores were compared. The comparison between the control and experimental groups' mean scores on the post-test is given in Table 9.

This concludes that learners' achievement scores show a significant difference between the experimental and control groups. The higher increase mean score of the experimental group from pre-test to post-test as compared to the control group mean score, supports the previous studies by Gambari, Shittu, Ogunlade, & Osunlade, (2017), Hussein & Elttayef, (2017), Krishnan, (n.d). and Widyawati and Trisanti, (2017) who found out that their experimental group showed a significant improvement in academic achievements compared to the control group.

The high performance of the experimental group on the post-test seems to support the views of Gull and Shehzad (2015). Gull and Shehzad argue that the intervention within the experimental group often has a positive effect on learners' academic performance because authentic learning activities enable learners to be proactive in their learning (Mehta & Kulshrestha, 2014). When learners are proactive in their learning, they tend to contribute positively to their academic achievements. This result is in line with the views of McCarthy and Lockwood (2013) and Sahin and Namli (2016) who suggest that authentic materials motivate learners to fully engage with others; inspire learners to learn by doing; and motivate learners to become academic achievers.

Similarly, Moodley and Aronstam (2016) state that authentic learning activities promote a theoretical inquiry and also encourage learners to demonstrate higher levels of critical thinking. Based on the findings of this study, authentic learning activities seemed to enhance learners' acquisition of science concepts and enabled learners to observe the reality of science. When learners fully acquired science concepts and understood the reality of science, they tended to out-perform learners who were not exposed to authentic learning activities.

Nonetheless, the results also indicated that learners in both groups improved their academic achievements from the pre-test to the post-test. The increased control group's mean score on the post-test seemed to indicate that learners benefited from extra teaching given to them on the topic of 'electricity' and improved their understanding of electricity under the traditional approach. These results agree with the findings of Shivaraju, Manu, Vinaya, and Savkar (2017).

Shivaraju et al. found that all their learners overall mean scores on the post-test scores showed a highly significant improvement compared to their pre-test scores. According to Shivaraju et al. (2017), the lecture method that was used during the teaching and learning process by the control group was found also to have a positive impact on the learners' academic performance. Similarly, the results also concur with the findings of Malik (2011) who indicate that the active lecturing approach enables learners to comprehend what was taught to them and as a result the learners also tended to perform better on the post-test.

The findings of this study provide strong evidence on the effects of authentic learning activities on learners' achievements. Thus, learners' achievement scores show a significant difference between the experimental and control groups. Hence, it could be concluded that authentic learning activities had a positive impact on learners' achievement scores on the topic of 'electricity'.

The next section discusses the results from The Simpson Troost Attitude Questionnaire-Revised (STAQ-R) questionnaire.

5.3 The influence of authentic learning activities on the learners' attitude towards Natural Science

The findings on the level of the learners' feeling on whether authentic learning activities influenced their attitude towards Natural Science are discussed under the following headings: self-directed efforts; anxiety about science; career awareness; motivating classroom; relevance of science; science is fun; and value of efforts in learning Natural Science in this case. Learners' frequency responses on various items that assessed their attitude towards Natural Science were recorded; whereby, ‘strongly agreed’ and ‘agreed’ were combined, the same was done with responses like ‘disagreed’ and ‘strongly disagreed’.

5.3.1 Self-directed efforts

The results presented in Table 10 indicate that more than 80% of the learners ‘agreed’ and ‘strongly agreed’ that they enjoyed science, liked to learn more about science, when they failed, that made them to try much harder, they learned about important things in science and they really enjoyed science lessons. It seems that most of the learners enjoyed learning science itself and its lessons. The findings are in congruence with that of Gomez-Arizaga, Bahar, Maker, Zimmerman, and Pease (2016) who found that learners enjoyed science lessons and science learning activities as much as they could because they were provided with an “opportunity to create, share and put their ideas into action” (p. 449).

Similarly, Harlen (2010) states that learners liked to study science as it enabled them to enjoy and understand the natural world. The results also indicated that due to the fact that learners liked science, they were motivated to try much harder even if they failed. Similarly, the results were also in agreement with Deans for Impact (2015) who argued that in self-directed learning, learners were motivated to believe that to work harder, their intelligence and abilities might improve. Therefore, the results proved that authentic learning activities encouraged learners to be self-motivated and enabled them to achieve.

According to the results of this study, learners agreed that they learned important things in science. These results are supported by Gomez-Arizaga et. al., (2016) and Harlen (2010) who argue that it is important for the learners to learn more about science in order to understand the world around them; increase their subject content knowledge; and realise that science is more fun, enjoyable and motivating.

The findings further indicated that learners agreed that science was easy for them and they really liked science. These findings agreed with the report by the Wellcome Trust (2011) which found that young learners appreciated science as an easy subject and learners liked the subject because it was interesting, and its content related to real life compared to other subjects. On the contrary, the study conducted by Rohandi (2015) found that learners experienced difficulty in learning science comprehensively. According to Rohandi (2015), learners hardly understood their teacher's teaching and the use of uninterested learning activities in the science class. Lack of interested learning activities in science class seemed to lead learners to dislike science and might contribute to learners' poor academic achievements.

The results of this study also found that learners agreed that they had good feelings towards science, confident that they could understand science and always tried hard in science no matter how difficult the work was. This result is in line with the result obtained by Lalmuanzuali, Malsawmi, and Lalchhandami (2019) who argue that learners who develop positive feelings towards science at the beginning of their science education, tended to be more motivated and were likely to have a deeper understanding of scientific concepts in the future.

Learners’ responses on self-directed efforts’ items concurred with what Kan’an and Osman (2015) found in their study that “learners that were highly self-directed can depend on themselves in learning science and would have greater academic achievements in science” (p. 794). This view seems to suggest that the experimental group in this study was self-driven and motivated towards Natural Science and their achievement scores in Natural Science were a result of their attitude towards the subject.

5.3.2 Anxiety about science

Learning Natural Science should be an exciting experience to learners and should not cause anxiety among learners. According to Langat (2015), learners’ negative attitude towards science subjects cause fear and anxiety within the learners as they continue to perform poorly in science subjects due to lack of interest, curiosity and patience required for learning and performing in science subjects. The results in Table 11 show that 21% of the learners ‘agreed’ and ‘strongly agreed’ that they were fearful and anxious about Natural Science. The findings are in line with the results reported by Cooper, Downing, and Brownell (2018) who found high levels of anxiety shown by learners towards science. According to Cooper at al. (2018), the anxiety was shown because learners were afraid of their academic performance during active learning activities.

On the contrary, Ali (2015) found that authentic learning activities tend to help learners “understand science and not be fearful of it” (p. 21). Ali further indicated that “science anxiety is the fear of science” (p. 24). Hence, Ali (2015) seemed to caution learners that they should not be worried about science otherwise their academic achievements and attitude towards science would be negatively affected when they fear the subject. This study also found that learners agreed that if they could choose, they would not take any more science subjects in school because they did not understand science even if they tried harder. In the same line, Darlington (2017) found that learners who struggled with understanding science had indicated that they started to work harder and that would enable them to work easier later.

Despite the fact that 68.6% of the learners had 'disagreed' and 'strongly disagreed' on the questionnaire that science lessons were a waste of time, 16.9% of learners had 'agreed' and 'strongly agreed' that they did not like science although teachers were encouraging them to understand concepts in science classes. Based on this result, learners seemed to regard their science teachers as motivators because teachers encouraged learners to do science and understand its concepts while learners disliked science.

These findings are in the line with the results reported by Christmas (2014) who found that in authentic learning, teachers facilitated and encouraged learners to take ownership and responsibility of their own learning. According to Christmas (2014), learners were also encouraged to be critical thinkers, problem solvers and to develop interest in science subjects. The findings seemed to establish that teachers were not only encouraging learners to understand science concepts but also to overcome the anxiety and fear that they developed towards science subjects. This means that science teachers should encourage learners in their classes not to fear Natural Science but rather to overcome their anxieties and negative perceptions towards the subject. Thus, Sabzian and Gilakjani (2013) argue that the "high anxiety can lead to negative attitude and eventually negatively influence the learning process" (p. 633).

5.3.3 Career awareness

The results presented in Table 12 show that 45.1% of the learners 'agreed' and 'strongly agreed' that they would become scientists in the future, 19.4% of the learners 'disagreed' and 'strongly disagreed' while 35.5% of the learners were not sure. The result findings in this study concur with the findings of Veloo, Nor, and Khalid (2015) who found that learners especially girls showed a negative attitude towards any career related to science. On the other hand, the findings by the American Society for Engineering Education (2017) found that more girls than boys in the experimental group increased their interests and attitude towards pursuing careers in the science field.

The results of Ahmad and Asghar (2011) seem to caution learners to guard against their attitude towards science as this might affect their course, achievements and future career choices. Even though, the study also revealed that 37.9% and 79.0% of the learners agreed and strongly agreed that they would study science if they get to the university and do well in science respectively; this does not necessarily mean that all these learners would become scientists in the future.

Similarly, the results also confirmed the findings of Cohen, Patterson, Kovarik, and Chowning (2014) who argued that the "understanding of the role of science in our society" (p. 16) and awareness in science related careers are important for all the learners even if learners opted not to become scientists. The findings of this study proved that career awareness is necessary and should be introduced to the learners at an early stage of their schooling. When learners are aware of their future careers at an early stage of their education, this is likely to positively influence their attitude towards a given school subject and they might achieve good results in the subject. In the same vein, Fernandez (2017) states that "authenticity in science had the potential to radically improve career awareness and in so doing, it improves learners' motivation to study the subject by making them aware of their future relationship with the subject" (p. 5).

5.3.4 Motivating classrooms

Table 13 shows that 65.3% of the learners 'agreed' and 'strongly agreed' that their science classrooms contained a lot of interesting equipment. The findings are in line with the results reported by Gürgil (2018) that the authentic materials prepared for science teaching were found to be effective and interesting to the learners. Similarly, the results are supported by Ghanbari et al. (2015) who found that science materials in a science class were helpful as they encourage and motivate learners to understand the real world rather than the classroom environment. This means that when learners are exposed to science classrooms that contain interesting, encouraging, and motivating science equipment, their attitude towards the science subject tend to be positively influenced.

In addition, these study results are supported by Christmas (2014) who found that meaningful and useful authentic learning materials provide learners with in-depth understanding of the subject content and discourage them on depending solely on the textbooks. The results of this study on a motivating classroom environment revealed that the majority of the learners had a positive attitude towards Natural Science, because their science classrooms contained a lot of interesting equipment. According to Needham (2014), the interesting science equipment seems to attract and motivate learners to like science subjects and not to give up when they do not understand science concepts.

For the learners to understand science concepts and perform better, they should be motivated, encouraged and be taught in a science oriented classroom environment with interesting science activities, otherwise, they might lose interest in the subject and give up (Ivowi, 2001). This is supported by Lyons and Quinn (2010) who found that the most effective way to encourage learners to understand science was to ensure that science classrooms' environment were interesting and enjoyable.

5.3.5 Relevance of science to learners' lives

Natural Science seems to be an important subject since 63.7% of the learners 'agreed' and 'strongly agreed' that they would miss studying science when they leave school. The findings concurs with Lewin (1992) who found that science was relevant to the lives of the learners, mostly to those who left school during or after secondary education as their understanding of science content were still useful and were positive towards science. According to Lyons and Quinn (2010), the best way to encourage learners to pursue science after leaving school was to make science lessons at primary level authentic.

Furthermore, 61.3% of the learners 'agreed' and 'strongly agreed' that science was useful in solving everyday life problems. This is in line with the views of the

European Union (2015) that suggests that learning science is more relevant in learners' lives and should be prioritised and connected to their lives for solving social problems. On the contrary, the findings of Sharpe (2012) reveals that learners did not see the relevance and usefulness of what they learned or did in practical science work after leaving school because what they learned in science had little influence on their lives or careers.

Similarly, the study published by OpinionPanel (2010) found that only few learners who indicated that studying science was relevant to them because they intended to pursue their careers in science fields at the university as compared to the majority of the learners. According to the Wellcome Trust (2011), there was a need to increase learners' understanding of science so that what they learned in school would be relevance and have a direct influence in their everyday lives after leaving school.

