

**Enactment of hands-on practical activities through using easily accessible
resources in a Grade 10 Physical Science classroom**

Submitted in fulfilment of the requirement of the degree

Of

MASTER OF EDUCATION

SCIENCE EDUCATION

FACULTY OF EDUCATION

AT

RHODES UNIVERSITY

BY

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June 2019

Declaration of originality

I, Martha Kashike Ndevahoma, hereby declare that the work contained in this thesis is my own original work and has not been previously submitted at any other university for degree purposes. Where I have used ideas from the work of others, these have been acknowledged using complete references according to the Rhodes University departmental guidelines.

Signature: 

Date: 18 June 2019

Dedication

This thesis is dedicated to my beloved parents, Nahas Mukwaita wa Kristus Ndevahoma and his lovely wife Taimi Etuna Ndevahoma. Mom and Dad, you taught me how to be responsible and hard working. Here are the fruits for you to harvest. I further dedicate this thesis to my lovely husband Fritz Tuhafeni Inamutwika David and our lovely children: my Junior Martha, Ndapewoshali Ndahafa and Spencer Wato. Their patience, motivation and support have been amazing. I love you all and may God bless you!

Abstract

The Namibian National Subject Policy Guide for Physical Science Grade 8-12 (MoE, 2010) indicates that science teachers should be creative and innovative in producing their own teaching and learning support materials that are linked to practice. Practical activities play a major role in the learning of science. Due to the lack of science laboratory equipment, however, minimal practical activities are done in some schools especially under-resourced disadvantaged schools. It is against this background that this case study investigated the possibilities and challenges associated with the use of easily accessible resources to carry out hands-on practical activities.

Underpinned by an interpretive paradigm, this study used a mixed-method approach by generating both quantitative and qualitative data. It was carried out in the Otjozondjupa region in Namibia at Wato Secondary School (pseudonym). It was conducted with a Grade 10 Physical Science class consisting of 30 learners. To generate data, questionnaires, focus group interviews, lesson observations, stimulated recall interviews, as well as learners' journal reflections were used. Conceptions, dispositions, interest and sense-making were used as conceptual lenses while Vygotsky's social constructivism was the theoretical framework that informed this study.

Quantitative data were analysed using the conceptual lenses and were subsequently presented in tables and graphs. That is, a deductive approach to analysis was used. On the other hand, a thematic approach was used to analyse the qualitative data. That is, qualitative data were inductively analysed to come up with sub-themes and themes. The findings from this study revealed significant shifts in learners' conceptions, dispositions and interest towards science after the use of easily accessible resources to do hands-on practical activities. Similarly, learners' sense-making of science concepts improved. This study thus recommends that science teachers should, where possible, make use of easily accessible resources to carry out hands-on practical activities during their science lessons. During such hands-on practicals, however, emphasis should be on the development of scientific concepts.

Key words: Physical Science, scientific concepts, hands-on practical activities, easily accessible resources, conceptions, dispositions, interest, sense-making, social constructivism

Acknowledgements

First and foremost, I would like to give thanks to the Almighty God for his grace and wisdom given to me in order to withstand the pressure throughout this journey. It is by his grace that I made it through.

My sincere gratitude goes to my supervisor, Professor Kenneth Mlungisi Ngcoza for his invaluable guidance and support throughout this journey. Not only did you supervise my work, but you have been very encouraging, inspirational and you always have your students' best interest at heart. I am grateful for your hardworking and patience throughout this journey. Professor Ken, You have truly put things in place as your name says 'Mlungisi'.

My appreciation also goes to my co-supervisor, Dr Sirkka Alina Nambashu Tshiningayamwe. You provided insightful feedback and comments that prompted me to widen my perspective and ability to modify my work for a smooth flow of ideas. Thank you for your support.

In the same vein, I would like to thank Ms Zukiswa Kuhlana, for her unconditional support throughout this journey. Your motivation and words of encouragement are acknowledged. You provided an opportunity for me to carry out this research successfully. Without your precious support, it would not have been easy for me to complete this research. Be blessed.

To Mrs Energy, I thank you for availing your time whenever I needed you for the lesson presentations of this research. I appreciate your invaluable contributions.

I would also like to thank the Grade 10 learners of the year 2018 at Wato Secondary School (pseudonym), who volunteered to be participants in this study. You willingly availed your precious time throughout this research process.

I would like to thank my parents for your tireless support and words of encouragement throughout my studies. You kept on reminding me about the importance of education in my life. Surely, I appreciate you.

To my wonderful husband, Fritz Tuhafeni David, I could not have done this without your support and patience. Thank you for the sleepless nights we spent together and helping me with lots of readings although you also had a lot to do for yourself. To our lovely children, Martha Junior, Ndapewa and Spencer, I neglected you many times in order to complete this study. Thank you for being brave and for your understanding. One could not wish for a better and supportive family than all of you.

To my fellow Masters' students, thank you so much for the motivational discussions, your involvement and support contributed to the completion of this study. Thank you for the fun we had. Let us keep up this good spirit!

I would also like to thank Ms Nikki Watkins for professionally editing my thesis.

Finally, I give thanks to everyone who supported me in either way to make this research a success. Your support is highly appreciated and acknowledged.

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List of abbreviations and/or acronyms

COP: Community of Practice

LCE: Learner Centred Education

MBEC: Ministry of Basic Education and Culture

NCBE: Namibia Curriculum of Basic Education

NSSCO/H: Namibia Senior Secondary Certificate Ordinary level/Higher level

ZPD: Zone of Proximal Development

ZPL: Zone of Proximal Learning

CHAPTER ONE: SITUATING THE STUDY

1.1 INTRODUCTION

Certain research findings have outlined challenges and shortcomings regarding the teaching and learning of science, and especially the implementation of practical activities in science classrooms (Fitzgerald, 2012). For instance, Fitzgerald (2012) points out that most science teachers are dependent on textbooks when teaching science in both primary and secondary schools. It is against this background that in this study I investigated the use of easily accessible resources to carry out hands-on practical activities in a Grade 10 Physical Science class in Namibia.

In this introductory chapter, the background of the study is explained, as well as the statement of the problem and the significance of the study. The research goals, objectives and research questions of the study are highlighted, followed by the definition of key concepts used. The chapter concludes with the outline and overview of the different chapters and ends with some concluding remarks.

1.2 BACKGROUND OF STUDY

In a study conducted in the United Kingdom on effectiveness of practical activities, Abrahams and Millar (2009) found out that the majority of learners enjoyed science lessons with practical activities to a greater extent than theoretically based science lessons without practical activities. According to them, practical activities help learners to better understand scientific concepts. Science educators have suggested many benefits as a result of engaging learners in practical science investigations. Woodley (2009) claims that most practitioners agree that only quality practical activities which engage learners help them understand important scientific skills, understand the process of scientific investigations and develop understanding of science concepts. Hofstein and Mamlok-Naaman (2007) highlight that science activities have long played a distinctive and central role in science education.

It has been shown that science investigations allow learners to form scientific hypotheses, design and conduct inquiry and scientific investigations, formulate and revise scientific explanations, as well as communicate and defend scientific arguments (Hofstein & Mamlok-Naaman, 2007). In a study conducted in the Eastern Cape Province, South Africa, Maselwa and Ngcoza (2003) found that learners enjoyed science lessons which included components of practical activities, and they highlighted a need to emphasise conceptual development during such practical activities.

The South African National Curriculum Statement for Grade 8-12, that encompasses the Curriculum and Assessment Policy Statement, requires Natural Sciences teachers to teach science in a way that focuses on solving problems, understanding the natural world, communicating and evaluating findings and completing investigations using practical skills (Department of Basic Education, 2012). Similarly, the Namibian National Subject Policy Guide for Physical Science Grade 8-12 (MoE, 2010) indicates that science teachers should be creative and innovative enough to produce their own teaching and learning support materials that are linked to practice. Learners should be involved during the lessons, as the guide emphasises the concept of Learner-Centred Education (LCE) in the Namibian context. The LCE policy was formulated after Namibian independence in 1990 in order to respond to the curriculum review and the national goals of equity and democracy (MoE, 1999). The policy further highlights that the teachers in Namibia are expected to mediate learning to ensure the active participation of learners (Sedlacek & Sedova, 2017; Vygotsky, 1978a).

According to the Namibian National Subject Policy Guide for Physical Science Grade 8-12 (MoE, 2010), the LCE takes as its starting point that the learner is an active, inquisitive human being, striving to acquire knowledge and skills to master his/her surrounding world. It also highlights that a learner centred classroom should be productive, interactive and enriching. The curriculum prescribes a need to empower learners with scientific knowledge, skills and attitudes so that they can investigate, observe, make sense of and understand the physical world in a rational, scientific way.

In contrast, Thompson (2013) argues that a survey carried out by Schweisfurth (2011) revealed that LCE was more difficult to implement in rural settings, where the paradigm shift required to move from formalistic to learner-centred practice is complex and overwhelming; where the

acceptable distance between teachers and learners in overfilled classrooms also tends to be far greater than in urban schools. This situation is similar to what happens in the context of Namibia.

In the Namibian context, Physical Science in general is perceived as a difficult subject and thus most learners avoid taking it at their senior secondary level. According to the Namibian Senior Secondary Certificate syllabus (NSSC) (MoE, 2010), which is the examination offered in Namibia where learners either take Physical Science at the higher or ordinary level, the scheme of assessment criteria highlights that all learners should be entered for three papers (Paper 1, 2 and 3) for the end of Grade 12 examinations. Paper 3, which is applied practical skills for the Namibian Senior Certificate Ordinary (ordinary level) and a practical test for Namibian Senior Certificate Higher (higher level), is a compulsory examination for both higher and ordinary level learners. It is designed to test familiarity with experimental and investigative skills and abilities. This requires learners to be exposed to practical activities and demonstrations for them to be able to handle the practical examination papers.

1.3 STATEMENT OF THE PROBLEM

The Namibian Examiners' Reports for 2014-2016 indicate that Grade 10 and 12 learners failed to handle practical examination questions. The Examiners' Report for 2017 also reveals that the learners' performance, in relation to how they had responded to practical questions, was both questionable and worrisome. A general comment in the Examiners' Report for 2017 states that "it seems like the conducting of practical activities in the Physical Science classrooms seems to be challenging and teachers are encouraged to carry out practical activities" (MoE, 2017, p. 104).

My assumption is that, although the Namibian Physical Science Syllabus suggests some practical activities to be carried out during the teaching and learning of certain topics in the subject, it is possible that some teachers do not carry out the activities with learners as suggested, because not all Namibian schools have laboratories or science apparatus and chemicals with which to conduct practical activities. Consequently, learners are not being afforded an opportunity to do hands-on practical activities in their science classrooms. Yet, Millar (2004) urges that practical activities play an important role in learners' learning science, and they provide them with an opportunity to develop skills that they can use in real life situations. Hodson (1992) posits that in most science

classrooms practical activities are not conducted, and if conducted, they are misconducted, unproductive, and confusing. As a result, they contribute little to learners' meaningful learning of science.

It is against this background that this study sought to investigate whether the use of easily accessible resources to carry out hands-on practical activities influenced Grade 10 Physical Science learners' conceptions, dispositions and sense-making. The Namibian Broad Curriculum places emphasis on the inclusion of local context and the use of the immediate environment in the teaching of science (MoE, 2010). My study therefore intended to close the gap between what the curriculum entails and the current situation existing in the teaching and learning of science in Namibian schools, as far as the enactment of practical activities is concerned.

1.4 SIGNIFICANCE OF THE STUDY

The main goal of this study was to investigate whether or not Grade 10 Physical Science learners' conceptions, dispositions and sense-making was influenced when easily accessible resources were used to carry out hands-on practical activities.

- This study may thus provide a better understanding of hands-on practical activities and the importance of using easily accessible resources;
- The result of this study may assist teachers in guiding learners to make sense of easily accessible resources and enable them to carry hands-on practical activities which might ultimately help improve performance in Physical Science;
- Learners may also appreciate the value of local materials as they can be used as resources to carry out hands-on practical activities. This might hopefully change the learners' conceptions, dispositions and sense-making towards science. An outcome of this study may be that teachers are better guided to enable learners to better realise that science is around them;
- It might help curriculum developers to realize the importance of the inclusion of some easily accessible resources when they suggest practical activities in the Physical Science syllabus, and this may be extended to other science subjects.

1.5 THEORETICAL FRAMEWORK

Huff (2009) notes that “theories are explanations of a generalised nature which enable the researcher to compare and analyse empirical data” (p. 44). Biesta, Allan and Edwards (2011) remark that we need theory in any sort of educational research. Concurring, Ramasike (2016) states that a theoretical framework encompasses a theory that predicts, explains and shapes a study. To Cohen, Manion and Morrison (2018), theory is a proposition that brings together concepts and constructs into a coherent, whole framework or system, which has clearly set limits and assumptions. They argue that it gathers together all the isolated pieces of empirical data into a coherent conceptual framework of wider applicability. Given the above, Vygotsky’s (1978a) social constructivist theory informed this study.

1.6 RESEARCH GOAL, OBJECTIVES AND QUESTIONS

The main goal of this study was to investigate whether or not carrying out hands-on practical activities using easily accessible resources influenced Grade 10 Physical Science learners’ conceptions, dispositions and sense-making. To achieve this goal, the following specific objectives and research questions guided the study.

1.6.1 Specific objectives for the study

1. To find out the Grade 10 Physical Science learners’ initial conceptions, dispositions and interests towards science;
2. To find out the Grade 10 Physical Science learners’ conceptions and dispositions on the use of easily accessible resources when doing practical activities in their classrooms; and
3. To find out whether or not carrying out hands-on practical activities using easily accessible resources influenced the Grade 10 Physical Science learners’ conceptions, dispositions and sense-making.