Be that as it may, Mukhopadhyay (2013) argues that problem solving activities should be taught to the science learners to enable them to cope with their lives beyond school. Generally, the results show that learners who agreed to the three items about the relevance of science had a positive attitude towards Natural Science as a subject and they were likely to miss science when they left school and they viewed science as being a useful and relevant subject in solving everyday life's problems.

5.3.6 Science is fun

Under the item 'science is fun', 57.3% of the learners indicated that they would enjoy working in a science-related career even though they believed with 34.6% that scientists did not have time for fun. Whereas, 45.1%, total number of the learners were uncertain to both items while 61.3%, total number of the learners ‘disagreed’ and ‘strongly disagreed’ with the item. The findings are in line with the results reported by Chapman (2013) and Lewin (1992) who found that school science was fun and enjoyable to the learners; therefore, learners were interested in science and opted to study in science-related careers after high school, but they were unsure which specific careers they would study.

Similarly, previous studies by Ahmad & Asghar, (2011), Newell, Tharp, Vogt, Moreno, & Zientek, (2015) found that learners were interested in science and were encouraged to pursue careers related to science even though they were not aware before which careers, they would follow. The results on learners’ interest in a science-related career support the findings of Sadi and Cakiroglu (2011). Sadi and Cakiroglu found that teachers were using authentic activities in their classrooms to make science lessons fun, more enjoyable and attract learners’ attention. In so doing, it motivated learners to enjoy science subjects and encouraged them to take science-related careers in the future.

On the other hand, Sharpe (2012) found that authentic activities had very little influence on learners’ career aspirations. According to Sharpe’s findings, although learners appreciated the benefits that authentic activities had on their careers and valued the science subject itself, most of the learners were found not interested to take a job in a science profession especially where practical work would be involved.

5.3.7 Value of efforts in learning Natural Science

In Table 16 the results indicate that 86.3% of the learners ‘agreed’ and ‘strongly agreed’ that they always tried to do their best in school while 84.7% of the learners ‘agreed’ and ‘strongly agreed’ that their science teachers were very good in teaching Natural Science. These results are supported by the findings of Darlington (2017) who found that learners praised their teachers as good teachers.

According to Darlington’s findings, teachers were good because they were explaining the contents of science clearly to the learners and also used authentic learning activities that helped learners to better understand science. Darlington’s findings were in line with the results reported by the Wellcome Trust (2011) that teachers positively influenced learners’ attitude towards science.

According to the Wellcome Trust (2011), teachers made their “science lessons enjoyable, interesting and understandable through their passion for their subject” (p. 7). This implied that teachers’ passion for teaching science using authentic learning activities also motivated learners to perform better in science. On the contrary, the findings of Sharpe (2012) revealed that not all the learners regarded their teachers’ use of authentic learning activities as the best way of learning science. According to Sharpe’s findings, learners mostly valued their self-effort as that was what motivated them to learn science.

Generally, the study also found out that learners considered their science classrooms as being attractive and comfortable which motivated them to do better in science even though 25.8% of the learners agreed that they would not pursue a science-related career in the future. This result is supported by Sieberer-Nagler (2016) who found that it was important for teachers to create a positive and comfortable classroom atmosphere which attracts and rouses learners' abilities and interests towards science.

Similarly, the results of Arthur (2005) found that learners liked science and regarded themselves as good in science because they were doing and learning new things every day in science classrooms. In the same vain, the findings reported by the Wellcome Trust (2011) revealed that teachers were found to be helpful. According to the report by the Wellcome Trust (2011), teachers were helping learners to find relevant information on how to pursue their careers in the science-related fields. In so doing, this tended to highly encourage learners to value their efforts to pursue a career in science and also to positively influence their attitude towards science subjects including Natural Science.

5.3.8 Exploratory factor analysis on factors extracted after varimax rotation with items and factor loadings

The results in Table 17 indicate that seven factors explaining 44.06% of total variance were obtained. The self-directed effort factor of 24 variables had 15.7% of variance with factor loadings ranging from 0.31 to 0.68 and it was the highest factor in explaining the variance compared to other factors. This implies that self-directed effort factor was the factor that mostly attracted learners to Natural Science and positively influenced their attitude towards the subject.

It appears that learners appreciated the variables that formed self-directed effort factor the most as this factor motivated them to succeed in science and influenced their attitude towards Natural Science more than other factors (Liaghatdar et al., 2011). With this factor, learners seemed to develop self-reliance which encouraged them to be self-motivated towards the learning of Natural Science after exposure to authentic learning activities. Despite learners’ views of the variables on self-directed effort factor, learners were also sceptical about Natural Science. Learners seemed to be afraid of science. Therefore, anxiety towards science factor was the second highest factor with 6.7% of variance and factor loadings ranging from 0.32 to 0.6 of the variables measuring learners’ attitude towards Natural Science as a subject.

For instance, with reference to the variables, learners were grateful and confident that they would continue studying science after leaving school, although they were also worried that working as a scientist would be boring. Despite the fact that anxiety about science factor had 6.7% of variance of variables that measured learners’ attitude towards Natural Science, learners were aware of their future. In other words, the career awareness factor concerned with learners’ future interests had 5.05% of variance with factor loadings ranging from 0.38 to 0.57 and that also appears to have attracted and changed learners’ attitude positively towards Natural Science.

The study also found that motivating classroom and relevance of science influenced learners with 4.6% and 4.55% of variance with factor loadings ranging from 0.43 to 0.49 and from 0.32 to 0.59 respectively. This implies that only few learners who believed that variables loaded on motivating classroom and relevance of science factors influenced the attitude towards Natural Science. This also means that learners usually gave up when they do not understand science concepts, even though they believed that science is useful in solving everyday life problems.

These are factors that also played equal roles on learners' attitude towards Natural Science which increased learners' interest in science-related careers and achievements in the science subjects (Ahmad & Asghar, 2011; Liaghatdar et al., 2011). This suggests that a science classroom that contains a lot of interesting science equipment seems to develop learners' interest to study science after leaving school.

However, 'science is fun' and 'the value of efforts' had 3.87% and 3.59% of variance with factor loadings ranging from 0.33 to 0.47 and from 0.32 to 0.46 respectively. These were regarded as the factors that had no great effect neither influencing learners' attitude towards Natural Science as they had the lowest percentages of variance among other factors. In fact, few learners believed that scientists as professionals had time for fun. Therefore, these learners indicated that they would not pursue a science-related career in the future. Nevertheless, the findings by factor analysis indicate that authentic learning activities positively influenced learners' attitude towards Natural Science.

The next section discusses results from the semi-structured interviews of the experimental group on how they viewed the effects of authentic learning activities in Natural Science.

5.4 Experimental group's views on the effects of authentic learning activities in Natural Science

Twenty-two learners were interviewed with a specific intention to investigate what they thought about the effects of authentic learning activities in teaching and learning Natural Science. The eleven interview questions are given in Appendix F and elaborated upon herein. The researcher wanted to know from the learners what they thought of being taught through authentic learning activities.

5.4.1 Learners' views on what they thought of being taught through authentic learning activities

Seven learners (Table 19) appreciated the fact that they were being taught through authentic learning activities during the research. To support this illustration, learner MBO02 said *"being taught in authentic is a good thing, because now we know how series are like and the bulbs. It is much better than being taught but you do not know how things are like"*. Whereas, learner OKO06 mentioned that *"I understand more, better than not using authentic"*. The learners' views seem to indicate that authentic activities enhanced the learners' understanding of the content they were being taught (Iucua & Marina, 2014; Suryawati & Osman, 2018). Furthermore, learners' answers indicated that being taught through authentic learning activities helped learners to understand and remember the subject content that they were taught.

In support, Hui and Koplin (2011) state that authentic activities help learners to understand and remember the complexities of the real world outside the classroom. This means that authentic learning activities would not only help learners to remember and understand what they were taught during the research but even later. These views are supported by Ilter and Kilic (2015) who aver that authentic learning activities enable learners to experience and learn the subject content much better and would serve them beyond the classroom.

5.4.2 What learners liked most when taught through authentic learning activities

In Table 20, learners indicated that they liked to be taught the topic on electricity with authentic learning activities. Learner MBO13 mentioned that *"...my favourite part of being taught with authentic actually see what the teacher is explaining to you, so at the end of the day you know what you were taught on"*. Learner OPO33 indicated that *"... a learner can really learn better by experiencing or visualising the items that the teacher can teach so that he or she can understand..."*. And learner OKO28 stated that *"it* (refers to authentic learning activities) *gives the learners and teachers more information about how and why things should be used"*.

The study found that learners appreciated the use of authentic learning activities as it enabled them to actually listen to their teacher's explanations and at the same time, they were able to see the reality of what the teacher was teaching or talking about. This sentiment is supported by Iucua and Marina (2014) who state that in authentic science classrooms, learners take responsibility for their learning that reflects the real-world and requires them to know real objects and engage in authentic learning activities rather than engaging in rote learning activities.

Furthermore, learner JKO13 stated that *"I like authentic because it teaches us how to make electrical, how to make the circuit, and how to connect them"*. Whilst learner JKO17 put it that *"...authentic taught you how to make and use your own thing like if* *you are not having a bulb, you can search a bulb from the lamp, from the torch so that you can make your own circuit"*. It seems that learners liked to be taught in authentic learning activities as they prepared learners for the real world. These results are supported by the findings of Koplin and Hui (2011) and Pearce (2016) who found that authentic learning helped learners to connect their classrooms' learning to the real world and also prepared learners to make a meaningful link from what they learned in classrooms to the outside world.

This means that learners need to understand the real meaning of the universe in authentic science classrooms so that they can better understand themselves and the world around them in which they live. Similarly, Christmas (2014) maintains that in authentic science classroom, learners fully participate and engage in meaningful activities that interact with their own environment and that of the outside world. In so doing, it enhances their conceptual understanding and motivates them to perform better in Natural Science.

As it was pointed out by learner OPO33 that *"... a learner can really learn better by experiencing or visualising the items that the teacher can teach so that he or she can understand..."* This implies that learners understood science better when they visualised real teaching and learning materials than being taught without authentic learning activities. This is supported by the findings of Shabiralyani, Hasan, Hamad, and Iqbal (2015) who found that learners considered visual aids as useful and relevant as they were subject content related and they improved learners' understanding towards science lessons.

These results are in line with what Kusi (2017) found in her study. Kusi found teachers using visuals and real things in science classrooms and also demonstrated them to the learners on how to apply them in their daily activities. Similarly, Kovač and Kovač (2011) argue that learners should use learning materials that stimulate their conceptual understanding and relate to their own real life experiences.

5.4.3 What learners disliked most when taught through authentic learning activities

In Table 21, learners JKO13 and OKO06 indicated that they disliked being taught using authentic learning activities when the topic was about human anatomy. Learner JKO13 narrated that *"I do not like the human being because some teachers told us that human being ...long ago ...like monkeys".* While learner OKO06 indicated that *"some authentic things are also scarily and might damage learners' brains; example, the skeletons".* Learners' remarks are supported by the findings of Al Darwish (2014) who found that the language used during the use of authentic learning activities was difficult to understand and also the items used disturbed both teachers and learners. This agrees with the results by Edrenius (2018) who found that with authentic materials "it is difficult to know if the material is at a suitable level for the learners" (p. 24).

In the same way, learners OKO11, OKO12 and OKO28 cautioned that when teachers are using authentic materials in teaching and learning the topic of 'electricity', they must ensure that these materials should be handled with care; otherwise, they might cause shock that would lead to fire and/or accidental fall and damage. According to learner OKO12, *"sometimes authentic materials are dangerous because some* *teachers do not know how to use that materials and the slightest mistake, he or she drops it or do mistakes or something can cause shock reactions and it might ruin the whole period, the class. Those physical damages can be dangerous can cause electrical explosion and the classroom lead to fire".* It is important to note that when this happen, it disrupts the whole lesson and therefore, teachers are cautioned to be well trained, have experience and/or practical knowledge on how to use authentic learning activities in advance.

This is what learner OKO28 said *"...the teacher has to practice before he or she jumps to the conclusions that he or she knows how to use..."* otherwise *"...teaches us there might be mistakes and cause troubles to the school and lose his or her job"*. In so doing, this eliminates making mistakes and avoids wasting teaching and learning time in the classroom. Learners' remarks are supported by Huda (2017) who argues that teachers need training on how to use authentic materials mostly on how to design relevant and appropriate teaching and learning task activities. Huda's claim is in line with the work of McLaughlin and Arbeider (2008) who found that science teachers were trained on how to conduct authentic field work during teaching and learning process.

5.4.4 Whether authentic learning activities helped learners better understand electricity

Nine learners in Table 22 indicated that authentic learning activities helped them to understand the topic 'electricity' better. This is how learner OPO27 put it across *"...it* (referring to authentic) *really helped me to understand and know how the circuit works, now I know how, and why people put lights in parallel and not in series and* *so on, that's why and I learned a lot of stuffs in authentic way"*. And learner JKO13 said that *"...we understand that topic* (referring to the topic 'electricity') *because we learned, and you explained to us what we have to do, and we know thoroughly"*.

In support of these learners' views, Widowati, Nurohman, and Anjarsari (2017) found that authentic learning activities help learners to better learn and be critical thinkers and also help teachers to better teach during the teaching and learning process. Furthermore, learner OKO28 mentioned that *"...what makes it very easy is how the teacher designed the parallel circuit for the learners to understand more about it"*. This is in the agreement with Pantiwati et al. (2017) and Suryawati and Osman (2018) who argue that using authentic learning materials during teaching and learning of Natural Science enables learners to understand better as they connect the real activities to the real world.

According to learner OKO28, authentic activities really helped him to figure out which electrical connections were in series circuits and which one was in parallel circuits. This is what he had to say, *"...really helped me to figure out which electricity in series circuit and parallel circuit"*. This is in line with Moe (2011) who states that authentic learning activity as an inquiry-based instruction can help learners to understand science content and its concepts.

Authentic activities also helped learner OKO12 who maintained that authentic activities were useful for his future career. This is what learner OKO12 stated *"...useful in our future because like when if a person want to become a scientist..."* Similarly, the results also confirm the findings of Houbad (2016) that authentic materials had a motivating effect on the learners. Houbad found that learners needed authentic materials to help them for their future careers or studies.

5.4.5 Extent to which learners view the use of authentic learning activities

In Table 23, learner MBO13 confirmed that she experienced no challenges or difficulties when she was taught with authentic learning activities. This is what learner MBO13 said *"I do not think anything was challenging with the things we taught using authentic. It was really easy I would say, I do not think anything was difficult"*. Reeves, Herrington, and Oliver (2002) disagreed with learner MBO13's statement. Reeves et al. found that learners often experienced difficulties and challenges when taught with authentic activities if they do not receive support from their teachers and/or other fellow learners.

In the same vein, learners OKO11, OKO12 and OKO28 experienced some minor challenges during the use of authentic learning activities. Some of the challenges that were mentioned by the learners were that, to design electrical circuits, one needed to pay more attention during the designing process since a lot of materials (e.g. conductor wires) were needed especially in the parallel circuits. Learners' sentiments were supported by Anker-Hansen and Andrée (2019) who found that learners experienced challenges on how to "design activities that were both culturally and personally authentic" (p. 506). Anker-Hansen and Andrée (2019) also found that learners were challenged to come up with the best way on how to learn science, how to apply scientific knowledge and how to transfer the learned knowledge to new application of authentic learning.

The results of this study also found that learners expressed their concerns that it took them time to understand what the teacher was talking about as he was talking whilst connecting the electrical circuit simultaneously. Learner OKO12 recited that *"it takes more time to understand the teacher about how to connect and how its diagram, how it should be and the way the parallel is..."* The problem of teachers experiencing difficulties with using authentic learning activities are not new, according to the Resource Area For Teaching (2013), teachers are faced with many challenges when adopting authentic learning activities in their classrooms. Despite the challenges, learners managed to understand and were able to know how to connect the electrical circuits by themselves as appreciated by learner OKO12 in Table 23.

5.4.6 Learners' views on whether they got clear instructions through authentic teaching and learning activities

As can be gleaned in Table 24, learners MBO13, OPO33, OKO11 and OKO28 stated that the instructions given to them to guide them through authentic teaching and learning activities were very clear and straight forward. This is what learner MBO13 averred *"me, I would say that the instructions were very clear and straight out"*. And learner OKO11 postulated, "f*or me, it was extremely very clear because when before you came showing us those pictures I so shocked and surprised, because I came to get and take something from that, and it was really interested"*.

Another learner OKO28 highlighted that the teacher*"...gave me clear instructions to understand how to connect the parallel and series circuit".* The clear and straight forward instructions resulted in the learners' clear understanding of the topic ‘electricity’ and they were able to connect the parallel and series circuits and to differentiate between the two types of circuits. These findings are supported by Wrobbel (2004) who said that for learners to gain authentic learning experiences, the instructions provided to them should be clear and of greater depth.

Wrobbel’s (2004) findings are in line with the views of learner OPO25 who articulated that *“it is better being taught in authentic method rather than be taught in audio. ...it is better teaching with things, tools and such stuff in action rather than just being teaching by mouth”*. These results imply that learners learned more and better when taught using the authentic instructions as compared to the audio whereby learners were expected to listen to their teacher without being engaged in authentic activities. This sentiment is supported by the findings of Ortiz and Cuéllar (2018) who found that in authentic classrooms, “learners are engaged in their own learning and this makes the learning process a meaningful one” (p. 66).

5.4.7 Authentic learning activities provided learners with sufficient time to complete tasks

Learners MBO24 and OPO27 (Table 25) clearly stated that authentic learning activities that were given to them were not time consuming at all. This is what learners MBO24 postulated *“I think it’s a good thing, it’s not time consuming and we finish the work on time”*. On the other hand, learners’ authentic activities provided them with enough time to finish their work. The findings of this study supports the previous studies by Ekwueme, Ekon, and Ezenwa-Nebife (2015), Festile (2017) and Qamariah (2016) who found that authentic activities were easier and less time consuming for the learners and they exposed learners to real objects.

On the contrary, Reeves et al. (2002) found that authentic learning activities given to the learners were complex and required ample time to complete. In Table 25, learners OKO11 and OKO28 also indicated that even if the authentic learning activities provided them with too many activities to do, they were able to understand the way the teacher was teaching because he also showed them the diagrams and they were therefore able to complete their activities on time. Learner OKO28 said that *"authentic learning activities make it easier for me to understand the way the teachers show the diagrams..."* The findings were also in the line with the results reported by Berardo (2006) who found that authentic lessons where pictures, diagrams and photographs are used help learners to better understand the meaning of the lessons taught.

5.4.8 How authentic learning activities helped learners in understanding the subject content

In Table 26, seven learners indicated that authentic learning activities helped them to a great deal in understanding the subject content and were also impressed by the way the bulbs were connected and switched on and off compared to the lecture method. To illustrate this learner OKO28 had this to say, *"I think authentic activities should really be done by the teachers because it makes easier for the learners to understand the diagrams easily and make me feel comfortable when the teacher is teaching"*.

Another learner, OKO11 highlighted, *"let me say that, it's a really great deal because I was impressed by those bulbs..."*. These results are supported by the findings of Coskun, Dogan, Uluay (2017) who found that authentic learning tasks were helpful and supported learners to understand the subject content. Authentic learning activities did not only make learners' learning easier and feel comfortable, but learners were also able to see and do activities practically rather than just listening to the teachers' talk. This is what Learner OPO25 had to say *"...authentic method is the best method or let me say the best plan to teach children because you can see and do things in action rather than the teacher talking in audio"*.

This sentiment is in line with Nasab (2015) who stressed that learners should be taught authentic learning activities that are prepared with the aim of reaching and creating tangible, meaningful and useful outcomes. It was remarked by learner OKO11 that he never knew before that, in parallel circuit, when you remove one bulb, other bulbs would remain switched on unlike in the series circuit where other bulbs will switch off. Learner OKO11 said *"...if you take the holder from that bulb the other still light, light up. I never knew it..."* Similarly, learners OKO12 and OKO28 emphasised that authentic activities should be always used by teachers in their teaching since they help learners to see or visualise real materials. These findings are supported by Rasimah Yusoff, Zaman and Ahmad (2010) who argue that "authentic learning is to provide real materials and real activities" (p. 885) to learners.

5.4.9 The extent to which authentic learning activities helped learners to understand electricity

Two learners (Table 27) responded by saying that authentic learning activities helped them a great deal in increasing their understanding of the topic 'electricity'. This sentiment was supported by learner OPO27 who found the topic 'electricity' very easy after she was taught the topic using authentic activities as compared to when she was in Grade 6. In Grade 6, learners were not taught with authentic activities as nothing was shown or practically demonstrated to them. The findings in Table 27 seems to support Neo et al. (2012) who state that with authentic learning activities, teachers should demonstrate to the learners what they teach and thereafter test learners' understanding of the content taught before they continue to the next topic.

Moreover, learner JKO12 stated that authentic activities helped him to understand electricity as he wanted to become an electrical engineer. This is what learner JKO12 said when authentic learning activities where used in teaching the topic of 'electricity' *"this topic helps me because when I grown-up I want to be working as electrical engineer, so, I want to learn more from electrical"*. Similarly, the results also confirm the findings of Har (2013) who found that authentic learning was preparing learners and encouraging them to understand and choose their future careers.

It should however be noted that although authentic learning seem to play an important role in learners' learning and preparing their future careers, this study also found that not all the learners appreciated the use of authentic learning activities in the Natural Science classes. This finding is in line with the views of learner JKO13 who suggested that *"it helps me a little because if I grown-up I do not want to be electrical and if I grown-up I want to be a teacher but not a teacher to teach Natural Science or whatever I just teach Social Studies".* This implies that authentic activities did not really help some learners to better understand Natural Science or did they influence them to pursue careers in science related fields.

5.4.10 Learners' overall reactions on using authentic learning activities in the Natural Science classroom

Nine learners (Table 28) responded that using authentic learning activities in Natural Science classrooms was helpful to them since they enabled learners to see real materials such as bulbs, conductor wires and cells rather than imagining them. This is what learner MBO02 had to say, *"I think it is very helpful because we get to see the things in reality, and you do not have to imagining".* Similarly, learner MBO34 averred that *"I would say that, seriously when you are in the class and the teacher is explaining on the chalkboard, sometimes you will be trying to imagine what she said but I may get confuse...".*

These results findings are supported by the findings of Malova (2016) who established that authentic materials are important in teaching and learning any subject as it was impossible for the learners to imagine things without seeing them in reality. According to the findings of Knobloc (2003), the authentic teaching and learning materials influence learners' future experiences. With regards to learners' experiences, learner OKO11 postulated that *"my experience was great, fun and good because I get to know the holders of the bulbs and it was really interesting, I was happy, I was really happy because it taught us a lot..."*. Similarly, the findings by Knobloc (2003) states that learners learn through real-life experiences that influence how they learn, and learners' past experiences influence their future experiences.

Learner MBO34 stated that it was important to be taught with authentic activities because they allowed learners to hold discussions during teaching and learning in order to avoid confusion. The findings of this study are supported by Beldjilali

(2019) who found that teachers were using authentic materials that attracted learners' attention during class discussions without making learners feel bored and/or confused. In so doing, learners also understood the topic much better than being taught without using authentic activities.

Authentic learning activities also helped slow learners to understand better the content through sharing ideas and discussions. This finding is supported by learner OPO27 who stated that *"I'm a very slow learner; I cannot really capture things in my head just like that when the teacher is just explaining. It was very easy for me when Mr Uugwanga* (researcher) *was teaching us in the authentic way. It was very easy for me".* This means that slow learners cannot really capture things in their heads when teachers only explain the subject contents, but they could learn better when authentic activities were used. In support, Bal-Gezegin (2014) found that the use of video (authentic) materials in the language classrooms improved learners' learning of the vocabulary.

Learner OKO12 suggested that when they were taught with authentic activities, it was like information sharing in the class between the teacher and the learners. Similarly, Chmielowiec (2009) found that authentic materials did not only expose learners to the platform of sharing information within themselves and their teachers but also to argue scientifically to reach the desired results. In addition, learner OKO12 mentioned that when learners are taught with authentic learning activities, they would easily visualise what the teacher was teaching them in class without even having to memorise what they were being taught, learners could recall what was taught even if they were at home.