1.6.2 Research questions

1. What are the Grade 10 Physical Science learners’ initial conceptions, dispositions and interest towards science?

2. What are Grade 10 Physical Science learners' conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities?
3. How does carrying out hands-on practical activities using easily accessible resources influence (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making?

1.7 DEFINITION OF KEY CONCEPTS

Practical activities: Tasks that engage learners in several activities such as observing or controlling objects and materials, as well as conducting experiments (Millar, 2004).

Easily accessible resources: Local, improvised materials that are in the immediate environment.

Conceptions: Views that students hold towards a certain phenomenon and what they believe is required in learning and doing it (Atallah, Bryant, & Dada, 2010).

Dispositions: Acquired patterns of behaviours which are dynamic and can manifest in a specific context.

Mediation: The intervening process used by the knowledgeable person in assisting learners to make sense of new knowledge (Vygotsky, 1978b).

Mediational tools: The teaching and learning techniques incorporated for the purpose of accessing new knowledge or making sense of new concepts (Lemke, 2000).

Sense-making: When learners relate a particular situation to what they know or experience from their environment.

Social Constructivism: A theory where learning is viewed as a social process, which does not take place only with the individual, but occurs when individuals are engaged in social activities (Vygotsky, 1978a).

1.8 THESIS OUTLINE

This thesis consists of six chapters, each discussed below.

Chapter One: Situating the study

Chapter One served as an introduction and orientation to the study, stating the background of the study, the statement of the problem and significance of the study, research goals, objectives and questions. The chapter also presented the definition of concepts, as well as the thesis outline.

Chapter Two: Literature review

Chapter Two presents a review of the relevant literature for my study. An in-depth study and analysis on social constructivism, prior knowledge and indigenous knowledge, practical activities, easily accessible resources, sense-making and dispositions are all discussed in this chapter.

Chapter Three: Research Methodology

The research process and methodology which guided my study is discussed in Chapter Three. The research approach, design and orientation, goals and research questions, the research site, the participants, as well as data generation methods are presented. The method used for data analysis is explained, as well as all measures taken to ensure validity and trustworthiness. Ethical considerations are also stated.

Chapter Four: Data presentation, analysis and discussion (Phase 1)

In this chapter, I present, analyse and discuss the data generated from questionnaires and focus group interviews. The learners' journal reflections are also interwoven into the discussions. In this chapter, the research data are presented according to the themes and subthemes that emerged during data analysis.

Chapter Five: Data presentation, analysis and discussion (Phase 2)

In Chapter Five, I present, analyse and discuss the data generated from lesson observations, the stimulated recall interviews, as well as from the learners' journal reflections. The empirical

research findings are discussed with reference to the literature from Chapter Two on practical activities and the use of easily accessible resources in the teaching of science, in order to compare findings of my study to the findings of previous studies. Vygotsky's (1978a) social constructivist theory was used as a lens through which my research findings were interpreted.

Chapter Six: Summary of findings, recommendation and conclusion

In this chapter, the summary of the findings, recommendations, limitations of the study, reflections and conclusion are presented in detail. It also provides recommendations for the areas of future research and reflects on the overall research process. Conclusions are drawn by answering the main research question and sub-questions which guided this study. Finally, recommendations are made for teachers, learners, curriculum developers and further researchers.

1.9 CONCLUDING REMARKS

In this chapter, I introduced the research study and provided background information, the statement of the problem, the significance of the study, theoretical framework, the research goal, objectives and research questions. Definition of key concepts were also given, as well as an overview of the chapters to provide a clear understanding of the research and enable the readers to navigate through the thesis easily.

The next chapter describes the literature relevant to my study, as well as my theoretical framework of the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

The main goal of this study was to investigate whether or not carrying out hands-on practical activities using easily accessible resources influenced Grade 10 Physical Science learners' conceptions, dispositions and sense-making. In the previous chapter, I discussed the background or context of this study. In this chapter, I thus discuss literature relevant to my study.

Firstly, I discuss an overview of the international context and of the Namibian curriculum in particular, as they relate to the concepts that are key to the study. This is followed by a discussion on practical activities. Secondly, I discuss prior everyday knowledge and indigenous knowledge. Thirdly, I discuss the perspectives from literature that look at the conceptual framework of the study, as well as Vygotsky's social constructivism as my theoretical framework. The theory helped me to maintain a conceptual focus as it was the lens through which I analysed my data in this study.

2.2 THE NAMIBIAN NATIONAL CURRICULUM OF BASIC EDUCATION (NCBE)

In Namibia, Natural Sciences is one of the fields offered across the curriculum. Physical Science is one of the subjects within Natural Sciences. The Natural Sciences area of learning contributes to the foundation of a knowledge-based society by empowering learners with scientific knowledge, skills, and attitudes to investigate, observe and make deductions (MoE, 2016). The Namibian National subject policy for Physical Science Grades 8-12 (MoE, 2001) indicates that science teachers should be creative and innovative enough to produce their own teaching and learning support materials, especially those that can afford them, a chance to use them to carry practical activities. Hence, in the Namibian Physical Science syllabus for Grades 8-12, practical activities are suggested for each topic, guiding teachers on what and how to go about doing them, in order to involve learners in actively learning through doing them.

As a result, the Namibian National Broad Curriculum for Basic Education (NCBE) (MoE, 2016) emphasises that learners should be actively involved during lessons. This is because the NCBE takes a stand in promoting the concept of Learner-Centred Education (LCE) in this context, as the curriculum entails that learners are at the centre of learning; hence, lessons should involve practical tasks as often as possible. In support, Nyambe (2008) argues that LCE should be practically orientated so that learners physically participate in the lessons.

The Namibian curriculum emphasises that learning processes must always lead to increased understanding or skills and an increased ability to handle knowledge – not knowledge for its own sake. Thus, teachers should be fully conversant with and be competent in how to teach in accordance to LCE approaches (MoE, 2016). The NCBE (MoE, 2010) also stipulates that learners should use the immediate environment and everyday items to investigate phenomena using a scientific approach. The everyday items are what I refer to as easily accessible resources in my study, as reflected in Asheela's (2017) study.

At the same time, the NCBE (MoE, 2016) highlights that learning in Namibian schools should constantly relate to, involve and extend the learners' prior knowledge and experiences (Kuhlane, 2011). Taylor (1999) however, cautions that not all everyday contexts provide appropriate entry points into school knowledge as some contexts might be misleading. Oloruntegbe and Ikpe (2011) argue that practical activities can be seen as too time consuming in terms of completing the syllabus, as teachers are expected to cover the syllabus in time for tests. They further claim that learners might also find it difficult to establish the bridge between science learned at school and phenomena that they experience in their everyday chores.

2.3 PRACTICAL ACTIVITIES

In this study, practical activities refer to teaching and learning that engages learners in several activities such as observing and controlling materials and apparatus (Asheela, 2017; Millar, 2004).

Woodley (2009) defines practical activities as activities prepared by the teachers or educators which enable learners to be actively involved in the learning process. She further asserts that

practical activities allow learners to comprehend the significances of experiencing hands-on activities in science.

Asheela (2017) adds that practical activities have a potential to create a link between the observations and the theories/ideas of science, while Millar (2009) uses the term ‘practical work’ in preference to ‘laboratory work and experiments’ to refer to any teaching and learning activity that at some point involves the students in observing or manipulating the objects and materials they are studying. Millar (2010) argues that practical experience of observing and intervening in the world is essential for promoting understanding. Moreover, Dillon (2008) also claims that engaging learners in practical activities promotes cognitive development from context to content knowledge and believes that hands-on practical activities encourage learners to discover more knowledge and develop creativity. Maselwa and Ngcoza (2003) emphasise that learners are encouraged to predict, explain, explore, observe and explain their actions in science learning when they are doing practical activities. Such an assertion is supported by Motlhabane and Dichaba (2013) as they believe that learning through practice can boost learners’ memory retention capacity, self-efficacy, determination, as well as attitudes. Well-designed practical activities should also be aligned with practical procedures and enquiry skills, which would inform the cognitive process (*ibid.*).

Millar (2004) emphasises that effective practical activities enable learners to make connections between everyday knowledge and scientific knowledge. He claims that practical activities are important as they provide the opportunity to educate learners to be scientifically literate citizens and allow them to work hands-on and learn to make informed decisions. Woodley (2009) supports this by arguing that the purpose of quality practical activity is to help learners to develop their understanding of scientific concepts and to make sense of them. Howell and Eison (1991) outline that the main role of practical activities is to involve learners in meaningful learning processes that enable them to think about what they are learning, instead of merely listening to teachers. Research shows that practical activities are important because they have the potential to help learners develop useful skills, develop scientific concepts and encourage learners to enjoy learning science (Haigh, 2007).

Some scholars have however, identified the disadvantages associated with practical activities. In his study, Millar (2004) explained that some teachers were concerned that practical activities did not promote effective learning and that most of the learners did not learn what was required of them during practical activities. Thus, some science teachers in his study questioned the effectiveness of practical activities.

In her study, Asheela (2017) highlighted the dominant factor hindering teachers from carrying out practical activities such as the lack of chemicals, equipment and laboratories. Asheela thus suggested that teachers needed to make use of easily accessible resources to carry out hands-on practical activities during their lessons. In my case, I view practical activities as playing a useful role in learning, thus my study aimed at closing the gap that was identified by Asheela (2017).

Easily accessible resources can be accessed from the environment around the school, as well as materials that are easily available within a particular context; materials which can be obtained from the local environment, or which can be purchased cheaply from local shops. Kibirige and Van Rooyen (2006) emphasise that the use of easily accessible resources ensures education which is locally relevant and culturally appropriate, which empowers individuals and unlocks their potential. This might also make learners value their prior knowledge as it is based on what they already know from their respective environments.

2.4 PRIOR EVERYDAY KNOWLEDGE

Roschelle (1995) defines prior knowledge as learning experiences that focus on a theoretical shift – viewing learning as a conceptual change. He further argues that it is not possible for learners to learn without having prior knowledge, because prior knowledge is the baseline for the construction of new knowledge as a mediational tool.

Lemke (1990) reasons that to make more sense of science, the primary meaning of concepts should be incorporated through language then supplemented by prior knowledge, practical activities and other mediational tools. In support, O'Malley and Chamot (1990) and Keys (1999) state that learners' thinking may adapt faster if new knowledge is linked to prior knowledge through a range of techniques. This study focused on the use of easily accessible resources to carry out hands-on

practical activities which I believe are part of learners' immediate environment and hence might afford them an opportunity of including their prior knowledge during the learning process.

This is supported by Vygotsky (1978b) who believes that learners might have prior knowledge about the materials from their homes and so it is important for teachers to consider such prior knowledge during teaching and learning activities. For instance, they can do this by finding ways of allowing learners to share and discuss their everyday experiences and to link them with science content knowledge. Learners' prior knowledge might arise from their immediate society or from their culture. Easily accessible resources that are collected or found locally can be used as community/cultural tools to carry out hands-on practical activities which are easy for the learners to use, as they are linked to their prior knowledge.

Drawing on Vygotsky's seminal work, Leach and Scott (2002) posit that knowledge is socially acquired and constructed. As a result, they refer to prior knowledge as pre-social knowledge and suggest that prior knowledge should be checked for alternative conceptions so that there is a connection to scientific knowledge. Kasanda et al. (2005) recommend that prior knowledge can be used to complement in-class and out-of-class knowledge in order to make sense of new science knowledge, as they believe that acknowledging learners' prior knowledge might serve as a foundation for science knowledge. To add, Stern and Ahlgren (2002) explain that learning takes place when the transformation of ideas from prior knowledge occurs, which is from known to unknown. That is, prior knowledge can be used to expose learners to new knowledge (Kuhlane, 2011; Rennie 2011).

Stears, Malcolm and Kowlas (2003) highlight that it is beneficial when a teacher builds on learners' prior knowledge when teaching the science curriculum as learners can relate to content that they deal with in their daily lives. Stears et al. (2003) emphasise that learners learn well and embrace learning of science when their everyday experiences are incorporated into the teaching and learning process. Svinicki (1993) explains that, once there is connection between what the learners know, it is easier for them to remember new concepts that they have learned. Roschelle (1995) warns that neglecting learners' prior knowledge can result in the learners learning something which is different from what was intended, no matter how well it was executed.

Namibia's MBEC (MoE, 1996) also emphasises that schools have a special responsibility to use the curriculum together with the syllabus, to identify locally relevant content within a common framework so that learners experience their education as being meaningful for them. Supporting this, Nyambe and Wilmot (2012) outline that one of the goals of LCE is to encourage teachers to build learning on the prior everyday knowledge or indigenous knowledge of learners.

The NCBE (MoE, 2016) states that learners do not come to school like empty buckets to be filled with information, but that they already have experience and are learning. The NCBE cautions that if teaching does not build on that experience, learning might limit the learners' thinking and thus they will not see the connection between the world outside the school and what is taught and learnt in school. The NCBE (MoE, 2016) supports the recognition of learners' prior-knowledge and that teaching should always begin with helping the learners realise what they might already know about something or what idea or question they might have, by relating it to the environment within and around the school. In science, the inclusion of learners' prior knowledge in teaching and learning can also assist learners' understanding of learning competencies through the use of practical activities when teaching.

2.5 CONCEPTUAL FRAMEWORK

According to Maxwell (2013), a conceptual framework is a system of concepts, assumptions, expectations, beliefs and theories that shape one's research. The function of a conceptual framework is to help researchers to assess and refine their goals (Maxwell, 2013). The conceptual framework developed for this study was based on three concepts, namely, conceptions, dispositions and sense-making and I discuss these below.

2.5.1 Conceptions

Thompson (1992) refers to conceptions as mental structures that encompass beliefs, concepts, meaning, proposition, mental images and others. Oaks (1994) describes conceptions as views that students hold of mathematics and what they believe is required in learning and doing mathematics. Atallah et al. (2010) regard conceptions as views that learners hold towards the subject and what they believe is required in learning and doing it.