This is exactly what learner OKO12 meant when she said *"...after class lessons that learner will go home and try to visualise what the teacher was teaching and memorise and when he come back to school, he will know that the teacher has been teaching him using authentic..."*. This seems to support the sentiments by Dreher (2013) who mentioned that authentic learning activities give learners the possibility of remembering the subject matter given to them even for a very long time.

5.5 The four-domain model for teaching and learning science using authentic activities

To meet the challenges of the 21st century, the Namibian education system should be reformed in terms of its teaching and learning approaches. Teaching and learning Natural Science for conceptual understanding requires appropriate and effective teaching approaches (Ilter & Kilic, 2015). Therefore, there is need to practice constructive approaches such as authentic learning activities in teaching and learning of science concepts in order to nurture learners' scientific skills and understanding. To compliment these sentiments, this study proposed the CPSR model as the appropriate and effective model to use when one intends to use authentic learning activities in teaching and learning Natural Science.

The use of CPSR model encourages learners to overcome anxiety towards Natural Science and negative perceptions about the subject. This model motivates Natural Science teachers to prepare authentic instructions that encourage learners to engage in substantive conversations where they can think critically as they exchange their views openly with teachers and other learners about the subject matter (Lau, 2011; Wrobbel, 2004).

The use of CPSR model in teaching Natural Science using authentic learning activities helps learners to learn better and be critical thinkers. In critical thinking, learners need to acquire skills to conceptualise, apply, analyse, synthesise, and/or evaluate information generated by observing, experiencing, reflecting, reasoning or communicating (Kahlke & White, 2013). In addition, the model enhances learners' acquisition of science concepts and enables them to observe the reality of science. To incorporate CPSR model in teaching and learning with authentic materials, teachers should encourage learners to become good decision markers, promote learners' creativity, and encourage learners to work freely in teams.

The CPSR model promotes the inclusion of problem-solving activities in the teaching and learning of Natural Science as they enable learners to cope with their lives beyond the school (Mukhopadhyay, 2013). In other words, the model should be viewed as a useful method that is relevant in teaching learners to learn science subjects in preparation for solving everyday life's problems. The proposed model encourages learners to ask questions, developing learners' capacity to construct hypotheses, and inspiring learners to conduct investigations to get solutions. This means that learners need to acquire higher order thinking to enable them to overcome their daily obstacles by generating hypotheses and testing these to arrive at satisfactory solutions.

The CPSR model provides a suitable way of how learners learn and understand the natural world through conducting scientific investigations. Therefore, incorporated the CPSR model in teaching and learning Natural Science using authentic learning activities inspires learners to carry out scientific inquiries, provide evidence-based results and explain their findings scientifically, and share their knowledge with peers. Based on the findings of this study, learners were not only exposed to authentic learning activities to share information within themselves and their teachers but also to argue scientifically to reach the desired results. Anker-Hansen and Andrée (2019) found that learners had challenges to find the best way to learn science authentically, when to apply scientific knowledge and when to transfer the learned knowledge to practice. Similarly, Awe (2007) argues that the lecture method contributes to better performance in examinations; but learners are not fully equipped with varieties of opportunities that enable them to acquire scientific skills.

When incorporating the CPSR model in the teaching and learning process, learners should apply their learned knowledge to learn through doing, to realise their learning abilities, to adapt and change their lifestyle, and to form the habits required to perform successfully in their lives beyond the school (Pearce, 2016). According to Scott (2015), real-world refers to the learning that actively facilitates and engages learners to use classroom-based knowledge and skills to address the challenges beyond the school.

The use of authentic learning activities within the framework of the CPSR model inspires learners to make realistic expectations, enable learners understand self-concepts, and guide learners to choose the right careers. It was also revealed from the study results that learners liked to be taught Natural Science with authentic materials because these materials prepared them for the real world. This means that learners need to understand the real meaning of the universe in authentic science classrooms so that they can better understand themselves and the world around them in which they live.

The proposed Critical-thinking, Problem-solving, Scientific-inquiry, and Real-world (CPSR) model of teaching and learning Natural Science using authentic learning activities in Namibian schools should be encouraged and promoted. The model enables the learners to enhance their conceptual understanding of the content, to think critically; apply real-life activities to solve everyday life problems; conduct scientific investigations to provide evidence-based results; and connect to the real-life situations to explore the real-world independently.

The CPSR model is appropriate for the 21st century teaching and learning Natural Science. Thus, the model aims to prepare learners to be critical thinkers, problem solvers and good communicators. Furthermore, the CRSP model tends to prepare learners to be able to engage and collaborate with other peers and the society, and also intends to encourage learners to be inventors and compete in the global market of the 21st century.

5.6 Summary

This chapter discussed the main findings on the effects of authentic learning activities on achievements and attitude toward Natural Science among Grade 7 learners. The findings were discussed based on the study's objectives including the main and sub-hypotheses that informed the study. The next chapter summarises, concludes and suggests recommendations which emanated from the findings presented in chapter 4 and their discussions in this chapter 5.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the summary, conclusions and recommendations based on the results of this study.

6.2 Summary of the findings

This study was undertaken to investigate the effects of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners in the Khomas and Omusati educational regions. The study addressed the following objectives:

1. Determine the effect of authentic learning activities on achievement scores among Grade 7 learners in the Khomas and Omusati education regions.
2. Find out whether authentic learning activities influence attitude towards Natural Science among Grade 7 learners in the Khomas and Omusati education regions.
3. Investigate what Grade 7 learners in the experimental group think about the effects of authentic learning activities in Natural Science.

In addition, the following hypotheses were tested.

H_o: There is no significant difference between the achievement scores of the Grade 7 learners who are exposed to authentic learning activities and those who are not.

H_1: There is a significant difference between the achievement scores of the Grade 7 learners who are exposed to authentic learning activities and those who are not.

H_0: The authentic learning activities have no influence on attitude towards Natural Science among Grade 7 learners after exposing them to authentic learning activities.

H_1: The authentic learning activities have influence on attitude towards Natural Science among Grade 7 learners after exposing them to authentic learning activities.

A mixed research approach, specifically, the quasi-experimental design was used to collect data from the sample. The targeted population of this study consisted of seven hundred and sixteen (716) Grade 7 classes altogether (one hundred and eighty (180) classes in the Khomas region and five hundred and thirty-six (536) in the Omusati region) in the public senior primary schools offering Natural Science with twenty thousand four hundred and eighty (21 480) learners altogether; whereby five thousand and four hundred (5 400) learners are in the Khomas region and sixteen thousand and eighty (16 080) learners are in the Omusati region. Simple random sampling was used to select four schools per region and one class per school.

The selected schools were randomly assigned to groups, but the leaners were not randomly assigned to groups per se as they already formed part of the school that was randomly assigned. A total number of two hundred and twenty-one (221) learners participated in this study but only two hundred and thirteen (213) learners wrote both the pre- and post-tests. Eight (8) learners from the total number of two hundred and twenty-one (221) learners did not write both tests (they either wrote a pre-test or a post-test) but they attended Natural Science classes and completed the STAQ-R. Therefore, the eight (8) learners were not part of the pre- and post-tests' results but they formed part of the STAQ-R's results. Then, from the total number of one hundred and twenty-four (124) learners in the experimental group only twenty-two (22) learners were interviewed.

A pre-test and post-test was given to the control and experimental groups while the questionnaires [The Simpson Troost Attitude Questionnaire-Revised (STAQ-R)] and semi-structured interviews were given to the experimental group only to find out whether authentic learning activities influenced these learners' attitude towards Natural Science and to solicit their views regarding the effects of authentic learning activities respectively. The analysis of data was done using the Statistical Package for Social Sciences (SPSS) (Version 25). The Chi-square was used to analyse the STAQ-R's data to count the learners' responses per statement, exploratory factor analysis was used to cluster the similar variables/items that were measuring learners' attitude into one factor and T-test statistical analysis was run to analyse the pre- and post-tests' scores' data.

In order to measure the Grade 7 learners' achievement scores on the topic 'electricity', both the experimental and control groups were given the same pre-test before they were taught Natural Science on the topic 'electricity'. One hundred and twenty-four learners in the experimental group were taught the topic 'electricity' for one week using authentic learning activities while ninety-seven learners in the control group were taught using the lecture method. Thereafter, the same post-test was administered to both groups to determine the effects of authentic learning activities on learners' achievement scores.

It was found that the experimental group's mean of 18.91 was higher than the control group's mean of 17.28 on the pre-test. This means that both groups' mean scores were closer to each other and it seemed that learners in both groups had almost the same knowledge and understanding of the topic before intervention. Therefore, the study rejects the H_o and this concludes that there was a significant difference between the control and experimental groups before the intervention.

The results on the post-test for the two groups revealed that the experimental group had a mean of 31.72 while the control group's mean was 23.07. This shows that the experimental and control groups' scores on the post-test were significantly different. The higher performance of the experimental group on the post-test seems to support Gull and Shehzad's (2015) view that interventions within the experimental group often have a positive effect on the learners' academic performance, because authentic learning activities enable learners to be proactive in their learning.

As a result, learners tend to contribute positively to their academic achievements. Nonetheless, learners in both groups improved their academic achievements from pre-test (M = 18.91 for experimental group and M = 17.28 for control group) to post-test (M = 31.72 for experimental group and M = 23.07 for control group). The increased control group's mean score on the post-test seemed to indicate that learners benefited from extra teaching given to them on the topic 'electricity' using the traditional approach.

The results of this study further suggested that authentic learning activities seemed to enhance the learners' acquisition of science concepts and enabled learners to observe the reality of science. When learners fully acquired science concepts and understood the reality of science, they tended to outperform learners who were not exposed to authentic learning activities.

It emerged from the study that 80.6% of the learners agreed that they enjoyed science while 91.9% of the learners agreed that they liked to learn more about science. Failing made them try harder. Further, they learned about important things in science and they really enjoyed science lessons. Based on these results, it seems that most of the learners liked to learn more about science and the science lessons enabled them to understand the natural world. The results showed that authentic learning activities encouraged learners to be self-motivated and enabled them to achieve better in Natural Science. The learners also agreed that they had good feelings towards science, and confident that they could understand science.

It was also found that 21% of the learners agreed that they were fearful and anxious about Natural Science. About 69% (68.6%) of the learners disagreed that science lessons were a waste of time, while 16.9% agreed that they did not like science although teachers were encouraging them to understand science concepts. Learners seemed to regard their science teachers as motivating them because teachers encouraged them to do science and understand its concepts. The learning of Natural Science should be an exciting experience in order to curb learners' fear of learning science and anxiety that exists among learners.

The study also found that 45.1% of the learners agreed that they would become scientists in the future, 19.4% disagreed while 35.5% were not sure. About 38%

(37.9%) and 79.0% of the learners agreed that they would study science if they got admitted to the university and did well in sciences. This did not necessarily mean that all of them would become scientists in the future. The findings of this study seem to suggest that career awareness is necessary and should be introduced to the learners at an early age of their schooling. When learners are aware of their future careers at an early stage of their education, this is likely to positively influence their attitude towards a given school subject resulting often in better achievements in the subject.

It also emerged from the study that 65.3% of the learners agreed that their science classrooms contained a lot of interesting equipment. This seems to show that when learners are exposed to the science classrooms that contain interesting, encouraging, and motivating science equipment, their attitude towards the sciences tend to be positively influenced. These results are support Christmas (2014) who found that meaningful and useful authentic learning materials provide learners with in-depth understanding of the subject content and discourage them over depending solely on the textbooks. According to Needham (2014), the interesting science equipment seems to attract and motivate learners to like science subjects and not to give up when they do not understand the science concepts. For the learners to understand science concepts and perform better, they should be motivated, encouraged and be taught in a science oriented classroom environment with interesting science activities, otherwise, they might lose interest in the subject and give up.

It was also established from the study that Natural Science seemed to be an important subject as 63.7% of the learners agreed that they would miss studying science when they left school, while 61.3% of the learners agreed that science is useful in solving everyday life problems. According to the European Union (2015), science learning is more relevant in learners' lives and should be prioritised and connected to their lives for solving social problems. Generally, the results revealed that learners had a positive attitude towards Natural Science, and they would miss science when they leave school.

It also emerged from the study that 57.3% of the learners would enjoy working in a science-related career even though they believed that scientists did not have time for fun. Previous studies by Ahmad & Asghar, (2011); Newell, Tharp, Vogt, Moreno, & Zientek, (2015) found that learners were interested in science and were encouraged to pursue careers related to science even though they were not aware before which careers, they would follow. Sharpe (2012) argues that although learners appreciated the benefits that authentic activities had on their careers and valued science subject itself, most of the learners were found unwilling to take a job in a science profession especially where practical work would be involved.

It was further revealed from the study that 86.3% of the learners agreed that they always tried to do their best in school while 84.7% of the learners agreed that their science teachers were very good in teaching Natural Science. Good teachers explain science content clearly to their learners and also use authentic learning activities that help learners to better understand science (Darlington, 2017). This study furthermore revealed that learners considered their science classrooms as attractive and comfortable which motivated them to do better in science; even though 25.8% of the learners agreed that they would not pursue a science-related career in the future. Wellcome Trust (2011) reported that teachers were also helping learners to find relevant information on how to pursue their careers in the science-related fields. This tends to highly encourage learners to pursue a career in science and also to positively influence their attitude towards science subjects including Natural Science.

It also emerged from the study that seven factors explaining 44.06% of total variance were obtained. The self-directed effort factor of 24 variables had 15.70% of variance with factor loadings from 0.31 to 0.68 and self-directed effort was the highest factor in explaining the variance compared to other factors. This implies that self-directed effort factor mostly attracted learners to Natural Science and positively influenced their attitude towards the subject. With self-directed effort, learners seemed to develop self-reliance which encouraged them to be self-motivated towards the learning of Natural Science after exposure to authentic learning activities.

The anxiety towards science factor had 6.7% of variance and factor loadings from 0.32 to 0.6 of the variables measuring learners' attitude towards Natural Science as a subject. With reference to the variables, learners were confident that they would continue studying science after leaving school, though they were also worried that working as a scientist would be boring.

Career awareness factor concerned with learners' future interests had 5.05% of variance with factor loadings from 0.38 to 0.57 and that also appears to have attracted and changed the learners' attitude positively towards Natural Science. The study also revealed that motivating classroom and relevance of science influenced learners with 4.6% and 4.55% of variance with factor loadings from 0.43 to 0.49 and from 0.32 to 0.59 respectively. Thus, only few learners believed that variables loaded on motivating classroom and relevance of science factors influenced their attitude towards Natural Science. This means that learners usually gave up when they did not understand science concepts, even though they believed that science was useful in solving everyday life problems.

Science is fun and the value of effort had 3.87% and 3.59% of variance with factor loadings from 0.33 to 0.47 and from 0.32 to 0.46 respectively. These factors were regarded to have no great effect neither influencing learners' attitude towards Natural Science as they had the lowest percentages of variance among other factors. In fact, 34.6% of the learners believed that scientists have no time for fun; only 25.8% of these learners indicated that they would not pursue a science-related career in the future. Nonetheless, the findings by factor analysis seem to indicate that authentic learning activities positively influenced learners' attitude towards Natural Science.

The study revealed that female and male learners' attitude towards Natural Science were close to each other with an average of 110.51 and 115.16 respectively (Table 18). These results were generated from the T-test statistical analysis. This shows that there was no significant relationship between male and female learners' attitude towards Natural Science after having been exposed to authentic learning activities.

It also emerged from the study that none of the learners responded to the question on what they understood by the word 'authentic'. This probably means that learners had no idea of what 'authentic' meant before the intervention. The researcher had to provide the definition by making references to what he had been teaching to help them understand the meaning of ‘authentic’ and be able to respond to other questions.

Eight learners appreciated being taught through authentic learning activities during the research. This supports Hui and Koplin (2011) who state that authentic activities help learners to understand and remember the complexities of the real world outside the classroom. This means that authentic learning activities not only helped learners to remember and understand what was taught to them during the research but even later on beyond the classroom. It was also found that learners in this study liked to be taught Natural Science using authentic learning activities. They stated that authentic learning activities enabled them to actually listen to the teacher’s explanations and were able to see the reality of what he was teaching or talking about.

It was further found from the study that two learners disliked being taught with authentic learning activities when the topic was about the ‘human skeleton’ as this might not beneficial to sensitive and vulnerable learners. Some learners cautioned that when teachers using authentic materials in teaching and learning, the materials should be properly handled to avoid accidents. When the materials fall, it disrupts the whole lesson. Therefore, teachers are cautioned to be well trained on how to handle the materials and practice using them in advance. The results also indicated that authentic learning activities helped learners to understand the topic ‘electricity’ better. This result supports Widowati, Nurohman, & Anjarsari’s (2017) findings that points to the fact that authentic learning activities help learners to better learn and be critical thinkers and also help teachers to teach their lessons better. According to

Houbad (2016) learners need authentic materials to help them with their future careers or studies.

Few learners experienced minor challenges during the use of authentic learning activities such as how to design electrical circuits, as more attention was needed during the designing process, and lots of materials were needed especially for parallel circuits. Learners also expressed their concerns regarding the fact that it took them time to understand what the teacher was talking about as the teacher was connecting the electrical circuit whilst simultaneously teaching. Despite these challenges, learners appreciated the fact that they managed to understand and were able to know how to connect the electrical circuits by themselves. The clear and straight forward instructions resulted in learners' better understanding of the topic 'electricity'. The results seem to indicate that learners learned better when taught using the authentic materials rather than listening to their teacher only.

The results of this study revealed that using authentic learning activities in Natural Science classrooms was helpful to the learners as the authentic learning activities enabled learners to see and handle real materials such as; bulbs, conductor wires and batteries rather than imagining them. According to Malova (2016), authentic materials are important in teaching and learning any subject as it is impossible for the learners to imagine things without seeing them in reality.

Learners also stated that it was important to be taught with authentic activities because they allowed them to hold discussions during teaching and learning in order to avoid confusion. The discussions also enabled learners to understand the topic much better than being taught without using authentic activities. Authentic learning activities also helped slow learners to understand better the content through sharing ideas and discussions. Slow learners would not really capture things in their heads when teachers happened only to explain the subject contents, but they could learn better visually when authentic activities were used. This seems to support Dreher (2013) who maintains that authentic learning activities give learners the possibility of remembering the subject matter given to them even for a very long time.

6.3 Conclusions

This study investigated the effects of authentic learning activities on learners' achievements and their attitude towards Natural Science. The experimental group's mean score on the pre-test was 18.91 and that of the control group was 17.28 as compared to the post-test mean score of 31.72 for the experimental group and 23.07 for the control group. Teaching learners using authentic learning activities seems to improve learners' achievements in Natural Science. Therefore, the use of authentic learning activities / materials in teaching and learning Natural Science should be advocated for and supported. Teachers should use statements that promote learners' self-directed effort when teaching Natural Science to motivate learners and positively influence their attitude towards the subject.

It should also be stated that learners appreciated the use of authentic learning activities in teaching and learning Natural Science as an appropriate and effective teaching approach. Authentic learning activities seem to help learners to understand science concepts better and they easily remembered what was taught unlike being taught using the lecture method. Hence, the use of authentic learning activities in teaching Natural Science should be promoted as they seemed to enhance learners' conceptual understanding, improve learners' academic achievements, and positively influence learners' attitude towards Natural Science. Moreover, using authentic learning activities in teaching and learning Natural Science should be used concurrently with the suggested CPSR domain model. The model was proposed to teach learners Natural Science for the 21st century.

6.4 Recommendations

Based on the results of this study, the following recommendations are made:

6.4.1 Recommendations for the Ministry of Education, Arts and Culture

- The officials in the Ministry of Education, Arts and Culture should advocate and recommend the use and/or integration of authentic learning activities in their Natural Science lessons during teachers' workshops and/or trainings. The integration of authentic learning activities in teachers' lessons tends to enhance learners' academic achievements and positively influence learners' attitude towards Natural Science.
- The Ministry of Education, Arts and Culture should invest more in buying authentic materials and on building and/or upgrading science laboratories starting from Senior Primary Phase in order to impart learners with knowledge on how to conduct scientific investigations and provide evidence-based results while they are at an early stage of their education.
- Curriculum developers in the Ministry of Education, Arts and Culture should incorporate more fun and enjoyable activities such as investigations and projects in the National Curriculum for Basic Education, Grade 7 Natural Science

syllabus and other teaching and learning support materials where teaching and learning require the use of authentic materials.

6.4.2 Recommendations for the rural and urban schools

- Schools should procure appropriate authentic materials such as the science kits for the effective teaching and learning of science concepts that provide learners with in-depth understanding of the Natural Science content and allow learners to connect the science content with everyday real life situations rather than depending solely on the textbooks.
- Rural and urban schools should provide learners with opportunities to engage in designing authentic tasks to enable them to apply their learned knowledge of science concepts to their real life experiences.
- Schools should expose learners to science related careers to develop interest in the subject and also to be aware of their scientific future careers at an early stage of their education.

6.4.3 Recommendations for the Natural Science teachers

- Natural Science teachers should incorporate authentic learning activities in their lessons to improve their learners' academic achievements as opposed to the use of lecture method alone that has lesser value to the learners' learning and understanding of science concepts.
- Natural Science teachers should make sure that their classrooms contain interesting authentic materials to attract learners' attention.
- In the absence of purchased authentic materials, Natural Science teachers are encouraged to be creative by recycling the appropriate and available materials.

Teachers should improvise the materials and integrate them in teaching and learning of science concepts.

- Natural Science teachers should facilitate the teaching and learning process when authentic materials are used to pave way for the active learners' participation and collaboration.

6.4.4 Recommendations for further research

There were limitations experienced in this study that the study recommends to be addressed in future studies. These are:

- There is need to conduct a similar study focusing on other subjects from Grade 4 to 7 in other educational regions focusing on other topics and/or concepts.
- There is a need to undertake a similar study with private schools to see if learners from the same school environment as the current study will yield the same results.
- There is need to conduct a similar study with a larger sample in order to generalize the findings to the population and enhance the effective teaching and learning of Natural Science using authentic materials.
- There is need to investigate the teachers' perceptions towards the integration of authentic learning activities in Natural Science on whether they enable or constrain the learners' acquisition of science concepts.

6.5 Summary

This chapter presented a summary, conclusions and recommendations of the study in relation to the effect of authentic learning activities on achievements and attitude towards Natural Science among Grade 7 learners.