Atallah et al. (2010) further point out that conceptions have two components: knowledge and beliefs. For Perkins (2008) and Richardson (2011) there are two types of conception approaches: the deep approach and the surface approach. In a deep approach, the learners are constructing meaning, relating ideas and using evidence, while in the surface approach learners reproduce learning materials for the purpose of assessment (Richardson, 2011).

This study used Atallah's (2010) definition to understand the Grade 10 learners' views about the use of easily accessible resources to carry out hands-on practical activities in Physical Science. It is recognised, however, that concepts are related to dispositions.

2.5.2 Dispositions

The overall concept of disposition is difficult to define which has led to it being defined in various ways in the literature (Carr & Claxton, 2002). For Dewey (1922), habits and disposition are closely related concepts which both point to the readiness to accept a certain phenomenon. Dewey (1992) defines disposition as the readiness to act overtly in a specific fashion when it is the right time to do so.

To Graven (2012), disposition is a habitual tendency to act in a particular way when an opportunity presents itself. Similarly, Ritchart (2002) highlights that dispositions are acquired patterns of behaviours which are dynamic and can manifest themselves in a specific context. Bourdieu (1993) indicates that dispositions are acquired and manifest themselves in a social setting as a personality feature; while Diez (2007) claims that the learners' dispositions evolve as they engage in constant interactions with exposure to a particular kind of learning experience in a supportive and challenging environment. Diez (2007) further mentions that for dispositions to develop, there should be optimal interaction with the environment. In support of this, Agunbiade (2015) considers that learners could develop their disposition towards science in science-related settings and they could demonstrate their dispositions during activities, as well as in other science-related environments, which is in line with my study.

On the other hand, Bertram and Pascal (2002) consider dispositions as environmentally sensitive, having the ability to be fostered, refined and even weakened by interactions with others in such environments. Earlier theorists such as Vygotsky support the notion of individuals having the

potential to change who they are, based on interactions with the environment, while involved in cooperative activity with peers (Vygotsky, 1978b). Vygotsky (1978b) indicates that people are social beings and the social environment/experience influences what is learned and developed.

According to Gresalfi (2009), learning is considered to be a change in participation through which one ‘becomes’ a different person with respect to the practices of that activity setting (Lave & Wenger, 1991; Wenger, 1998; Wortham, 2004). Thus, learning is a process of developing *dispositions*; that is, ways of being in the world that involve ideas about, perspectives on, and engagement with information that can be seen both in moments of interaction and in more enduring patterns over time (Gresalfi & Cobb, 2006). As Thomas and Brown (2007) note, dispositions involve attitudes towards the world, generated through a set of practices which can be seen to be interconnected in a general way. In my study, dispositions are viewed as attitudes towards practical activities in Physical Science: the way learners feel about/how they act toward/how they take part in/whether they tend to like and enjoy or hate doing practical activities, as noted by Thomas and Brown (2007).

Katz and Raths (1985) view disposition as being descriptive and different from skills, attitudes, habits and traits. Rather, they see it as a criterion that incorporates a measure of competence of a skill that has been chosen to be used, not a measure of a skill that a person has, but has chosen not to use. Conceptions and dispositions towards a certain situation may also determine how one will make sense of such situation.

2.5.3 Sense-making

Sense-making refers to when learners are able to make sense of new concepts within the topic that is being taught. It deals with the issue of whether learners are able to relate a particular situation to what they know or experience from their society or environment. Weick, Sutcliffe and Obstfeld (2005) argue that sense-making involves turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action. They further claim that sense-making is about the interplay of action and interpretation, rather than the influence of evaluation on choice. In my study, I observed the learners sense-making by finding their “aha” moments, their moments of sudden discovery and insight. Defined by Walker (2013), “aha” moments are when characters realise something new that has the potential to change the story.

2.6 THEORETICAL FRAMEWORK

Sinclair (2007) refers to a theoretical framework as being similar to a map or travel plan while Merriam (2009) argues that theoretical frameworks are different structures around which research can be designed and conducted and influence every aspect of the research. To Bertram and Christiansen (2015), frameworks affect how the study is designed, and how empirical data are generated and analysed. This study used the social constructive theory of Vygotsky (1978b).

The term ‘social constructivism’ is derived from the concept ‘constructivism’, which entails learners gaining knowledge through concrete experiences within their direct environment (Huitt & Hummel, 2003; Powell & Kalina, 2009). Piaget’s (1965) cognitive constructivist and personal constructivist theory focuses on individual construction of meaning. Piaget (1953) believes that learning occurs in the thought processes of learners and that learners cannot learn anything unless they have reached a certain developmental stage. He believes that learning may occur through three processes, namely, assimilation, accommodation and disequilibrium. Assimilation is defined as the integration of new experiences into the prior knowledge (Roth & Roychoudhury, 1994). On the other hand, accommodation is defined as the transformation of the existing knowledge to fit in with the new experience and disequilibrium as a process of resolving a cognitive conflict between new and old experience in an individual’s thinking. Thus, Slavin (1988) posits that learners need to transform old knowledge or experiences to address their own needs and capabilities before accommodating new knowledge into their cognitive structure. However, my study focused on Vygotsky’s (1978b) social constructivism theory.

To Vygotsky (1978b), social constructivism emphasises the collaborative nature of learning through which reality is believed to be constructed through human activity. Knowledge is seen as a human product and is socially and culturally constructed. That is, individuals create meaning through their interactions with each other and with the environment they live in. Learning is viewed as a social process; it does not take place only with an individual but occurs when individuals are engaged in social activities. In the context of this study, that means hands-on practical activities.

Unlike Piaget, Vygotsky focuses more on a social aspect of the learners gaining information within their environment (Liu & Matthews, 2005). Furthermore, learning is not affected by stages of development but by social interactions with adults. Effective learning requires that individual knowledge construction should occur through social interactions to negotiate the meaning of new experience (Arends, 1997; Cobern, 1993; Palincsar, 1998). As with Chalesworth and Lind (2007) and Kim (2006), Vygotsky believes that the environment contains many opportunities for learners to gain knowledge and posits that learners interact with one another, share ideas and thus create new thoughts and knowledge.

Vygotsky (1978b) further claims that there are two levels of knowledge development, the level of actual and the level of potential development. The level of actual development is the level that the learners have already reached when they are capable of solving problems themselves. On the other hand, the level of potential development is where the problem solving is under the teachers' guidance or in collaboration with more knowledgeable others.

In a study conducted to break from the tradition of objectivist semantics that explored and interpreted learning environments through a lens of social constructivism, McRobbie and Tobin (1997) depict that a social constructivist perspective on learning highlights the role of active involvement in tasks associated with making connections between experience and prior knowledge. The learners' use of everyday language, their learning to use the technical register of science in discussing and engaging in argument over the meanings they are giving to experiences and the evidence relating to their knowledge claims, are important components in making these connections and testing the viability of their knowledge.

McRobbie and Tobin (1997) further reveal that the social constructivist perspective of learning suggests that learners should have control over their own learning and construct meanings for their experiences in terms of what they know at the time of learning. Learners need time to reconstruct their prior knowledge and to use it to make sense of experience and to reconstruct their understandings where necessary.

Arends (1997) highlights that through the guidance of teachers, learners may progress to the higher level of understanding. Vygotsky (1978b) argues that effective learning occurs in the zone of proximal development (ZPD).

2.6.1 Zone of Proximal Development

Vygotsky (1978b) defines the ZPD as the distance between the actual development level and the level of potential development as determined through the help of the more knowledgeable others. Arends (1997) and Bruning, Scharaw, Norby and Ronning (2004) describe the ZPD as an area between a learner's current level and the level which they can achieve through the assistance of a knowledgeable teacher. Teachers should use scaffolding in order to guide learners through ZPD (Bruner, 1966). To Bruning et al. (2004), scaffolding is a teaching strategy that assists learners to perform an action that they are unable to do on their own, but without just giving them the answers. Through scaffolding, learners are guided to discover knowledge by themselves.

Stott (2016) highlights that there is no ZPD before learning activity takes place. As a result, she calls the ZPD the zone of proximal learning (ZPL). She continues to argue that the ZPD is created through and during social interactions. In order for the ZPD to be reached, valuable contributions should come from all participants involved in an activity. In other words, the ZPD and self-regulation are accomplished through social interactions.

In the Namibian context, where my study was conducted, teachers play a role in scaffolding the learners as they prepare practical activities that learners will carry out during lessons. Teachers then guide and supervise the learners through the process as experts. Learners need to be guided on how to handle apparatus, how to observe reactions and how to conclude their observations. When learners interact and carry out hands-on practical activities in collaboration (Goos, 2004), they are actually moved from the actual development level to the potential level (Vygotsky, 1978b). When teachers facilitate by guiding and helping learners to collect and use easily accessible resources to carry out hands-on practical activities, learning is mediated with easily accessible resources as mediational cultural tools and learners may be free to self-regulate through interaction.

2.6.2 Self-regulation

Self-regulation for Vygotsky (1978b) is achieved through social interactions and begins with the learners exploring their inner potential to imitate adult actions. Harrison and Muthivhi (2013) define self-regulation as the learner's ability to regulate himself or herself and is essentially linked to social activity. It allows profound developmental activity because it provides opportunities to safely test new learning and to establish appropriate dialogue. In a study carried out to examine the role that pre-school teachers played in mediating self-regulation among pre-schoolers, self-regulation was defined as a deep internal mechanism that underlies mindful, intentional and thoughtful behaviour of children (Harrison & Muthivhi, 2013). Self-regulation is the capacity to control one's impulses, both to stop doing something and to start doing something else.

Karpov (2005) discusses how learners acquire self-regulation through conscious mediation by the teacher in a general classroom environment and suggests that it is only when the teacher actively provides the necessary tools for problem solving and unpacking tasks into manageable steps that self-regulation is optimised. He further puts forward the notion that the adult plays a key role in the learners' ability to develop self-regulation because it is the adult who helps the learners to develop their motivation to learn. In the case of my study, learners underwent self-regulation as they interacted with one another, and collected the easily accessible resources from the environment and used them to carry out hands-on practical activities in their groups, sharing ideas and knowledge through learning. In this study, easily accessible resources were essentially used as mediational tools to help learners understand what was taught.

Lantolf and Thorne (2006) discuss stages that develop self-regulation such as object-regulation and other-regulation. Object-regulation takes place when children are controlled by or use objects in their environment to think and other-regulation involves varying levels of assistance, direction and what is sometimes described as scaffolding by parents, peers, coaches or teachers. According to Lantolf and Thorne (2006), self-regulation refers to the ability to accomplish activities with minimal or no external support and it is made possible through internalisation (Vygotsky, 1978b). They further explain internalisation as the process of making what was once external assistance, a resource that is internally available to the individual.

Explaining self-regulation in the context of language, Lantolf and Thorne (2006) claim that learners develop the capacity to regulate their own activity through linguistic means by participating in activities (mental or physical) in which their activity is initially subordinated or regulated by others.

2.6.3 Mediation tools

Mediation tools are equipment/materials used in the teaching and learning process in order to make it much easier for the learners to understand the learning competencies, which in this study are the easily accessible resources.

Mediation tools are used during the mediation of learning. Ramasike (2017) defines mediation of learning as a technique or skill incorporated to answer how knowledge is required in the learning process, and it is a learner centred skill which supports the social constructivism perspective. Windschitl, Thompson, Braaten and Stroupe (2012) refer to mediation of learning as a theory which assists learners to make sense of abstract scientific concepts when cognitive development is required. Gibbons (2003) believes that it is possible that some learners' cognitive reasoning is higher than others. She therefore argues that mediation of learning is the bridge from the existing state of mental development through ZPD to the destined state where learners get an opportunity to share ideas with peers in order to promote joint construction of knowledge. Drawing from Donato and McCormick (1994), mediation of learning involves construction and reconstruction as learners try to make sense of new concepts with the assistance of the more knowledgeable other.

Using the term mediation artefacts, Lantolf and Thorne (2006) posit that Vygotsky reasoned that humans also have the capacity to use symbols as tools not to control the physical environment, but instead to mediate their own physical activities. Lemke (2000) suggests that scientific concepts are grasped through the incorporation of different modes of representation. In addition, Lemke (2000) notes that what is special about the use of the multiple modalities in the teaching of sciences is that scientific concepts are articulated across these media of representation. What it means is to be able to use a scientific concept, and therefore to understand it in the way that a scientist does; to be able to freely juggle with its verbal, visual or graphical aspects, applying whichever is the most appropriate in the moment and freely translating back and forth among them. To interpret this,

meaningful learning concerns how it was mediated with different learning abilities, where individual cognitive stages of development were considered.

In support, Gibbons (2003) argues that the mental processing of ideas through learning is mediated by tools between people with different knowledge and experience for the purpose of making sense of learning. Gibbons' argument strongly supports the basis of my study where easily accessible resources (mediational tools) are used to carry out hands-on practical activities in the teaching of Physical Science. In addition, an expert teacher presented the lessons and facilitated the learners through practical activities. This will be discussed in detail in Chapter Three.

In her study, Ramasike (2016) encourages the incorporation of various mediational tools in the teaching of science. She further highlights that the participation of teachers in professional development can help endow them with the importance of using mediational tools to enhance learning, especially easily accessible resources. She believes that the use of easily accessible resources enable social interactions to take place amongst learners.

2.6.4 Social interactions

Lave (1988) argues that learning is situated, as it normally involves knowledge. She describes the two components of situated learning, *social interaction* and *collaboration* where learners become involved in a community of practice (CoP). Wenger (1998) posits that in a community of practice, people are social beings and knowing is about participation in a social world. He asserts that human beings define themselves through active engagement and by how they are viewed by others within the CoP.

Lave and Wenger (1991, p. 2) define a CoP "as a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly". They also posit that CoP has three main elements: the domain of knowledge which defines the issue(s) (in my study the practical activities using easily accessible resources); the community of people who care about the domain of knowledge (the expert Chief Education Officer and learners) and a shared practice being developed to make the domain of knowledge effective (the easily accessible resources that were used to carry out hands-on practical activities).

In line with that, Lave and Wenger (1991) describe learning as an important part of social practice and as legitimate peripheral participation in the community of practice. ‘Legitimate’ in Lave and Wenger’s terms refers to being a potential member of the CoP. Periphery is viewed as an empowering position where a newcomer moves from the boundary towards gaining access to sources of understanding through growing participation in a CoP. Peripherality indicates the possibility of members contributing at different levels of expertise, depending on knowledge and skills that are set by a community of practice and who deepen their knowledge and expertise in this area by interacting. Ardichvilli, Page and Wentling (2003) explain that members are motivated to become active participants in a CoP when they view knowledge as meant for the public good, a moral obligation and as a community interest. Sharing knowledge is critical to success in a CoP.

Brown, Collins and Duguid (1989) posit that useful learning is embedded in the particulars of a corresponding social practice where learners will become involved in learning and becoming part of the community, learning to participate in the local activities of the community as well as learning to use tools of the community. In addition, LaBanca (2008) asserts that when learners participate in extended open inquiry learning experiences, they imagine the role of the scientist and become practising members of the scientific community.

What Brown et al. (1989) posit is in line with my study because carrying out hands-on practical activities using easily accessible resources is a social practice whereby learners become more involved in a way of doing, helping each other to understand and to learn differently from how they learn in the classroom culture where they normally use laboratory equipment. In the normal teaching, for instance, knowledge is mostly supplied by the teacher and learning in the classroom depends more on supplied laboratory equipment. In addition, the notion of a CoP is relevant in this study because I viewed the involvement of the Chief Education Officer to present the lessons and guide the learners through the use of easily accessible resources to carry out hands-on practical activities as an expert, as a legitimate peripheral participant (Lave & Wenger, 1991).

2.7 CONCLUDING REMARKS

In this chapter, I discussed relevant literature around the broad curriculum of Namibia, the concept of practical activities and easily accessible resources. I also discussed literature addressing the

concept of practical activities and easily accessible resources. I looked at literature about prior knowledge and it emerged from literature that learners do not come to school without prior knowledge. In support, the NCBE (MoE, 2016) emphasises the inclusion of learners' prior knowledge into teaching and learning, as it can assist learners understanding of learning competencies through the use of practical activities. It also emerged from literature that practical experiences of observing and intervening in the world is essential for promoting understanding. I also looked at the various concepts which informed my study; concepts such as conceptions, dispositions, sense-making and Vygotsky's social constructive theory. It emerged from literature that learners' dispositions evolve as they engage in constant interactions with exposure to a particular kind of learning experience, in a supportive and challenging environment. Conception, on the other hand, was referred to as a mental structure that encompasses beliefs, concepts, meaning and propositions.

In the next chapter, I discuss the research design and methodology employed in my study.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

In the previous chapter, I discussed the literature relevant to my study. This chapter deals with the research design and methods that were used to investigate the possibilities and challenges of carrying out practical activities using easily accessible resources, in a Grade 10 Physical Science class. The chapter starts with the research design and orientation where I explain an interpretive paradigm, the quantitative and qualitative approach and the case study research method in detail. It is followed by the research goals and questions. Thereafter, I explain the research site and the selection of participants, as well as my role as the researcher. The data collection and methods of data analysis are explained in detail, followed by the validation of findings. Ethical issues and some concluding remarks are then presented and discussed.

3.2 RESEARCH DESIGN AND ORIENTATION

The research design gives direction to a study, like footprints; that is, the interpretivist paradigm, the quantitative and qualitative approach and the steps in the approach that were used in the study as was suitable for this study (McMillan & Schumacher, 2010). In the following section, the footprints of the study are discussed.

3.2.1 An interpretivist paradigm

A research paradigm represents a particular worldview that defines, for the researchers who hold this view, what is acceptable to research and how this should be done (Bertram & Christiansen, 2015). According to Shkedi (2005), a paradigm is a way of analysing the world in order to understand how different views interrelate and connect with reality.

Williamson (2006) refers to the interpretive paradigm as knowledge that is constructed from observations that are made in a real and natural setting, making it well-suited for this study. Interpretivism can be defined as a way of understanding human meanings and their behaviour, without intervening in the process (Cohen, Manion, & Morrison, 2011). Besides this, the

interpretive research paradigm views reality and meaning making as socially constructed; it holds that people make sense of social realities (Cohen et al., 2018). In the context of my study, I worked within the interpretive paradigm in observing and understanding conceptions and dispositions that Grade 10 learners had about the use of easily accessible resources to carry out hands-on practical activities in Physical Science. Within the interpretive paradigm, a case study approach using a mixed-method approach was adopted.

3.2.2 A mixed-method case study approach

This study followed a mixed-method approach, involving a case study developed from the perspective of practical activities and the use of easily accessible resources. Turner and Ireson (2010) define mixed-method research as a research approach in which quantitative and qualitative data or techniques are mixed in a single research study. In addition, Johnson, Onwuegbuzie and Turner (2007) view mixed-method research as a type of research design in which qualitative and quantitative approaches are used in identifying types of questions, research methods, and data collection and analysis procedures. ‘QUAL’ in the upper case indicates that the mixed-method research was dominated by the qualitative data, and ‘quant’ in lowercase indicates that the quantitative data were used to a lesser degree in my research (*ibid.*).

Drawing from Harris and Brown (2010), a mixed-method approach enables the researcher to answer confirmatory and explanatory questions. Johnson et al. (2007) further highlight that mixed-method research has advantages over the other forms of research. Firstly, the combinations are used for confirmation of each other to provide triangulation. Secondly, combinations are used to enable or to develop analysis, in order to provide a much richer context to the data. Thirdly, the combinations are used to initiate the new modes of thinking by attending to the paradoxes that emerge from the data sources. For Christensen, Johnson and Turner (2015), a mixed-method approach allows multiple sources and methods of data collection, and this ensures further data validation.

I used a mixed-method approach because it enabled me to get a more comprehensive and complete understanding of phenomena than could be obtained with a single-method approach, and the mixed-method approach allowed me to answer complex research questions more meaningfully, combining particularity with generality (Cohen et al., 2018). This study was pragmatic because I

focused on framing and answering the research question which was eclectic in its design, methods of data collection and analysis. A pre-and post-intervention questionnaire was used to collect quantitative data in this study (see Appendix D1). I adapted this questionnaire from Fraser's (1981) Test of Science-Related Attitudes (TOSRA). Some of the questions were changed, some removed and replaced in order to fit with the context of my study. I translated the questions into the learners' local language (Afrikaans) in order to for them to be able to understand the questions well.

Focus group interviews, observations, stimulated recall interviews, as well as learners' journal reflections were used to gather qualitative data in this study. Nisbet and Watt (1984) define a case study as a specific instance that is frequently designed to illustrate a more general principle. That is, it is the study of an instance in action. Cohen et al. (2018) highlight that case studies can establish cause and effect. Indeed, one of the strengths of case studies is that researchers observe effects in real contexts, recognising that context is a powerful determinant of both causes and effects.

According to Creswell (2014), a case study is an in-depth exploration of a bounded system (e.g. an activity, event, process or individuals) based on extensive data collection. Concurring, Ary, Jacobs, Sorensen and Razavieh (2010) explain a case study as a type of ethnographic research study that focuses on a single unit, such as one individual, one group, one organisation or one programme where the goal is to arrive at a detailed description and understanding of the case. Ary et al. (2010) further highlight that case studies use multiple methods such as interviews, observations, and archives to gather data. Creswell (2008) posits that case studies can involve multiple cases where more than one case gives insight to the phenomenon being studied. Furthermore, case studies allow in-depth understanding of the case (Cresswell, 2007). In this study, I made use of a case study to investigate the possibilities and challenges of carrying out hands-on practical activities using easily accessible resources in a Grade 10 Physical science class. A case study was appropriate to my study because I researched a specific case – how the use of easily accessible resources influenced, or not, the learners' conceptions, dispositions, interest and sense-making. To find out about this, I looked into the learners' views, feelings and attitudes towards science.

3.3 RESEARCH GOAL, OBJECTIVES, QUESTIONS AND PURPOSE

This section describes in detail the research goals, objectives and purpose of the study. It also gives the outline of the research questions, in relation to the types of data generation techniques used in this study.

3.3.1 Research goal

The main goal of this study was to explore whether Grade 10 Physical Science learners' conceptions, dispositions and sense-making were influenced when easily accessible resources were used to carry out hands-on practical activities. To achieve this goal, the following specific objectives and research questions guided the study.

3.3.2 Specific objectives for the study

- To find out Grade 10 Physical Science learners' initial conceptions, dispositions and interest towards science;
- To find out Grade 10 Physical Science learners' conceptions and dispositions on the use of easily accessible resources when doing practical activities in their classrooms; and
- To find out whether carrying out hands-on practical activities using easily accessible resources influenced the Grade 10 Physical Science learners' conceptions, dispositions and sense-making.

3.3.3 Research questions

1. What are the Grade 10 Physical Science learners' initial conceptions, dispositions and interest towards science?
2. What are Grade 10 Physical Science learners' conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities?
3. How does carrying out hands-on practical activities using easily accessible resource influence (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making?

3.3.4 Research purpose

The purpose of this study was to enable learners to carry out hands-on practical activities using easily accessible resources in order to learn scientific concepts emerging from the practical activities. Additionally, learners were required to create mind maps and concept maps to enable them to make sense of the scientific concepts developed from the hands-on practical activities. It was also hoped that ultimately, learners' conceptions and dispositions would be influenced towards science. Additionally, I wanted learners to realise that there is science within their environment and to know that even waste materials in the environment can be useful in a scientific context.

3.5 RESEARCH SITE, PARTICIPANTS AND SAMPLING

This section describes in detail where the research took place and what steps I took in selecting participants for the study.

3.5.1 Research site

This study was conducted in Namibia in the Otjozondjupa region. Otjozondjupa is the largest region among all 14 regions in Namibia, located close to the centre of the country (see Figure 3.1 below).

The map below shows the geographical map of Namibia, with Otjozondjupa region highlighted in light green. Otjozondjupa region is where Wato Secondary School was located.

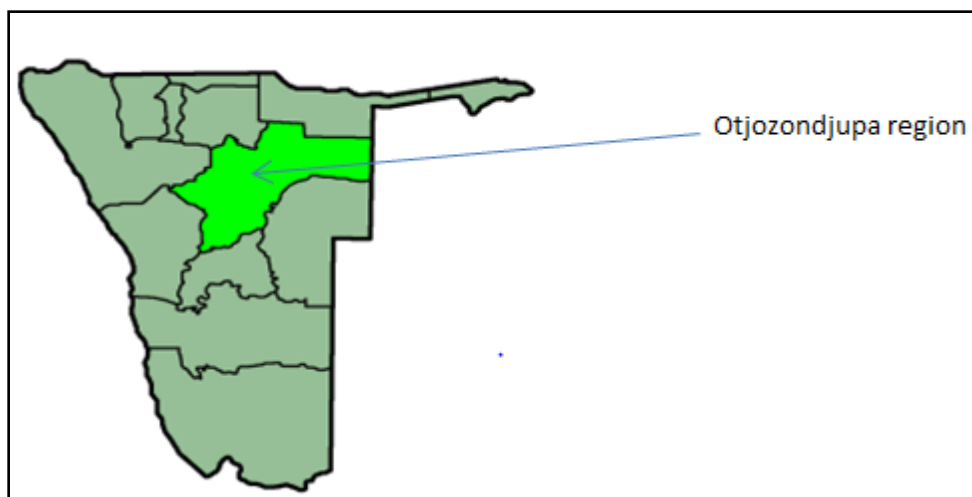


Figure 3.1: Namibian geographical map with the Otjozondjupa region highlighted in green

The study took place at Wato Senior Secondary school (pseudonym), an urban school where I teach. This school is an average-performing school, consisting of multicultural learners who come from different tribes.

The school has grades ranging from Grade 8 to Grade 12, with a total number of 675 learners and 25 teachers. Although the school is in the middle of town, there is no well-equipped science laboratory for the teachers and learners to carry out practical activities. Still, learners attempt to do Physical Science at a higher level at the end of their senior secondary phase, as influenced by the type of career they want to follow. For the latest performance statistics (2017), the school shows the Grade 10 pass rate in Physical Science as 65% in 2010, 51% in 2011, 44% in 2012, 54% in 2013, 66% in 2014, 70% in 2015 and 77% in 2016 (see Section 1.3). The results drew my attention, and I therefore decided to carry out my study at this school.

3.5.2 Participants

The participants in this study were Grade 10 Physical Science learners and the Chief Education Officer who presented the lessons using easily accessible resources to carry out hands-on practical activities.

3.5.2.1 The Grade 10 learners as participants

The learners were purposively selected based on their grade, in this case Grade 10. Nieuwenhuis (2007, p. 79) defines sampling as “the process used to select a portion of the population for study” and continues by pointing out that purposive sampling is generally used for qualitative studies, which means that the research site and participants are selected specifically for the purpose of collecting the best data possible to answer the research questions. I chose to do my research on a Grade 10 class because the focused topics for my study are both offered in the Grade 10 syllabus in the context of Namibia. Since the focus of this study was on learning scientific concepts, all learners of the class took part in answering questionnaires, in the observations and in the writing of journal reflections, on their experiences on the use of easily accessible resources during hands-on practical activities.

Four learners were asked to volunteer randomly for the focus group interview, as well as the stimulated recall interview (SRI). The purpose of the focus group interview was to establish learners’ conceptions and dispositions towards the use of easily accessible resources during hands-on practical activities. The rationale for using a focus group interview in this study was to minimise risks and create a relaxed and non-threatening environment for my learners. Both the focus group and the stimulated recall interviews went very well; however, more learners wanted to take part in the interviews, especially in the stimulated recall interview.