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APPENDICES

Appendix A: Learners' raw scores at School C_1 and X_1 on pre-test and post-test

Control Group (School C_1) [N = 34]			Experimental Group (School X_1) [N = 35]		
Learner Code	**Pre-test**	**Post-test**	**Learner Code**	**Pre-test**	**Post-test**
PPO01	26	30	MBO01	14	23
PPO02	19	35	MBO02	28	42
PPO03	11	17	MBO03	25	43
PPO04	19	26	MBO04	19	28
PPO05	12	23	MBO05	22	36
PPO06	12	16	MBO06	25	42
PPO07	19	22	MBO07	14	30
PPO08	23	37	MBO08	18	34
PPO09	11	17	MBO09	21	29
PPO10	17	24	MBO10	29	41
PPO11	15	23	MBO11	17	32
PPO12	23	33	MBO12	29	38
PPO13	15	18	MBO13	29	37
PPO14	19	21	MBO14	18	25
PPO15	23	30	MBO15	18	22
PPO16	18	28	MBO16	18	34
PPO17	19	25	MBO17	15	26
PPO18	18	17	MBO18	18	38
PPO19	12	27	MBO19	16	28
PPO20	14	17	MBO20	21	27
PPO21	18	29	MBO21	12	25
PPO22	16	8	MBO22	19	37
PPO23	16	10	MBO23	18	32
PPO24	14	18	MBO24	19	41
PPO25	15	27	MBO25	15	29
PPO26	14	14	MBO26	21	31
PPO27	19	28	MBO27	26	33
PPO28	30	42	MBO28	15	28
PPO29	8	15	MBO29	9	19
PPO30	17	25	MBO30	15	32
PPO31	23	26	MBO31	16	28
PPO33	16	19	MBO32	26	32
PPO34	20	31	MBO33	20	35
PPO36	14	21	MBO34	32	44
			MBO35	23	33
Total	**585**	**799**		**700**	**1134**
Mean	**17.21**	**23.50**		**20.00**	**32.40**

Appendix B: Learners' raw scores at School C_2 and X_2 on pre-test and post-test

Control Group (School C_2) [N = 25]			Experimental Group (School X_2) [N = 31]		
Learner Code	**Pre-test**	**Post-test**	**Learner Code**	**Pre-test**	**Post-test**
ASO01	16	23	OPO02	20	21
ASO02	22	27	OPO03	15	27
ASO03	23	29	OPO04	19	31
ASO04	18	15	OPO05	15	28
ASO05	20	25	OPO08	12	26
ASO11	17	17	OPO09	17	41
ASO12	12	17	OPO10	10	31
ASO13	22	29	OPO11	16	24
ASO14	11	16	OPO12	8	25
ASO15	10	13	OPO13	22	28
ASO17	16	13	OPO14	17	38
ASO19	19	36	OPO15	16	33
ASO20	26	18	OPO16	17	37
ASO22	28	35	OPO17	18	29
ASO24	14	23	OPO18	15	18
ASO27	19	16	OPO19	12	31
ASO28	24	25	OPO20	9	24
ASO29	16	24	OPO21	12	26
ASO30	11	10	OPO22	17	33
ASO31	10	20	OPO23	15	33
ASO32	9	13	OPO24	19	28
ASO33	13	18	OPO25	8	31
ASO34	14	23	OPO26	18	25
ASO35	9	27	OPO27	15	27
ASO36	12	7	OPO28	13	29
			OPO29	13	29
			OPO30	20	33
			OPO31	11	27
			OPO32	16	35
			OPO33	23	36
			OPO34	10	22
Total	**411**	**519**		**468**	**906**
Mean	**16.44**	**20.76**		**15.10**	**29.23**

Appendix C: Learners' raw scores at School C_3 and X_3 on pre-test and post-test

Control Group (School C_3) [N = 20]			Experimental Group (School X_3) [N = 20]		
Learner Code	**Pre-test**	**Post-test**	**Learner Code**	**Pre-test**	**Post-test**
WAO01	21	30	JKO01	16	31
WAO03	20	21	JKO02	17	27
WAO04	15	23	JKO03	16	27
WAO05	20	26	JKO05	16	32
WAO06	20	28	JKO06	18	30
WAO07	14	23	JKO07	17	28
WAO08	16	23	JKO08	12	23
WAO09	24	35	JKO09	9	25
WAO10	14	24	JKO10	13	28
WAO11	19	29	JKO11	10	21
WAO12	27	26	JKO12	11	21
WAO13	19	24	JKO13	17	27
WAO14	13	19	JKO14	26	27
WAO15	18	22	JKO15	23	26
WAO16	15	13	JKO16	15	29
WAO17	14	22	JKO17	19	29
WAO18	18	30	JKO18	20	41
WAO19	23	34	JKO19	18	30
WAO20	19	26	JKO20	11	24
WAO21	21	27	JKO21	8	26
Total	**370**	**505**		**312**	**552**
Mean	**18.50**	**25.25**		**15.60**	**27.60**

Appendix D: Learners' raw scores at School C_4 and X_4 on pre-test and post-test

Control Group (School C_4) [N = 18]			Experimental Group (School X_4) [N = 30]		
Learner Code	**Pre-test**	**Post-test**	**Learner Code**	**Pre-test**	**Post-test**
TAO01	17	15	OKO01	24	35
TAO02	16	16	OKO02	15	29
TAO03	17	18	OKO03	26	34
TAO04	18	25	OKO04	29	36
TAO05	17	19	OKO05	23	45
TAO06	17	19	OKO06	31	43
TAO07	17	32	OKO07	19	31
TAO08	16	24	OKO08	32	47
TAO09	26	26	OKO09	19	30
TAO10	22	29	OKO11	23	35
TAO11	17	21	OKO12	26	34
TAO12	17	17	OKO13	25	45
TAO13	16	15	OKO14	28	43
TAO14	18	30	OKO15	16	29
TAO15	11	22	OKO16	25	38
TAO16	20	34	OKO17	31	45
TAO17	14	28	OKO18	25	31
TAO18	14	25	OKO19	22	32
			OKO20	31	46
			OKO21	19	32
			OKO22	25	37
			OKO23	11	26
			OKO24	20	37
			OKO25	27	41
			OKO26	22	30
			OKO27	35	49
			OKO28	29	40
			OKO29	16	28
			OKO30	23	33
			OKO31	17	26
Total	**310**	**415**		**714**	**1087**
Mean	**17.22**	**23.06**		**23.80**	**36.23**

Appendix E: Experimental group' responses on five points Likert Scale (N = 124)

	Responses					Entries		Total
Items/statements	Strongly Agree	Agree	Undecided/ Uncertain	Disagree	Strongly Disagree	Missing	Double	Participants
1. I will become a scientist in future.	37 29.8%	19 15.3%	44 35.5%	14 11.3%	10 8.1%	0 0.0%	0 0.0%	124 100.0%
2. Learning science is not important for my future success.	17 13.7%	8 6.5%	17 13.7%	30 24.2%	51 41.1%	0 0.0%	1 0.8%	124 100.0%
3. My friends like science.	39 31.5%	34 27.4%	31 25.0%	7 5.6%	12 9.7%	1 0.8%	0 0.0%	124 100.0%
4. I will study science if I get into a university.	47 37.9%	29 23.4%	31 25.0%	8 6.5%	9 7.3%	0 0.0%	0 0.0%	124 100.0%
5. We learn about important things in science class.	88 71.0%	25 20.2%	4 3.2%	1 0.8%	5 4.0%	1 0.8%	0 0.0%	124 100.0%
6. I usually give up when I do not understand a science concept.	16 12.9%	19 15.3%	23 18.5%	22 17.7%	44 35.5%	0 0.0%	0 0.0%	124 100.0%
7. Our science classroom contains a lot of interesting equipment.	44 35.5%	37 29.8%	10 8.1%	20 16.1%	11 8.9%	2 1.6%	0 0.0%	124 100.0%
8. Science is one of the most interesting school subjects.	64 51.6%	24 19.4%	18 14.5%	7 5.6%	9 7.3%	2 1.6%	0 0.0%	124 100.0%
9. We do a lot of interesting activities in science class.	48 38.7%	42 33.9%	14 11.3%	9 7.3%	8 6.5%	2 1.6%	1 0.8%	124 100.0%
10. Teachers encourage me to understand concepts in science classes.	59 47.6%	32 25.8%	15 12.1%	9 7.3%	6 4.8%	0 0.0%	3 2.4%	124 100.0%
11. I enjoy science.	66 53.2%	34 27.4%	12 9.7%	7 5.6%	3 2.4%	2 1.6%	0 0.0%	124 100.0%

12. Science classes will help prepare me for university.	53 42.7%	37 29.8%	21 16.9%	3 2.4%	8 6.5%	2 1.6%	0 0.0%	124 100.0%
13. I always try to do my best in school.	87 70.2%	20 16.1%	7 5.6%	2 1.6%	5 4.0%	2 1.6%	1 0.8%	124 100.0%
14. Science is easy for me.	62 50.0%	29 23.4%	21 16.9%	8 6.5%	3 2.4%	1 0.8%	0 0.0%	124 100.0%
15. We do a lot of activities in science class.	44 35.5%	49 39.5%	15 12.1%	10 8.1%	5 4.0%	1 0.8%	0 0.0%	124 100.0%
16. My science teacher is very good.	79 63.7%	26 21.0%	6 4.8%	2 1.6%	10 8.1%	0 0.0%	1 0.8%	124 100.0%
17. I consider our science classroom attractive and comfortable.	27 21.8%	40 32.3%	27 21.8%	15 12.1%	14 11.3%	1 0.8%	0 0.0%	124 100.0%
18. I will not pursue a science-related career in the future.	11 8.9%	21 16.9%	33 26.6%	25 20.2%	30 24.2%	3 2.4%	1 0.8%	124 100.0%
19. My best friend likes science.	47 37.9%	26 21.0%	31 25.0%	6 4.8%	10 8.1%	4 3.2%	0 0.0%	124 100.0%
20. I like to watch TV programs about science.	51 41.1%	23 18.5%	20 16.1%	14 11.3%	15 12.1%	0 0.0%	1 0.8%	124 100.0%
21. My science teacher makes good plans for us.	51 41.1%	42 33.9%	13 10.5%	10 8.1%	5 4.0%	2 1.6%	1 0.8%	124 100.0%
22. I cannot understand science even if I try hard.	15 12.1%	12 9.7%	17 13.7%	25 20.2%	53 42.7%	1 0.8%	1 0.8%	124 100.0%
23. I am sure I can do well in science.	75 60.5%	23 18.5%	12 9.7%	6 4.8%	3 2.4%	3 2.4%	2 1.6%	124 100.0%
24. Science is useful in solving everyday life problems.	52 41.9%	24 19.4%	25 20.2%	15 12.1%	7 5.6%	1 0.8%	0 0.0%	124 100.0%
25. When I fail that makes me try much harder.	72 58.1%	31 25.0%	9 7.3%	4 3.2%	6 4.8%	2 1.6%	0 0.0%	124 100.0%
26. I look forward to science activities in class.	53 42.7%	43 34.7%	17 13.7%	4 3.2%	4 3.2%	2 1.6%	1 0.8%	124 100.0%

27. I have good feelings toward science.	52 41.9%	39 31.5%	20 16.1%	6 4.8%	6 4.8%	1 0.8%	0 0.0%	124 100.0%
28. A job as a scientist would be boring.	14 11.3%	20 16.1%	30 24.2%	20 16.1%	39 31.5%	1 0.8%	0 0.0%	124 100.0%
29. My family watches science programs on TV.	37 29.8%	23 18.5%	24 19.4%	15 12.1%	25 20.2%	0 0.0%	0 0.0%	124 100.0%
30. I like to learn more about science.	80 64.5%	34 27.4%	3 2.4%	3 2.4%	3 2.4%	1 0.8%	0 0.0%	124 100.0%
31. My mother likes science.	24 19.4%	32 25.8%	41 33.1%	15 12.1%	10 8.1%	1 0.8%	1 0.8%	124 100.0%
32. I really enjoy science lessons.	67 54.0%	35 28.2%	12 9.7%	3 2.4%	3 2.4%	3 2.4%	1 0.8%	124 100.0%
33. My father likes science.	30 24.2%	24 19.4%	44 35.5%	13 10.5%	9 7.3%	3 2.4%	1 0.8%	124 100.0%
34. I will continue studying science after I leave school.	47 37.9%	27 21.8%	26 21.0%	11 8.9%	8 6.5%	3 2.4%	2 1.6%	124 100.0%
35. My best friend in this class likes science.	42 33.9%	42 33.9%	24 19.4%	6 4.8%	6 4.8%	2 1.6%	2 1.6%	124 100.0%
36. My family encourages my interest in science.	35 28.2%	38 30.6%	26 21.0%	14 11.3%	8 6.5%	2 1.6%	1 0.8%	124 100.0%
37. Most of my friends do well in science.	56 45.2%	30 24.2%	19 15.3%	7 5.6%	5 4.0%	7 5.6%	0 0.0%	124 100.0%
38. I am confident that I can understand science.	62 50.0%	28 22.6%	13 10.5%	6 4.8%	13 10.5%	1 0.8%	1 0.8%	124 100.0%
39. I really like science.	63 50.8%	34 27.4%	15 12.1%	3 2.4%	8 6.5%	1 0.8%	0 0.0%	124 100.0%
40. We live in a better world because of science.	59 47.6%	25 20.2%	25 20.2%	1 0.8%	10 8.1%	3 2.4%	1 0.8%	124 100.0%
41. My brothers and sisters like science.	36 29.0%	35 28.2%	27 21.8%	16 12.9%	8 6.5%	2 1.6%	0 0.0%	124 100.0%