3.5.2.2 The Chief Education Officer

I purposively selected the Chief Education Officer, who is responsible for leading the sub-division of Mathematics and Natural Sciences at the National Institute of Education Development, because she has expertise on the use of easily accessible resources to carry out hands-on practical activities. For instance, in 2017 she conducted a workshop on the use of easily accessible resources for students who were doing their Bachelor of Education (Honours) Science elective course at a certain university from the Eastern Cape, South Africa. Additionally, she attended workshops on the use of easily accessible resources in the United States of America, as well as in Namibia, which were conducted by experts from the USA and Australia respectively. Having her as a participant to present and facilitate the lessons afforded me an opportunity to learn with my learners during the

research process, so that I could improve my own practice. I therefore positioned myself as a co-learner in this study and my students were delighted to hear that I was also a learner during this research process.

3.5.3 Sampling

Sampling involves making decisions about which people, settings, events or behaviours to include in the study (Bertram & Christiansen, 2015). Purposeful sampling was used to select participants in this study. According to Creswell (2014), purposive sampling means that the researcher makes specific choices about which people, groups or objects to include in the sample. The word purposive indicates that the sample is chosen for a particular purpose (Bertram & Christiansen, 2015). In purposive sampling, often a feature of qualitative research, researchers handpick the cases to be included in the sample on the basis of their judgment (Cohen et al., 2018). In my study, a group of 30 Grade 10 learners gave consent to take part and out of 30 learners, four of them volunteered for the focus group. I purposively elected to research the Grade 10 learners because all the topics that I wanted to research on were covered in the Grade 10 syllabus.

3.5.4 Positionality

This study was conducted in the school in which I am currently teaching, and so I anticipated that the issue of positionality might arise. Positionality is determined by where one stands in relation to others in terms of studying his or her own culture or other's cultures (Merriam et al., 2001). It plays a role in conducting research as the researcher may be considered as either an insider or an outsider. Defined by Mercer (2007), an insider researcher is one who shares particular characteristics with the participants such as ethnicity or culture. On the other hand, an outsider does not share any particular characteristics with the participants. In the case of my study, I was an insider in this study, but I positioned myself as a co-learner since I was observing the invited Chief Education Officer teaching my learners.

I therefore addressed the issue of positionality by assuring my participants that they did not need to feel obliged or be forced to participate in the study and that they had a right to withdraw at any time. I explained to the learners as well as their parents, the purpose of the study. I told the learners that I was a co-learner, learning together *with* the more knowledgeable other, as espoused by Vygotsky (1978). As

a result, the learners were free to participate and express themselves with no fears. Learners were comfortable interacting with me and the presenter, as we all learned together.

3.6 DATA GENERATION

I used the following techniques to generate data in this study: questionnaires, interviews, observations and learners’ journal reflections. The data were gathered in three phases. For Phase 1, I used both closed-ended and open-ended pre-intervention questionnaires. I also used the focus group interview to augment the quantitative data. During Phase 2, I observed lesson presentations, and these were also videotaped. For Phase 3, I asked learners to write reflections in their journals. I also used stimulated recall interviews as well as a closed-ended post-intervention questionnaire.

The Table below presents the different data collection methods used to collect data for the study.

Table 3.1: Summary of stages of data collection process

Stages	Method of data collection	Data to be collected	Targeted research question	Time of data collection
1	Questionnaires and focus group interview	To acquire data on learners’ conceptions, attitudes and experiences of the use of easily accessible resources when doing practical activities in science. Learners answered the closed-ended questionnaires first and then later answered open-ended questionnaires. Prior to the presentations, I conducted a focus group interview with four learners that volunteered.	1 and 2	Before using easily accessible resources to carry out hands-on practical activities.
2	Observations and videotaped lessons	To get data on how using easily accessible resources to carry out practical activities influences learners’ conceptions, dispositions and sense-making. Four lesson presentations were observed where I was looking at how learners acted, how they interacted generally during the lessons (the ‘AHA’ moments), how they asked questions and used the scientific terms, how they handled the apparatus and their general feelings, which were determined by their comments.	3	During the lesson presentations where easily accessible resources were used to carry out hands-on practical activities.

3	Stimulated recall interviews, learners' reflections and the post-intervention questionnaires	To obtain data on how using easily accessible resources to carry out practical activities influences learners' conceptions, dispositions and sense-making. Learners were interviewed on their feelings after the use of easily accessible resources, how they understood the use of easily accessible resources and how they make sense of them and the scientific concepts.	3	After easily accessible resources were used during the lesson presentations.
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3.6.1 Questionnaires

According to Bertram and Christiansen (2015), a questionnaire is a list of either closed-ended or open-ended questions which the respondents answer.

A pre-and post-intervention questionnaire was used to find out learners' conceptions, dispositions and interest in learning science. The main advantage of questionnaires is that data can be collected from a large group of participants in a short period of time. In addition, it enables the researcher to standardise the questions asked, as highlighted by Bertram and Christiansen (2015). I adapted this questionnaire from Fraser's (1981) Test of Science-Related Attitudes (TOSRA) (see Appendix D1 for the adapted questionnaire). The questionnaire consisted of 45 items whereby the learners had to tick the level of agreement for each item, such as strongly agree (SA), agree (A), not sure (NS), disagree (D) or strongly disagree (S). I only analysed 20 questionnaires, seeing as only that number of learners completed both pre-and post-intervention questionnaires. I also translated English to Afrikaans because it was the language used by most learners at my school and in the community.

In my study, I took cognisance of the fact that completing questionnaires might be a new experience for some learners. To facilitate the completion of questionnaires, I first explained the questions to the learners so that I could make things clear to them. The pre-intervention questionnaire was given to the learners prior to the four lesson presentations, and the post-intervention questionnaires were given after all the presentations, to find out if there was a shift in the learners', conceptions, attitudes and dispositions or not.

Out of a total number of 30 pre-intervention questionnaires that were given to learners, a total of 27 questionnaires (90%) were retrieved. However, for the post-intervention questionnaires, only 20 questionnaires were retrieved (67%). Perhaps this was caused by the fact that learners were approaching examinations, and most of them stayed home to prepare for the examinations during the time I collected the questionnaires (permission was granted to them by the school management, for those who wanted to study at home); so not all of the learners handed back their questionnaires.

3.6.2 Interviews: Focus group interview

Bertram and Christiansen (2015) define an interview as a conversation between the researcher and the respondent. This study made use of two types of interviews, focus group interviews and stimulated recall interviews, which are described below.

To Kitzinger (1996) and McLafferty (2004), a focus group interview is a semi-structured group discussion usually conducted in an informal setting intended to gather participants' understandings, experiences, attitudes and beliefs on a topic by exchanging views in a group discussion. Similarly, Johnson and Christensen (2004) argue that a focus group interview is a type of group interview in which the moderator leads a discussion with a small group of individuals to examine, in detail, how the group members think and feel about a certain topic. In addition, Campbell (2011) describes a focus group interview as an in-depth qualitative interview or organised discussion held with a small number of carefully selected individuals brought together to discuss a particular topic, so a researcher can gain information about their view and experiences of a topic.

Agreeing, Cohen et al. (2011) posit that focus groups are a contrived setting that bring together a specifically chosen sector of the population to discuss a given topic, where the interaction with the group leads to data and outcomes. In my study, the focus group interview consisted of four learners, and was based on my study because the discussion focused on the learners' conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities. Fantana and Frey (2005) define a focus group interview as a qualitative data gathering technique that relies on the systematic questioning of several individuals simultaneously in a formal or informal setting. "Instead of interviewing the participants individually, a homogenous

group is chosen who have certain characteristics in common, which are related to the research topic (McMillan & Schumacher, 2010, p. 363).

To Nieuwenhuis (2007), focus group interviews produce wider responses, trigger forgotten experiences and contribute to data generation. Participants are generally more relaxed in the group than they would be in individual interviews, which was certainly true for my interview with the learners. He explained that participants can elaborate on each other's ideas and comments, contributing to the richness of the data, which would not happen during individual interviews. Creswell (2008, p. 226) states that "those participants who are hesitant to share information might do so in a focus group interview". I experienced this in my study because even learners who were normally hesitant in discussions, volunteered for the focus group. This 'sharing' happened during the focus group interview, which I actually enjoyed, because the learners developed new ideas as they listened to others. They really gave quality comments which revealed data to me.

In this study, I had two aims for using a focus group interview. Firstly, I felt that it would afford me an opportunity to interact well with the learners, which it did. I was able to make my questions clear to the participants and thus gained in-depth, quality data. Secondly, I could use it to validate data that was gathered from questionnaires. Thirdly, I could find out more about learners' conceptions, dispositions and interests in the use of easily accessible resources when doing practical activities in science. Four learners volunteered to take part in the focus group interview before using easily accessible resources, and the interviews were audio recorded and transcribed verbatim.

This interview went very well, I planned it for 30 minutes but learners had so much to say we took 35 minutes to finish with the interview. I really enjoyed the learners' responses and comments. The same learners who participated in the focus group interview also volunteered to participate in the stimulated recall interview.

3.6.3 Observations

Cohen et al. (2018) describe observation as a technique that allows the researcher to gain live data in a social situation or context. In this study, I invited a Chief Education Officer based at the National Institute for Educational Development, who has expertise on the use of easily accessible

resources, to carry out hands-on activities for my learners. I observed four lessons while videotaping them (see Appendix D5). The focus of the lessons was on gases and pressure; that is, two hands-on practical activities on pressure and two on preparation and testing of gases (carbon dioxide, hydrogen and oxygen). The practical activities were presented using the predict, explain, explore, observe and explain approach as proposed by Maselwa and Ngcoza (2003) (see Appendix D4).

Learners were first asked to predict and then explain their predictions. Thereafter, they had to observe and explain what they observed, as well as write their conclusions. It has been argued that observation is a powerful tool for gaining insight into a situation, although it has the challenge of being potentially intrusive (Bertram & Christiansen, 2015). For instance, the presence of the researcher in the learning environment may make both learners and the presenter behave differently; the effect is known as the Hawthorne effect (Kawulich, 2005). I therefore made sure that all the participants understood my role as a researcher and encouraged free participation during the lessons. Learners were actively involved in the lessons' discussions, as well as in taking turns to do hands-on practical activities, and I was convinced as a researcher that my presence did not influence their participation.

During the observations, I videotaped all the lessons. It was really an exciting experience for both me as a researcher, the presenter, as well as the learners. As one of the data collection techniques, I also instructed learners to keep writing journal reflections on the presentations and of course an overall reflection after all presentations were done.

However, an interesting experience happened during the presentations, as all the learners wanted to take part in the experiments. While it was not possible for all of the learners to take turns in doing one activity, at least all got chances in different activities. I used stimulated recall interviews to complement and triangulate data generated from the observations.

3.6.4 Stimulated recall interview

A stimulated recall interview (SRI) is a collaborative inquiry that is between research participants and the researcher, with the dialogue focused on the practice through video or audio recall (Lyle, 2003; Nguyane, McFadden, Tangen, & Beutel, 2013). Additionally, SRI is known to have a

potential strength as a clear professional development tool, whereby teachers can critically reflect on their own teaching practice (Reitano, 2005). After all four lessons were presented, I conducted an SRI with the same four learners that I conducted a focus group interview with, and this was before the intervention. My aim was to further establish any shifts in the learners' conceptions, dispositions, interest and sense-making towards hands-on practical activities using easily accessible resources.

During the SRI, I first played a recorded video of the presentation for the learners in order to recall and refresh their ideas and thinking, as Cohen et al. (2018) suggest. The interview was conducted in the afternoon, and so I felt that the learners would be tired because they first had to watch the video, but that was not the case. After learners had watched the video, they got so excited and were still active when I started asking them some questions. The interview took about 45 minutes although I had planned to do it in 30 minutes.

3.6.5 Learners' journal reflections

McMillan and Schumacher (2014) explain that journals are a personal account of the learning experienced. It is a way of affording learners an opportunity to express their feelings and views about the learning experience so that they are able to make suggestions. As a strategy to prepare learners for writing reflections, I asked all learners from the beginning of the year to write journal reflections on their experiences of Physical Science lessons and their experiences on practical activities. These reflections were written at the end of every topic so that learners could get used to writing reflections. I also asked them to write reflections after they had attended lessons where easily accessible resources were used to carry out hands-on practical activities. The writing of reflections went very well and a lot of data was collected in this way. Essentially, this data gathering technique explored the factors affecting learners' sense-making, conceptions and dispositions towards practical activities in Physical Science.

3.7 DATA ANALYSIS

This study collected both quantitative and qualitative data. Quantitative data were analysed by first coming up with a rubric in relation to the conceptual framework (see Section 4.3.2). Thereafter, data were presented in tables and in graphs.

As I have already mentioned, the interpretivist paradigm was ideal for this study and therefore, inductive data analysis was used as it was appropriate to analyse qualitative data. Inductive data analysis is when categories and patterns from the coding of the data emerge (McMillan & Schumacher, 2010). McMillan and Schumacher further explain that the process of inductive analysis is an ongoing process where the researcher can double check the previous data to refine the analysis. In my study, I followed the data analysis process as described in Creswell (2008). The Table below shows the process of data analysis that I used to analyse my data.

Table 3.2: The process of data analysis

<p>Step 1: Data generation: Data were collected from within the research site. Learners answered the questionnaires first; I then conducted the focus group interview, and then observations were also done. Stimulated recall interview was done after observations; last came the learners' journal reflections.</p>
<p>Step 2: Data analysis: Data were transcribed from audio records of interviews so that they were ready to be analysed. Data from questionnaires were summarised. Learners' journal reflections were collated in order to be analysed.</p>
<p>Step 3: Coding and categorizing: I read through data which I collected to get a general impression and make sure I understood all data. For example, I transcribed the interviews in order to be able to colour code them. After colour coding, I identified the categories, sub-themes and themes that I used to analyse my data. To analyse data from the observations, I wrote stories from the videos in order to identify the episodes that I used to put my data into categories and themes (see Appendix 2b). This way of data analysis worked well for me.</p>
<p>Step 4: Discovering patterns: After I categorised my data, I studied the data in order to find the relationship between data in different categories and themes. I then merged themes that had similar data and came up with my main themes.</p>
<p>Step 5: Writing the report for findings: Finally, I did my presentations and analysis of data and wrote the discussion and summary of results in a narrative manner. I also included some tables, graphs and other visual structures in the report.</p>

3.8 VALIDITY AND TRUSTWORTHINESS

Validity and trustworthiness are important in any discussion of rigor in scientific research. According to Maxwell (2008), validity is the key issue in the debate over the legitimacy of qualitative research. However, the standard for rigor in qualitative research differs from that of quantitative research (Merriam, 2009). Graven (2002) notes that issues related to validity and reliability might differ based on the nature of the research conducted and the philosophical and ontological assumptions of the researcher. In this research study, I employed multiple strategies to ensure and enhance the validity and reliability of data.

Validity refers to the degree to which a test measures what it is supposed to measure. According to Graven (2002), validity must take on different meanings and use different techniques in relation to qualitative research. McMillan and Schumacher (2001, p. 407) describe validity in qualitative designs as “the degree to which the interpretations and concept have mutual meanings between the participants and the researcher”.

Maree (2007) describes trustworthiness as the assurance of truth, honesty and reliability towards data, as in qualitative research. Maree (2012) refers to trustworthiness as the way in which the researcher and the audience believe that the findings in the study are worth paying attention to and that the study is rated as a high quality one. A research study is trustworthy to the extent that there has been some rigor in carrying it out (Merriam, 2009, p. 209). “A research study is trustworthy to the extent that there has been some rigor in carrying it out”. To ensure trustworthiness in my research, I maintained a quality standard of the following in my research procedures: transferability, credibility and dependability (Loots, 2016) as presented in Figure 3.2 below.

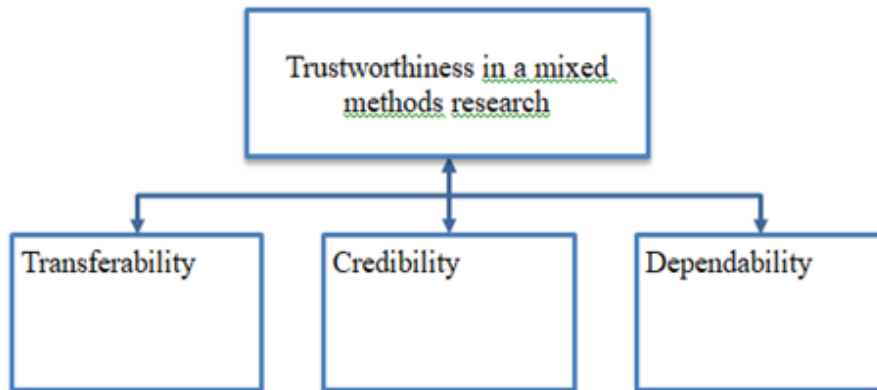


Figure 3.2: The research procedure

3.8.1 Transferability

Ary, Jacobs, Sorensen & Razavieh (2010) define transferability as “the degree to which the findings of a study can be generalized to other contexts”. In addition, Ary et al. (2010) further describe transferability as referring to the findings of the data that can be used and understood by others in different settings in the same context. Based on these definitions, I believe that my research contains some values that can be tried by other teachers in other subject settings. Easily accessible resources can be used to teach other subjects, not only Physical Science.

3.8.2 Credibility

Maree (2007) defines credibility as the quality of being unbiased. This is when the findings of the researcher are regarded to be correct, based on the data that is retrieved. Bassey (1999) posits that a researcher is expected to be truthful throughout the data collection process until findings are compiled. As indicated by White (2011), there are ways to ensure credibility of the research which I have also followed in my study.

- During data collection, I used a variety of data collection tools in order to cross-validate data by comparing data found through different tools;
- I had been taking pictures throughout my teaching so that learners could get used to me taking pictures during teaching and learning. This helped me in the sense that learners

would not panic and get uncomfortable because they were used to video recording and taking pictures;

- Before the lesson presentations, we had familiarisation lessons with the expert who came to present the lessons; I did this in order to make learners feel comfortable and not to panic as it was not me presenting the lessons when hands-on practical activities using easily accessible resources were done; and
- I asked learners to write reflective journals after every lesson. The presenter and I also wrote journals. This also helped me to recognise any biases that could reflect in the study as highlighted by Mills et al. (2010).

3.8.3 Dependability

Dependability is the way in which a study is conducted so that it is consistent across time, different researchers or different analysis techniques (Morrow, 2005). This simply means that the procedures used to find data should be explicitly documented and repeatable, so I as a researcher I carefully tracked each step used to develop the research design (Morrow, 2005). I also kept a research journal that consisted of all the research activities' details, impacts on data collection, as well as data analysis processes. According to Shenton (2004), the purpose of this construct is to indicate that whenever the same study is to be carried out in the same context and the same methods are used on equivalent participants, then similar results will be achieved.

Shenton (2004) further posits that dependability is when the researcher accounts for the changing conditions in which the research is carried out. In other words, it was my responsibility to describe changes that occurred and how they affected the way I approached the study. To ensure dependability as mentioned by Shenton (2004), I made sure that my research activities were reviewed by my supervisor who also closely supervised each stage of my research procedures.

Triangulation is viewed as a method that ensures validity and establishes trustworthiness of data collected in a study through different means of collecting data (Marvasti, 2004). Triangulation is a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study. The term comes from military navigation at sea where sailors triangulate different distant points to determine their ship's bearing.

Denzin and Lincoln (2005) identified four types of triangulation: across data sources (i.e. participants), theories, methods (i.e. interview, observations, documents), and among different investigators.

Hatch (2007) describes triangulation as the way of making use of other methods such as theories to back up the evidence, while McMillan and Schumacher (2006) argue that triangulation is a way of cross-validating data by comparing different data that were found through various data collection tools. Webb, Campbell, Schwartz and Sechrest (1966) posit that triangulation refers to the designed use of multiple methods, with offsetting or counteracting biases, in investigations of the same phenomenon in order to strengthen the validity of inquiry results. In addition, Greene, Caracelli and Graham (1989) further argue that the core premise of triangulation as a design strategy is that all methods have inherent biases and limitations, so the use of only one method to assess a given phenomenon will inevitably yield biased and limited results.

3.9 COMPLIANCE WITH ETHICAL STANDARDS

Ethical standards were important aspects of this study since participants under the age of 18 were involved. In other words, ethical issues had to be in place before the study was undertaken to ensure that learners were safe, as argued by Hedges (2001). To get ethical clearance for this study I followed the procedures of the university, which was not an easy process. I first worked on my research proposal which had to be reviewed by the Rhodes University Education Faculty Ethics Committee for clearance to be given. My application was forwarded to the Rhodes University Human Ethical Standards Committee that deals with studies that involve minors. Upon approval from the Human Ethical Clearance Committee, a clearance certificate was granted (see Appendix A2).

3.9.1 Permission to conduct research

Although I am also a teacher at the school where the research took place, I could not start collecting data or do anything that had to do with my research without getting permission from higher authorities to conduct research. Since the school is a state school, I had to get a permission letter from the Director of Education for the Otjozondjupa region, which was stamped and signed by the

Director who also informed the circuit inspector. The school principal had to give me a permission letter too (Appendix B4).

3.9.2 Informed consents

According to Marvasti (2004), informed consent is the process of providing participants with written or verbal instruction that has to be signed or verbally consented to by them, to provide the participants with the idea of what the research is all about and how privacy would be maintained throughout the research process. In this study, as the participants were learners under the age of 18, they were unable to give their own consent. I therefore contacted the learners' parents through letters (see Appendix C2) to give me permission to use their children as participants in my study by signing the consent form. I also asked the Chief Education Officer to sign the consent form after I explained all research conditions to her (see Appendix C1). As Creswell (2008) highlights, the consents of this study included the importance of voluntary participation of participants in a study, that it would not put them in danger and that their identity would be protected. This study was also based on this statement.

3.9.3 Maintaining confidentiality and anonymity

According to Berg (1998, p. 48), confidentiality and anonymity are important in a research study. Confidentiality is the way in which the participants' identity and privacy are protected from harm (Marvasti, 2004) and so researchers need to assure participants that while all things discussed with them are confidential, they also need to understand that data will be reported. Baez (2002) argues that a qualitative research adheres to standards and confidentiality, as it respects the fact that individuals are entitled to privacy and freedom from harm. It can be reasonably assumed that persons may not be willing to speak freely unless they are assured of confidentiality.

In addition, Creswell (2007) posits that confidentiality needs the researcher to be the only one having access to data as well as to the participants' identities. Supported by McMillan and Schumacher (2010), confidentiality is when participants' identities are not revealed and the researcher makes use of pseudonyms or code names referring to the particular participants. In this study, I conducted focus group interviews as well as stimulated recall interviews with the learners and to maintain their privacy, I asked learners to give themselves pseudonyms and to keep on mentioning those when they were responding to questions during the interviews. Since I recorded

all interviews, I was able to analyze my data as the nick names were in the record. I also used a pseudonym for the school where I did the research.

3.10 CONCLUDING REMARKS

This chapter gave a detailed description of the research design and methodology that I used to investigate the possibilities and challenges of carrying out practical activities using easily accessible resources in a Grade 10 class. The qualitative study approach that I employed allowed me to make use of various data collection techniques in order to gather data for my study. The sample strategy employed is known as purposeful sampling whereby I selected Grade 10 learners as my participant and the chief education officer as a participant presenter.

In the next chapter, I analyse, interpret, present and discuss the data generated in this study.

CHAPTER FOUR: PRESENTATION, ANALYSIS AND DISCUSSION: QUANTITATIVE, QUALITATIVE AND REFLECTIONS (PHASE 1)

4.1 INTRODUCTION

The aim of this study was to investigate the possibilities and challenges of carrying out hands-on practical activities using easily accessible resources in a Grade 10 Physical Science class. In the previous chapter, I presented the research design and methodology informing this study. In this chapter, I thus present, analyse and discuss data generated from the pre-and post-intervention questionnaires and focus group interviews. The data from these generation techniques aimed at answering my research questions 1 and 2:

- What are Grade 10 Physical Science learners' initial conceptions, dispositions and interest towards science?
- What are Grade 10 Physical Science learners' conceptions, dispositions and interest on the use of easily accessible resources when doing hands-on practical activities?

I first discuss the quantitative data from the pre-and post-intervention questionnaires.

4.2 QUANTITATIVE DATA ANALYSIS

I first present quantitative data from the pre-intervention questionnaire which I administered to the learners prior to the presentation of the lessons, in which easily accessible resources were used to carry out hands-on practical activities as expounded by Asheela (2017). The purpose of the pre-intervention questionnaires was to establish the Grade 10 learners' conceptions, dispositions and interest towards science, prior to the intervention. The post-intervention questionnaire was administered to the learners after the lesson presentations.

However, when I collected both the pre-and post-intervention questionnaires, not all learners returned them. I therefore decided to use 20 learners, focusing on those who submitted both the

pre-and post-questionnaires. All responses of the 20 learners were used to analyse the qualitative data in both cases of pre-and post-questionnaires. The reflections from the learners' journal reflections are also interwoven in the discussions. For the reflections, I used 20 reflections which were from the same learners that I used in the questionnaires. This was because I wanted to keep track of the same learners. I gave them all codes, for example: RL1 (Reflection Learner 1), RL2 (Reflection Learner 2), and RL3 (Reflection Learner 3) and so forth.

4.3 PRESENTATION AND ANALYSIS OF THE PRE-AND POST-INTERVENTION QUESTIONNAIRE

As alluded to above, those 20 learners who completed both the pre-and post-intervention questionnaires were selected for in-depth analysis. I gave these learners codes such as QL1: which stands for Questionnaire Learner 1. This analysis was based on their responses based on the following categories: *conceptions*, *dispositions* and *interest* which emerged from my conceptual framework (see Section 2.5). These categories were used to measure the learners' conceptions, dispositions and interest toward science before and after the intervention and thus determined whether (or not) there were shifts in these levels. Table 4.3.1 below shows how the 45 items in the questionnaire were divided among the three categories.

Table 4.1: Items in each category of analysis

Categories	Items from questionnaire	Frequency
Conceptions	1, 2, 4, 24, 25, 27, 30, 31, 38, 39	10
Dispositions	3, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, 18, 19, 20, 22, 28, 29, 32, 33, 34, 35, 36, 37, 40, 41	25
Interest	13, 14, 17, 21 23, 26,42, 43, 44, 45	10

This table highlights the questions that appeared in each category, as well as the total number of questions per category.

To analyse my data, I started by designing a rubric based on the items provided in the questionnaires. The learners' responses were then placed into three sets, namely, low (1), moderate (2) and high (3) for each category as shown in Table 4.2.

Table 4.2: The rubric for quantitative data

CONCEPTION		
Low Conception (1)	Average Conception (2)	High Conception (3)
Learners do not see the relevance of science in everyday life.	Learners are not sure about the relevance of learning of science	Learners are able to establish the relevance of learning of science.
DISPOSITION		
Low Disposition (1)	Average Disposition (2)	High Disposition (3)
Learners give up easily when the content is difficult.	Learners try to seek help when the content is difficult.	Learners do not give up even if the content is difficult.
INTEREST		
Low Interest (1)	Average Interest (2)	High Interest (3)
A learner is not interested in learning science.	A learner tries to take part in science activities even though they do not really understand.	A learner enjoys science activities even when they do not understand.

Below, I summarise the results (average) for each learner in these categories for both pre-and post-questionnaires.