42. I would enjoy working in a science-related career.	44 35.5%	27 21.8%	37 29.8%	12 9.7%	3 2.4%	1 0.8%	0 0.0%	124 100.0%
43. I always try hard in science, no matter how difficult the work is.	73 58.9%	19 15.3%	17 13.7%	6 4.8%	6 4.8%	3 2.4%	0 0.0%	124 100.0%
44. I will miss studying science when I leave school.	49 39.5%	30 24.2%	12 9.7%	16 12.9%	16 12.9%	1 0.8%	0 0.0%	124 100.0%
45. If I could choose, I would not take any more science in school.	13 10.5%	13 10.5%	27 21.8%	20 16.1%	46 37.1%	5 4.0%	0 0.0%	124 100.0%
46. Science will help me to understand the world around me.	65 52.4%	30 24.2%	9 7.3%	8 6.5%	9 7.3%	3 2.4%	0 0.0%	124 100.0%
47. If I work hard enough, I can learn difficult science concepts.	51 41.1%	32 25.8%	20 16.1%	7 5.6%	11 8.9%	3 2.4%	0 0.0%	124 100.0%
48. Science lessons are a waste of time.	10 8.1%	8 6.5%	18 14.5%	9 7.3%	76 61.3%	2 1.6%	1 0.8%	124 100.0%
49. Scientists do not have time for fun.	23 18.5%	20 16.1%	19 15.3%	19 15.3%	42 33.9%	1 0.8%	0 0.0%	124 100.0%
50. I do not like science.	16 12.9%	5 4.0%	16 12.9%	13 10.5%	73 58.9%	1 0.8%	0 0.0%	124 100.0%

Appendix F: A focus group interview (learners' reactions) in experimental group

Opening statement

It is my pleasure to thank you all for allowing me to interview you. The interview consists of five open-structured questions based on your views about the effects of authentic activities that I used during the teaching process. You are therefore reminded that your responses will be treated with utmost confidentially and pseudonym will be used instead of your real names.

SEMI-STRUCTURED INTERVIEW:

1. What do you understand by the word "authentic"? (*The researcher will provide the meaning if the children do not know it*)

   ____

   ____

2. What do you think of being taught through authentic learning activities?

   ____

   ____

3. What do you like most about being taught using authentic learning activities?

   ____

   ____

4. What do you dislike most about being taught using authentic learning activities?

   ____

   ____

5. In general, did authentic learning activities help you understand the topic (electricity) better?

   ____

   ____

6. To what extent did you find this exercise of using authentic learning activities? *Explain why*.

   A Not at all a challenge

   B Minor challenge

   C Somewhat of a challenge

D Significant challenge

Explanation:____

____

7. Did you get clear instructions to guide you through authentic activities? *Explain how*.

____

____

8. Did the use of authentic learning activities provide you with sufficient time to complete the tasks given to you?

____

____

9. How much did the authentic learning activities help you to understand the subject content compared to the lecture method? *Explain how*.

   A Did not help me at all

   B Helped me a little

   C Helped me somehow

   D Helped me a great deal

   Explanation:____

____

10. So far, to what extent has this authentic learning activities helped you better understand the topics taught?

    A Helped a great deal

    B Helped somewhat

    C Helped a little

    D Did not help at all

    Explanation:____

____

11. How can you describe your overall reactions and/or feelings by using authentic learning activities in science class? *Explain how*.

    A It is helpful

    B It is fun

    C It is easy

    D It is difficult

E It is difficult but helpful

F It is boring

Explanation:____

____

Thank you for your time and valuable contribution!!

Appendix G: A pre- and post-tests' items on "electricity"

SECTION A ***(Multiple Choice Questions)***

Learner's No: _______ **Date: _______________**

Answer all the questions. For each question there are four possible answers: A, B, C and D. Choose the one that you consider as correct and mark your choice in SOFT pencil. If you want to change your answer, thoroughly erase the one you wish to delete.
1. Which particles are moving when there is an electric current passing through a wire? A Electronic B Protons C Atoms D Ions
2. What is the battery used for? A To maintain a potential difference B To measure electric current C To measure electric potential D To safeguard against short-circuit
3. What is Ohm's law relates potential difference with? A Power B Energy C Current D Time
4. When electric charges move through electrical conductor there is always a production of what? A Electric current B Electrical charges C Electric cell D Electric circuit
5. Measure of rate of flow of electric charges through an electrical conductor is known as A Electric current B Electrical charges C Electric cell D Electric circuit
6. What do electrical wires and appliances cause when they are overheated due to high electric current? A Fires B Burns C Both a and b D Freezing
7. When is not allowed to use appliances? A When damaged B When exposed wires C Both A and B D When working properly
8. What do we call a component which is used to close or break a circuit? A Bulb B Switch C Wire D Electric cell
9. What is the name of a diagram which is drawn using symbols and represents electrical components? A Circuit diagram B Current diagram C Charges diagram D Electric diagram
10. What do we call the short thin piece of wire which is heated up and melts while electric current flows? A Circuit B Fuse C Cell D Resistor

11. What is the level of the current when it flows through each branch connected in parallel circuit from the source?			
A Greater	B Lesser	C Equal	D Unequal
12. What do we call a circuit which splits into two or more branches?			
A Series circuit	B Parallel circuit	C Open circuit	D Close circuit
13. What is formed or made when two or more cells are connected in series?			
A Battery	B Circuit	C Terminal	D Resistor
14. What energy is used by gadgets, devices and machines in modern world?			
A Electrical energy	B Magnetic energy	C Heat energy	D Chemical energy
15. What do we call when an electric current flows in a continuous path within a circuit?			
A Close circuit	B Open circuit	C Switch	D Blocked circuit
16. What is an electric component which makes use of a simple electric circuit to work?			
A An electric torch	B An electric microwave oven	C An electric air conditioner	D An electric generator
17. What is the positive terminal inside a cell made of?			
A Zinc case	B Graphite rod	C Carbon	D Manganese
18. What is the source of energy involves?			
A Electric cell	B Battery	C Both A and B	D Switches
19. Give the name of a circuit which connects an electric source to its components on after another to form a single loop?			
A Series circuit	B Parallel circuit	C Open circuit	D Close circuit
20. What is needed if you want to control electric current in a circuit?			
A Resistor	B Insulator	C Conductor	D Wire
21. Where the positive terminal and negative terminal are normally present or found?			
A On the cell	B On the battery	C On the circuit	D On all of them
22. What will be happen if a high current pass through someone?			
A Electric circuit	B Electric current	C Electric energy	D Electric shock
23. What do we call the instrument which is used to measure electric current?			
A Ammeter	B Cell	C Battery	D Speed o meter
24. Where a flow of electrons is seen in a lighted bulb?			
A Filament	B Socket	C Glass	D Holder
25. What do we call the path along which electric current flows?			
A Electric current	B Electrical charges	C Electric cell	D Electric circuit
26. Why do electrons flow in conductors?			

A Because ions are free B Because protons are free C Because electrons are free and mobile D Because negative ions are free
27. Poor conductors of electricity consist of what? A Silver B Aluminium C Water D Copper
28. Ions are charges particles, how are they formed? They are formed when an atom… A Gains electrons B Loses electrons C Gains or loses electrons D Shares electrons
29. Materials that allow electrons to flow through them are known as what? A Insulator B Conductors C Electrolytes D Bases
30. Which one is an example of good electrical conductor? A Aluminium B Sodium C Potassium D Strontium
31. What is another cause of short circuits? A Insulated wiring B Fixed resistance C Variable resistance D Faulty wire insulation
32. What are the plugs of the main supply systems have? A One pin B Two pins C Three pins D Four pins
33. How is the current in the parallel circuit? A Is equal B Is unequal C Is more powerful D Is less powerful
34. Where is normally the earth wire connected? A To the ground B To the appliance C To the power house D To the transformer
35. What do you think if you turn off the switch, the bulb will go off? A The switch is cooled down B The switch is not complete C The switch is joined D The switch is unbroken
36. In which material do you think electricity can flow through? A Any material B Any insulator C Any conductor D Any state of matter
37. If you are only conductor around, electricity will flow through what? A You B Me C Us D The insulator
38. If a live wire comes in contact with metal casing, where is the excess current move to? A Power house B Earth C Dynamos D Transformers
39. What do you think of using a high current fuse in a low current appliance? A It is safe B It is dangerous C It is necessary D It is complicated
40. Where is the safest place to be during a lightning storm? A Under a tall tree B On top of a tall tree C Under your metal car D Inside your metal car
41. What electroscope detects?

A The scope of the electric current B The negatively charges only C The static electricity D The positive charges only
42. What are the charges of static electric charges? A Are stationary charges B Are produced by batteries C Flow through wires D Involve the transfer of protons between atoms
43. What are the electrical insulators do? A Keep you warm B Not allow the flow of electrons C Conduct current D Attract electrons easily
44. An object that is positively charged contains an excess of: A Protons B Electrons C Neutrons D Positron
45. Which form of electric discharge appears in nature? A Rain B Ocean currents C Lightning D Volcanoes

<u>SECTION B</u> ***(Open-ended "Structured" Questions)***

1. Explain the reason why insulating materials do not allow electrons to flow very well and give example of **two** insulators.
   Reason: ……
   ……
   ……
   Example 1: ……………………………………..……… **Example 2:** …………………………..…………………….

2. Use <u>three cells</u>, <u>conductor wires</u>, <u>a switch</u> and <u>three bulbs</u> to construct / draw a complete electric circuit in parallel and in series.
   Show all the connections using the correct circuit symbols.

1. Electric circuit connected in parallel	*2. Electric circuit connected in series*

Appendix H: Ethical clearance certificate from UNAM's Research Ethics Committee

UNAM

UNIVERSITY OF NAMIBIA

NAMIBIAN POLICE OKAHANDJA 21 AUG 2018 CHARGE OFFICE OTJOZONDJUPA REGION

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: FOE /404/2018 Date: 8 August, 2018

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: The Effects Of Authentic Learning Activities On Grade 7 Learners' Achievement And Attitudes Toward Natural Science In Khomas And Omusati Educational Regions

Researcher: JAFET SHIKONGO UUGWANGA

Student Number: 201176939

Supervisor(s): Prof C. D. Kasanda (Main) Dr. H. Kapenda (Co)

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.

(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.

(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.

(d) The UREC retains the right to:

(i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,

(ii) Request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Dr. J.E. de Villiers: UREC Chairperson

Ms. P. Claassen: UREC Secretary

Appendix I: A letter requesting permission from the executive director (Ministry of Education, Arts and Culture)

P.O. Box 2588
Windhoek
NAMIBIA

13 August 2018

The Permanent Secretary
Ministry of Education, Arts and Culture
Private Bag 13236
WINDHOEK

Dear Mrs Sanet L Steenkamp

RE: REQUEST TO CONDUCT A PhD RESEARCH STUDY

I am Jafet Shikongo Uugwanga, a Senior Education Officer at National Institute for Educational Development (NIED): Research Sub-division. I am currently pursuing a Doctor of Philosophy (PhD) in Science Education with the University of Namibia and my student number is: 20117693.

This letter serves to request your permission to conduct a study in (*number of schools*) primary schools. The schools in Khomas Region are (*schools' names*); whilst in Omusati Region are (*schools' names*). The research forms a critical part of the PhD course and it is to be conducted from **September** to **October 2018**, targeting only one Grade 7 class per selected school. The approval to carry out this research study is granted from UNAM's Ethical Clearance Committee (see attached letter).

The topic of the research is ***"The effects of authentic learning activities on Grade 7 learners' achievement and attitudes toward Natural Science in Khomas and Omusati educational regions***" under the supervision of Prof C.D. Kasanda and Dr H.M. Kapenda. The findings of this study will be shared with the participants, the schools and the Ministry of Education, Arts and Culture. I will personally present the lessons, conduct interviews and administer the tests and questionnaires to the Grade 7 learners.

I would like to assure you that I will strictly adhere to research ethics and all the information received from participants will be treated with utmost confidentiality and will entirely be used for the educational purposes. I am looking forward to receive your favourable response.