Table 4.3: Summary of results

LEARNER	CONCEPTION		DISPOSITION		INTEREST	
TEST	PRE	POST	PRE	POST	PRE	POST
QL1	1	2	2	3	2	3
QL2	2	3	2	3	2	3
QL3	2	3	2	3	3	3
QL4	2	3	2	3	1	3
QL5	2	3	2	3	1	2
QL6	2	3	2	3	3	3
QL7	2	3	2	3	2	3
QL8	2	3	2	3	2	3
QL9	2	3	2	3	2	3
QL10	2	3	2	3	2	3
QL11	1	2	1	3	2	3
QL12	2	3	1	2	2	3
QL13	2	3	2	3	2	3
QL14	2	3	3	3	1	3
QL15	2	3	2	3	2	3
QL16	1	3	2	3	1	2
QL17	2	3	2	3	2	3
QL18	1	2	1	3	2	3
QL19	2	3	2	3	1	3
QL20	1	3	2	3	2	3

The shifts in each category between pre-and post-intervention are observed in the table. For example, L1's interest was rated level 1 before the intervention and it shifted to level 3 after the intervention. This suggested that QL1 did not show interest in learning science before the intervention, whereas after the easily accessible resources were used to carry out hands-on practical activities, QL1's interest shifted from 1 to 3. This showed a positive influence on the learner's interest. The results in the table were further converted into overall percentages and are presented in Table 4.4 below.

Table 4.4: The overall percentages of responses per level

Levels	Pre-intervention	Post-intervention	Shift
Level 1 (Low)	22%	0%	-22%
Level 2 (Average)	73%	10%	-63%
Level 3 (High)	5%	90%	+85%

I now present the information in the table in a graph in Figure 4.1 below.

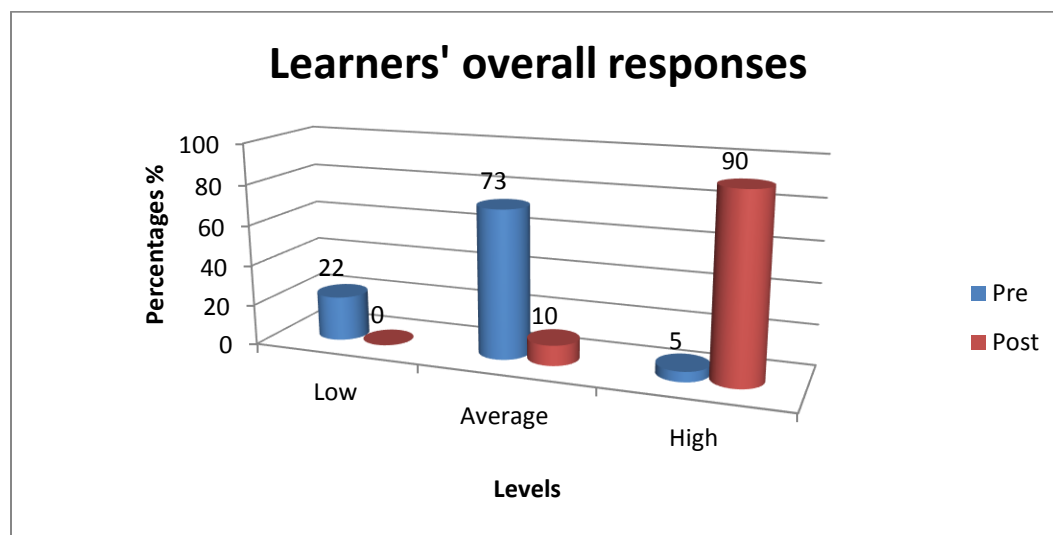


Figure 4.1: Learners' overall responses

Figure: 4.3.1 shows the overall responses of learners in percentages. It is clear from the graph that there were 13 learners (22%) who were rated as being at a low level. This was because the learners did not show interest in learning science; they did not see the relevance of science in everyday life and thus gave up easily when science concepts were difficult. However, it shows that there were no learners (0%) who were rated low after or post-intervention. This shows a positive influence as the percentage had decreased to 0%.

Forty four learners (73%) were rated as average, which meant they tried to take part in science activities even though they did not really understand. Sometimes they were not sure about what they were learning, and they tried to seek help when the content was difficult. After the

intervention, a positive shift was also observed as the 44 learners (73%) decreased to six learners (10%).

Furthermore, before the intervention, there were only six learners (10%) that showed that they enjoyed science activities, even when they did not understand, and they were also able to establish the relevance of learning. These learners did not give up even when the content was difficult. However, the learners who were rated high in the categories increased to 54 (90%) after the intervention. This also showed a positive influence towards science as the shift of three learners to 54 learners (85%) was observed. The Table below shows the percentage score of all categories in both pre-and post-intervention questionnaires.

Table 4.5: The percentage level per category

CATEGORY	LOW (%)		AVERAGE (%)		HIGH (%)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
Conceptions	25	0	75	15	0	85
Dispositions	15	0	80	5	5	95
Interest	25	0	65	10	10	90

Table 4.5 shows the percentage of learners' responses in each category. These percentages indicate the percentage of learners' responses before and after the intervention.

I now present the data in the table above in the graph in Figure 4.2 below. I start with the learners' conceptions.

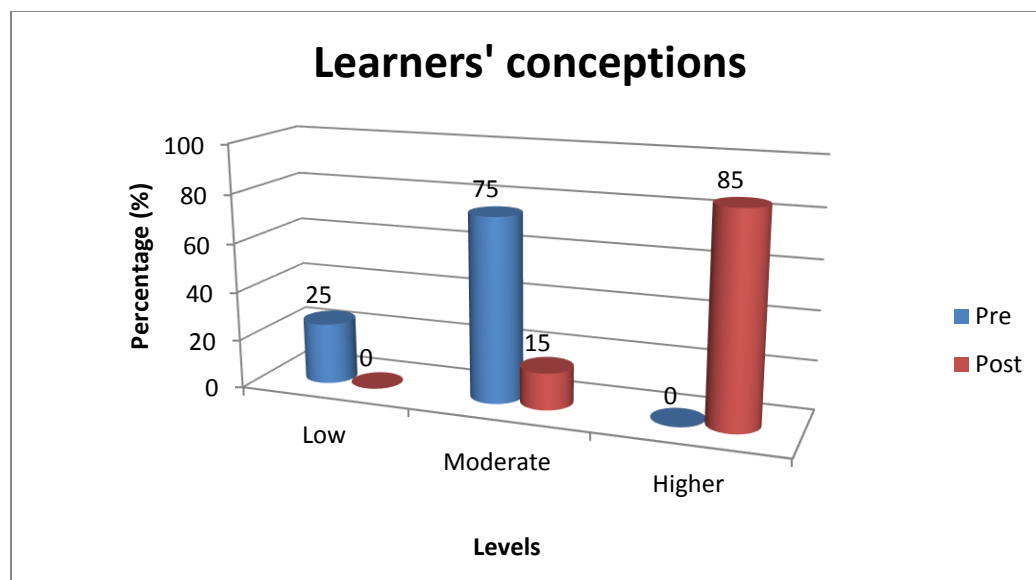


Figure 4.2: Learners' conceptions

The frequency of questions concerning conceptions was 10 out of 45 questions in both the pre-and post-questionnaires. The graph shows that there was a shift in the learners' conceptions because in all the responses, there was a difference between the percentage of responses between the pre-and post-intervention. Before the intervention, two learners out of 20 (25%) had low conceptions about the learning of science, 15 learners (85%) had average conceptions and none (0%) of the learners had high conceptions about the learning of science. However, it shows on this graph that the learners' conceptions shifted after the intervention, as there were no learners who had low conceptions, therefore, the low level was rated 0%.

There were 17 learners (75%) who had average conceptions, which also decreased to three learners 15%. Also, the number of learners with high conceptions increased after the intervention, as there were no learners (0%) with high conceptions before the intervention. This showed that the use of easily accessible resources to carry out hands-on practical activities had a positive influence on the learners' conceptions. For instance, one learner reflected that:

I suggest that we should continue to do the practical activities during the lessons because that will give us a better picture of physical science. Other learners should also be involved in these kinds of activities so that they also enjoy it. (RL10)

This learner acknowledged that the use of easily accessible resources to carry out hands-on practical activities enabled them to get a better picture of the subject. This suggested that the learner's views had actually changed positively, as the learner continued to say that other learners should also be involved in order to enjoy the subject.

This resonates well with Ledbetter and Nix's (2002) argument that hands-on experience is a distinctive feature of science education and it is regarded as important in improving learners' views and attitudes towards science.

In the next graph (Figure 4.3) I present learners' dispositions in science before and after the intervention.

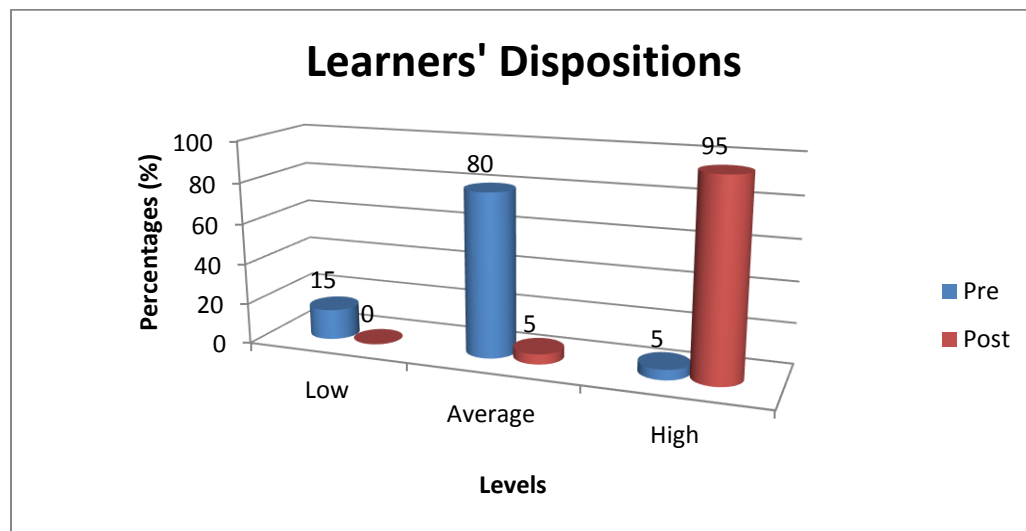


Figure 4.3: Learners' dispositions towards science

The frequency of questions relating to dispositions was 25 out of 45 questions in both the pre-and the post-intervention. Figure 4.3 shows the learners' responses in the questionnaire. This focuses on the category of dispositions. As in other categories, learners' dispositions in science were also influenced positively because there was a shift shown on the graph almost in all the levels. Three learners (15%) who had low dispositions, shifted to 0%, so there was a shift of -15% which was a positive influence. 16 learners (80%) had average dispositions towards their learning of science,

but after the intervention they had also decreased to one learner (5%) only; this also showed a positive influence on the learners' dispositions.

There was one learner (5%) who had high dispositions before the intervention only. The graph shows that after the intervention, nineteen (95%) learners were rated as having high dispositions towards science. Generally, this graph reveals that most of the learners had negative attitudes towards science which was eventually influenced according to the results. Moving from one learner (5%) to nineteen learners (95%) was a great positive shift which defined a positive influence on their dispositions. This was supported by the learners as they reflected that:

If we do hands-on activity with the easily accessible resources always in the physics lessons, it will help learners to change their feelings and behaviours because they always feel that it is a difficult subject. But maybe the practical activities will attract them and most of them will enjoy it. (RL1)

I feel that this will help us and encourage us to like the subject and enjoy coming to physical science. Even learners who like to bunk the classes will be coming because everybody wants to enjoy science and the easily accessible resources. (RL7)

The shifts on the bar graph clearly show that there was a shift in the learners' disposition after the intervention. These results are also congruent with the argument of Jung and Rhodes (2008) that educational experiences can change the disposition of people. Lucas (2000) also adds that conducting practical activities is good because it increases the enjoyment of the activity and facilitates question asking and promotes the active participation of learners. In Figure 4.4 below, I present learners' interest in science before and after the intervention.

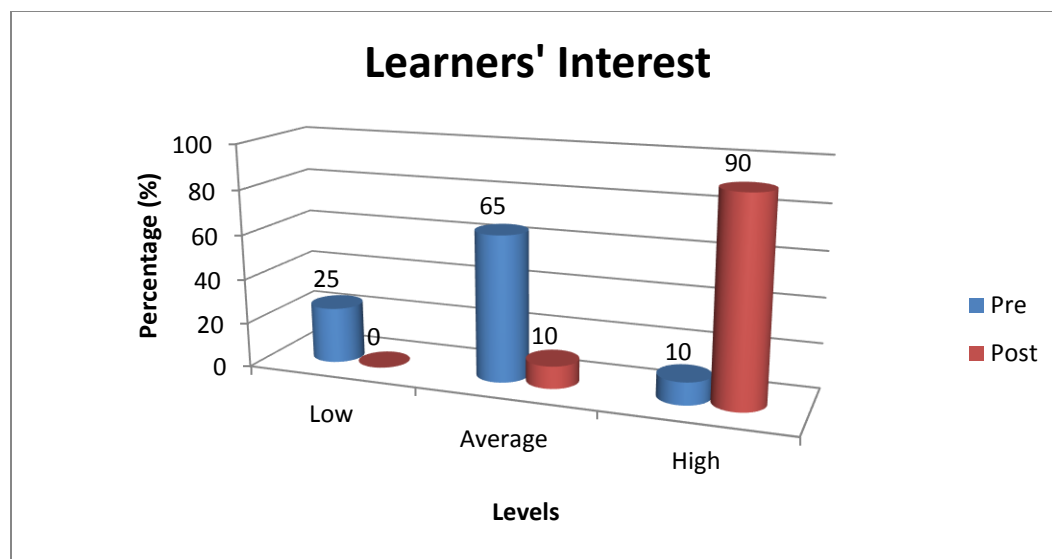


Figure 4.4: Learners' interest towards science

There were 10 questions out of 45 (22%) in the questionnaires that tested the learners' interest in learning science. Learners' responses to items assessing interest in science showed that there was a great shift in the interest; as seen in the graph, there were five learners (25%) who had low interest in learning science but after the intervention, there was 0% of learners with low interest. 13 learners (65%) were not sure about their level of interest in science (they had average interest) but after the intervention, the percentage decreased to two learners (10%); to me, this was a positive shift too. Then two learners (10%) who had high an interest in learning science had increased to 18 learners (90%). A great shift indeed, which showed that the learners interest in learning science had been positively influenced. In their journal reflections, two learners reflected that: *"I personally enjoyed the practical activities, especially the easily accessible materials because they make the lesson more enjoyable and very interesting"* (RL2). *"I want to suggest that this idea is given to other schools so that other learners enjoy science"* (RL5).