Yours faithfully,

____

Mr. Jafet Shikongo Uugwanga
Cell: 085 555 302 0 / E-mail: jsuugwanga@gmail.com

Appendix J: An approval letter from the executive director (Ministry of Education, Arts and Culture)

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION, ARTS AND CULTURE

Tel: +264 61 -2933200
Fax: +264 61- 2933922
Enquiries: C. Muchila/ G. Munene
Email: Cavin.Muchila@moe.gov.na/gm12munene@yahoo.co.uk

Luther Street, Govt. Office Park
Private Bag 13186
Windhoek
Namibia

File no: 11/1/1

Mr. Jafet Shikongo Uugwanga
P. O. Box 13236
Windhoek
Cell: 081 555 3020

Dear Mr. J. S. Uugwanga

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN KHOMAS AND OMUSATI REGIONS

Kindly be informed that permission to conduct an academic research for your PhD studies on *"The Effects of Authentic Learning Activities on Grade 7 Learners' Achievement and Attitudes towards Natural Science in Khomas and Omusati Educational Regions in Namibia"*, is here with granted. You are further requested to present the letter of approval to the Regional Director to ensure that research ethics are adhered to and disruption of curriculum delivery is avoided.

Furthermore, we humbly request you to share your research findings with the ministry. You may contact Mr. C. Muchila/ Mr. G. Munene at the Directorate: Programmes and Quality Assurance (PQA) for provision of summary of your research findings.

I wish you the best in conducting your research and I look forward to hearing from you soon.

Sincerely yours

SANET L. STEENKAMP
PERMANENT SECRETARY

Office of the Permanent Secretary
Private Bag 13186
Windhoek, Namibia

20/8/18
Date

All official correspondences must be addressed to the Permanent Secretary

Appendix K: A letter requesting permission from the director of education (Omusati Region)

P.O. Box 2588
Windhoek
NAMIBIA

21 August 2018

The Acting Regional Director
Omusati Education Region
Ministry of Education, Arts and Culture
Private Bag 529
OUTAPI

Dear Mr Shali Kankondi

RE: REQUEST TO CONDUCT A PhD RESEARCH STUDY

I am Jafet Shikongo Uugwanga, a Senior Education Officer at National Institute for Educational Development (NIED): Research Sub-division. I am currently pursuing a Doctor of Philosophy (PhD) in Science Education with the University of Namibia and my student number is: 20117693.

This letter serves to request your permission to conduct a study in (*number of schools*) primary schools in (*circuit name*), Omusati Region. The schools are (*schools' names*). The research forms a critical part of the PhD course and it is to be conducted from **September** to **October 2018**, targeting only one Grade 7 class per selected school. The approval to carry out this research study is granted from UNAM's Ethical Clearance Committee and the office of the Permanent Secretary - Ministry of Education, Arts and Culture (see attached letters).

The topic of the research is ***"The effects of authentic learning activities on Grade 7 learners' achievement and attitudes toward Natural Science in Khomas and Omusati educational regions***" under the supervision of Prof C.D. Kasanda and Dr H.M. Kapenda. The findings of this study will be shared with the participants, the schools and the Ministry of Education, Arts and Culture. I will personally present the lessons, conduct interviews and administer the tests and questionnaires to the Grade 7 learners.

I would like to assure you that I will strictly adhere to research ethics and all the information received from participants will be treated with utmost confidentiality and will entirely be used for the educational purposes. I am looking forward to receive your favourable response.

Yours faithfully,

____

Mr. Jafet Shikongo Uugwanga
Cell: 085 555 302 0 / E-mail: jsuugwanga@gmail.com

Appendix L: An approval letter from the director of education (Omusati Region)

NAMIBIA

OMUSATI REGIONAL COUNCIL

DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Team Work and Dedication for Quality Education

Tel: +264 65 251700
Fax: +264 65 251722

Private Bag 529
OUTAPI

22 August 2018

Enq: Celine Shapumba

Mr. Jafet Shikongo Uungwanga
P.O Box 13236
Windhoek

Subject: Request to carry out Educational Research in schools in Circuit in Omusati Region.

This letter serves to notify you **(Mr. Jafet Shikongo Uungwanga)** that permission has been granted to carry out educational research "The effects of authentic learning activities on Grade 7 learners achievement and attitudes toward Natural Science" at.

Omusati Region.

Please be informed that the research to be conducted at school should by no means whatsoever disrupt teaching and learning.

We hope and trust this exercise will enhance quality education in the Region.

Yours faithfully

……………………

Lars J Shali Kankondi
Acting Director of Education Arts and Culture

OMUSATI REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE
2018 -08- 22
OFFICE OF THE DIRECTOR
PRIVATE BAG 529, OUTAPI
REPUBLIC OF NAMIBIA

Teamwork and dedication for quality education

All official correspondence must be addressed to the Chief Regional Officer.

Appendix M: A letter requesting permission from the director of education (Khomas Region)

P.O. Box 2588
Windhoek
NAMIBIA

21 August 2018

The Regional Director
Khomas Education Region
Ministry of Education, Arts and Culture
Private Bag 13236
WINDHOEK

Dear Mr Gerard Vries

RE: REQUEST TO CONDUCT A PhD RESEARCH STUDY

I am Jafet Shikongo Uugwanga, a Senior Education Officer at National Institute for Educational Development (NIED): Research Sub-division. I am currently pursuing a Doctor of Philosophy (PhD) in Science Education with the University of Namibia and my student number is: 20117693.

This letter serves to request your permission to conduct a study in (*number of schools*) primary schools in Khomas Region. The schools are (*schools' names*). The research forms a critical part of the PhD course and it is to be conducted from **September** to **October 2018**, targeting only one Grade 7 class per selected school. The approval to carry out this research study is granted from UNAM's Ethical Clearance Committee and the office of the Permanent Secretary - Ministry of Education, Arts and Culture (see attached letters).

The topic of the research is ***"The effects of authentic learning activities on Grade 7 learners' achievement and attitudes toward Natural Science in Khomas and Omusati educational regions***" under the supervision of Prof C.D. Kasanda and Dr H.M. Kapenda. The findings of this study will be shared with the participants, the schools and the Ministry of Education, Arts and Culture. I will personally present the lessons, conduct interviews and administer the tests and questionnaires to the Grade 7 learners.

I would like to assure you that I will strictly adhere to research ethics and all the information received from participants will be treated with utmost confidentiality and will entirely be used for the educational purposes. I am looking forward to receive your favourable response.

Yours faithfully,

____

Mr. Jafet Shikongo Uugwanga
Cell: 085 555 302 0 / jsuugwanga@gmail.com

Appendix N: An approval letter from the director of education (Khomas Region)

REPUBLIC OF NAMIBIA

KHOMAS REGIONAL COUNCIL

DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Tel: [09 264 61] 293 9411
Fax: [09 264 61] 231 367/248 251

Private Bag 13236
WINDHOEK

File No.: 12/3/9/1

Mr Jafet Shikongo Uugwanga
P.O. Box 2588
Windhoek
Namibia

RE: REQUEST TO CONDUCT A PhD RESEARCH STUDY

Your letter of 21 August 2018 on the above mentioned topic refers.

Permission is hereby granted to you to do research for your Doctor of Philosophy (PhD) in Science Education with the title: "The effects of authentic learning activities on Grade 7 learners' achievement and attitudes toward Natural Science in Khomas Education Region". You are allowed to do your research at the following primary schools:

The following conditions must be adhered to:

- Permission must be granted by the School Principal;
- Teaching and learning in the respective schools should not be disrupted;
- Learners who will take part in the research should do so voluntarily;
- A copy of your thesis with the findings/recommendations must be provided to the Directorate of Education, Arts and Culture, Khomas Regional Council.

I trust this confirmation will suffice.

Yours sincerely

23/08/2018

Gerard N. Vries
Director of Education, Arts and Culture

MINISTRY OF EDUCATION
ARTS AND CULTURE
PRIVATE BAG 13236 WINDHOEK
23 -08- 2018
DIRECTOR
KHOMAS REGION

Appendix O: An informed consent / requesting permission from the parents of the learners (Khomas and Omusati Regions)

P.O. Box 2588
Windhoek
NAMIBIA
11 September 2018

Enquiries: Jafet S Uugwanga
Cell: 085 555 302 0 / E-mail: jsuugwanga@gmail.com

Dear Parent,

Learner's name: ……………………………………………….

RE: REQUESTING YOUR PERMISSION FOR YOUR CHILD'S PARTICIPATION IN A RESEARCH STUDY

I am Jafet Shikongo Uugwanga, a Senior Education Officer at National Institute for Educational Development (NIED): Research Sub-division. I am currently pursuing a Doctor of Philosophy (PhD) in Science Education with the University of Namibia and my student number is: 20117693.

This letter serves to request your permission for your child to participate in this research study that I will be conducting at his/her school as from (*calendar month dates*) till (*calendar month dates*) and (*starting and ending time*). The research forms a critical part of the PhD course and the approval to carry out this research study is granted from UNAM's Ethical Clearance Committee, office of the Permanent Secretary – Ministry of Education, Arts and Culture, Khomas Regional Director of Education and your child's school principal.

The topic of the research is ***"The effects of authentic learning activities on Grade 7 learners' achievement and attitudes toward Natural Science in Khomas and Omusati educational regions"*** under the supervision of Prof C.D Kasanda and Dr H.M Kapenda. I would like to assure you that I will strictly adhere to the research ethics and all the information received from your child will be treated with utmost confidentiality and will entirely be used for the educational purposes. In fact, your child's identity will not be revealed and pseudonyms will be used. I am looking forward to receive your favourable response.

…………………………………………..……………………..............................

INFORMED CONSENT

In terms and conditions of the ethical requirements of the University of Namibia and Ministry of Education, Arts and Culture, you are now requested to sign this form to declare yourself.

I ……………………………………………………………. understand the contents of this letter and I am granting my child permission to take part in this research project. I understand that my child may withdraw from the study at any time and that anonymity will be guaranteed.

Parent's Signature: ______________________ ***Date: ________________***

Researcher's Signature: ___________________ ***Date: ________________***

Appendix P: An email to the copyright requesting permission to use the STAQ-R

Gmail

Jafet Shikongo <jsuugwanga@gmail.com>

Permission Request to use "Simpson Troopson Attitude Questionnaire-Revised (STAQ-R)"

Jafet Shikongo jsuugwanga@gmail.com Sat, Nov 19, 2016 at 6:33 AM
To: customercare@copyright.com

Dear Sir/Madam,

I am Mr Jafet Shikongo Uugwanga, a Namibian citizen doing my PhD with the University of Namibia. I specialised in Science Education, looking to the effects of authentic learning activities on learners' achievement and attitudes toward Natural Science. Therefore, I am requesting your permission to make use of the "Simpson Troopson Attitude Questionnaire-Revised (STAQ-R)" that was designed by Simpson and Troopsonin 1982. I saw this questionnaire on the internet and I found that it is relevant to my study to test learners' attitude toward Natural Science.

I will be grateful to hear your positive respond.

Kind regards,
Mr JS Uugwanga

Appendix Q: An email from Professor Ronald D Simpson granted permission to use the STAQ-R

Gmail

Jafet Shikongo <jsuugwanga@gmail.com>

Permission Request to use "Simpson Troopson Attitude Questionnaire-Revised (STAQ-R)"

Ronald Simpson rsimpson@uga.edu Sat, Nov 19, 2016 at 7:00 PM
To: Jafet Shikongo <jsuugwanga@gmail.com>
Cc: "J. Steve Oliver" <soliver@uga.edu>

Thank you for your interest in our attitude scale. We are pleased that it has been so useful in many places around the world.

I have been retired for over 15 years, however, my colleague and co-author, Professor Steve Oliver (University of Georgia) now receives inquiries for those needing additional information about the scale. Though the initial research was conceived with Professor Troost (now deceased), Dr. Oliver participated closely throughout the duration of the study and with analysis of the final results. We both, of course, grant permission to use the scale in appropriate situations (with appreciation regarding results thereafter) and are pleased to know that additional research in this area is continuing.

Dr. Oliver is Professor of Science Education in the Department of Mathematics and Science Education at the University of Georgia and can be reached via email at the above address. Again, we appreciate your interest in our past research and wish you well in your important endeavours.

Ronald Simpson
Professor Emeritus
University of Georgia
[Quoted text hidden]