These excerpts showed that these learners felt that the use of easily accessible resources to carry out hands-on practical activities could change their interest, as they mentioned that science became enjoyable and interesting. To me, this meant that it was not interesting before the hands-on practical activities were carried out. In Figure 4.5 below, I present the summary of categories. That

is, it shows the combined categories and the percentage results of both pre- and post- intervention questionnaires.

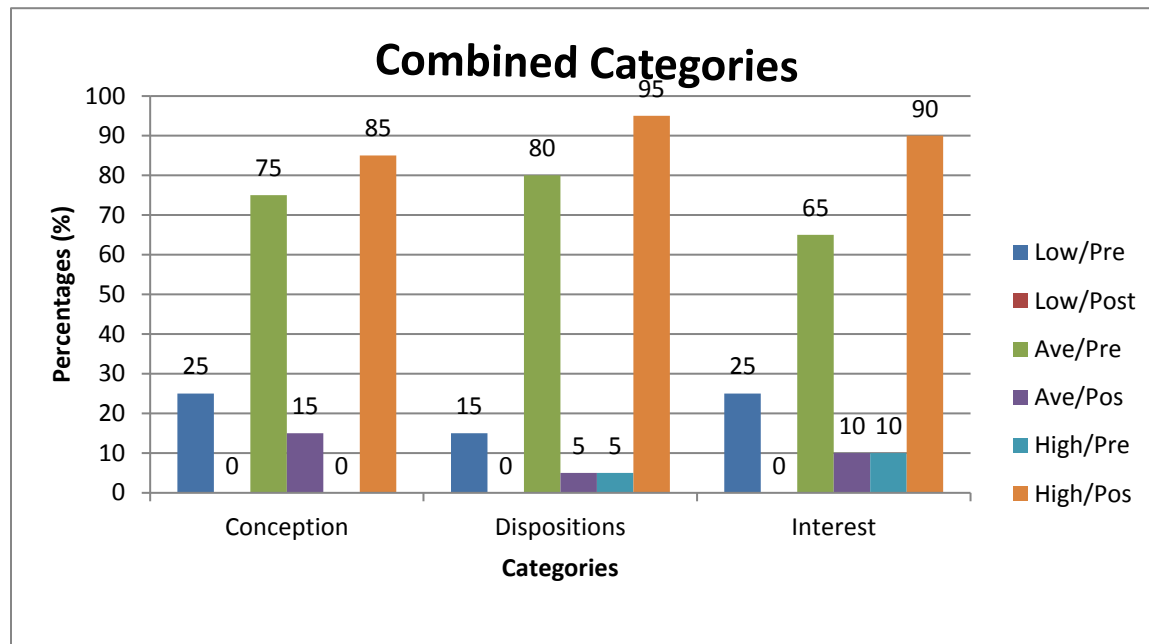


Figure 4.5: Summary of the combined categories

It emerges from this graph that all the low levels in all categories dropped to 0%. All the average levels dropped after the interventions. The percentage of learners who had high conceptions, dispositions and interest were very low before the intervention, but after the intervention, the percentage shifted to above 80%. This showed that learners’ feelings, interest and attitudes had changed as a result of the intervention. This also corresponded with one learner’s reflection:

The practical activities will help the learners to like the subject and eventually perform well because they decided to follow physical science and they can follow the career of science. (RL12)

This echoes Osborne’s (2002) assertion, when he stated that a practical activity should allow learners to learn to be independent. Concurring, Millar (2004) adds that a practical activity should allow learners to do ‘hands-on practical activities’ and learn to make informed decisions.

4.4 DISCUSSION AND SUMMARY OF FINDINGS

In response to my research question one, the results revealed that the learners' conceptions, dispositions and interest in this study were influenced positively by the use of easily accessible resources to carry out hands-on practical activities. That is, the general responses for the learners before and after the lesson presentation showed a shift in almost all responses. This was also indicated by the learners as they reflected after the intervention. For instance, three learners reflected that the intervention changed their conceptions and interest about their learning of science.

I was nearly giving up on science because of lack of hands-on practical activities, but now after the lessons that we had, and I have been part of, I developed the like of science more than before. (RL3)

To me science became more interesting after the presentations because I could really see things happening live and mostly when we used local materials. Science just became fun. (RL8)

I used to be confused about what type of science we are learning but now after the presentations I see that it is really science. I now have a positive feeling and I want to continue learning science and other learners from other schools should also get this opportunity. (RL9)

This showed that after the intervention, learners had different views about their learning of science, and that they now thought about the aspects of learning science differently and meaningfully as they were scaffolded by the use of easily accessible resources to carry out hands-on practical activities. *Bowell and Eison (1991)* emphasise that the role of practical activities is to involve learners in meaningful learning processes instead of listening to teachers and to make learners think about what they are learning.

Concurring, *Woodley (2009)* argues that the purpose of quality practical activities is to help learners to develop their understanding of scientific concepts and to make sense of them. This is reflected mostly on the 'not sure' response by the learners, because it shows how they were not really sure about the different items in their learning of science, but after the easily accessible resources were used as mediational tools to carry out hands-on practical activities in which learners

were actively involved, learners developed an understanding that helped them decide on items and they ended up either agreeing or disagreeing. Generally, most learners disagreed or were not sure about science as a subject. This is similar to the observation of Agunbiade (2015), where before learners were engaged in the Khanya Maths and Science Club, they were not sure about science as a subject and therefore did not enjoy science lessons and activities prior to their participation.

Kibirige and Van Rooyen (2006) emphasise that the use of easily accessible resources ensures education which is locally relevant and culturally appropriate, and which empowers individual learners and unlocks their potential. My finding is that learners' potential to think about science, to understand science, make sense of science and to be able to assist each other through interaction, was influenced positively as they carried out hands-on practical activities using easily accessible resources. The easily accessible use of resources enabled social interactions amongst the learners.

As proposed by Vygotsky (1978b), effective learning requires that individual knowledge construction should occur through social interactions to negotiate the meaning of new experiences. He further argues that effective learning occurs in the ZPD. In support of my findings, Meira and Lerman (2001) highlight that when learners work together in a positive social environment, they can learn from their interactions and social experiences and therefore achieve their potential. I now discuss qualitative data generated from the focus group interviews.

4.5 PRESENTATION, ANALYSIS AND DISCUSSION OF DATA FROM THE FOCUS GROUP INTERVIEW

The data generated from the focus group interview were analysed under this section. This data was generated from the interview with four learners. These participants volunteered to take part in the interview as described in Section 3.5.2.1.

The data gathered from the focus group interview were aimed at answering my research question 2:

What are Grade 10 Physical Science learners' conceptions, dispositions and interest on the use of easily accessible resources when doing hands- on practical activities?

The four learners that volunteered for this interview all used nicknames (pseudonym) that they had given to themselves. I asked them to give themselves nicknames so that I was able to recognise them from the audio recording but have used their codes in the discussions rather than their pseudonyms. I kept the same codes for these learners for the questionnaires, for the stimulated recall interview, as well as for the reflections. There were two girls: Ashley and Jossey and two boys, Hunter and Lungie.

CODES: Hunter (FGIL3), this means Focus Group Interview Learner 3, Ashley (FGIL5), Lungie (FGIL8) and Jossey (FGIL9). These numbers are fixed for the four learners in the other activities.

The data were colour coded first in order to develop categories. From the categories I then developed sub-themes in relation to my research question as well as to the literature. I combined similar sub-themes to form themes and these are presented in Table 4.1 below.

Table 4.6: Themes and the supporting literature and theory

Themes	Literature and Theory
<p>Theme 1: Learning with understanding through social interaction</p> <ul style="list-style-type: none"> - Improve learners' understanding - Learners learn better by doing - learners' scientific process skills - learning will be easier - Minimize memorizing way of learning - Local indigenous practice will make learning to become easier - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class 	<p>Bowell & Eison (1991). Dillon (2008) Vygotsky (1978b), Agunbiade (2015), Kuhlane (2011)</p>
<p>Theme 2: Learners' active involvement in learning</p> <ul style="list-style-type: none"> - Learners will understand the concepts - Learners will be able to assist one another. - Safety is guaranteed when one is doing practical activities - Learning will take place anywhere. - Promote practical activities in schools as well as environmental awareness 	<p>Bowell & Eison (1991). Vygotsky (1978), Maselwa & Ngcoza (2003) Gott & Duggan (1996)</p>

<p>Theme 3: Capture interest and stimulate attitudes towards science</p> <ul style="list-style-type: none"> - develops positive attitudes towards science - will be interested in becoming scientists - Hands on practical activities make Science more fun and interesting. - Promote positive attitudes towards certain topics in science - Science will become fun as it will be around us and learners will get a chance to explore more - Promotes environmental awareness in learners - Learners will have positive feelings about the subject and its values 	<p>Haigh, (2007); Ngcoza, Sewry, Chikunda & Kahenge (2016), Erinosh (2013), Hodson (1992), Roberts (2013)</p>
<p>Theme 4: Linkage between indigenous/local knowledge and the subject</p> <ul style="list-style-type: none"> - learners are familiar to the materials - Local indigenous practice will make learning to become easier - Learners re used to the indigenous practices - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class - Promote safety and positive attitude towards learning of science because learners are used to the practices already. - Helps learners to compare and link local knowledge to the one learned in class 	<p>Johnstone (2010), Kibirige (2006), Simasiku (2016) Atallah et al. (2010); Lotz-Sisitka & Lupele (2012); Johnstone (2010); Simasiku (2016)</p>

I now discuss these themes.

4.5.1 Learning with understanding through social interactions

Learners indicated that they learnt better by doing. When they used easily accessible resources to carry out hands-on activities, their scientific process skills were boosted and that made learning easier. This is because when learners get involved in practical activities, they understand things well because they see the reactions taking place. When learners have made and seen things happening themselves, that on its own has a positive impact on their understanding of the context.

For example, all four learners highlighted that:

I think that it plays an important role in the understanding of kids because it is scientifically proven that learners understand things better after they have been taught by seeing it or by doing it themselves. (FGIL3)

Learning is yes taking place on the board but doing it yourself helps you understand things well. (FGIL5)

Because Physics is a fun subject, it just becomes boring sometimes. But having materials to be used during learning it will make it easier to understand the topic well. (FGIL8)

I can differentiate them, and I will forever know them. So, bringing easily accessible materials to class will really positively promote learning because we understand things well. (FGIL9)

These excerpts illuminated their appreciation, that the involvement of easily accessible resources made learning easy. Learners showed, that when they integrated socially by using the easily accessible resources, they got to understand the concepts well and tended not to forget them easily. For example, when the learners were pumping air into a container of marshmallow sweets, they were confused between the pumping in and out and the pressure reducing and increasing. After the teacher scaffolded them, some commented that: “Ahaaa ... *I will never forget that*”. This is why I am also convinced that the learners learned with understanding through social interaction.

The above comments resonate well with Agunbiade’s (2015) findings. She commented that, learners desire activities that engage them as it influences their enjoyment of science. Kuhlane (2011) asserts that quality practical activities in science help learners to understand concepts. This is also highlighted by Maselwa and Ngcoza’s (2003) notions of “hands-on”, “minds-on” and “words-on” for practical activities promoting scientific skills of observation, investigation, problem-solving and so forth, so that learners can visualise phenomena, hence, promoting their enhancement of conceptual understanding.

4.5.2 Learners’ active involvement in learning

These learners in this study also commented on the active involvement of learners in their learning. For instance, one learner commented that the use of easily accessible resources to carry out hands-on practical activities during lessons would give the learners an opportunity to be active in their learning, because the materials to carry out activities were available. For example, learners were asked to blow the exhaled air in the bottles containing clear lime water and they were so happy to

take part and every learner wanted to blow. The teacher ended up even using some test tubes because the bottles were finished. This learner further highlighted that, what normally hindered their active involvement in their learning was a lack of materials; but, if there were such provisions, then there was no reason why learners had to sit and listen only, they could take part in doing and proving things themselves. The learner further explained that if learners did get involved in the practical activities, they would find it easier to understand and recall things.

Dillon (2008) expresses that engaging learners in practical activities promotes cognitive development from context to content knowledge and believes that hands-on practical activities encourages learners to discover more knowledge and develop creativity. This is also outlined in a study carried by Asheela (2017), on how the use of easily accessible resources to carry out hands-on practical activities in science influences science teachers' conceptual development and dispositions. She commented that practical activities should be reinforced in classrooms as it makes learning more meaningful and the use of easily accessible resources allows learners to understand that science is all around them.

To Howell and Eison (1991), the role of practical activities is to involve learners in meaningful learning processes, instead of listening to teachers and to make them think about what they are learning. A number of case studies conducted in South Africa on the use of easily accessible resources to conduct practical activities, also resonates well with the findings of my study, among these are Gott and Duggan (1996) and Maselwa and Ngcoza (2003), who accentuate that involvement of learners in practical activities encourages active participation, by making learners experience science first-hand and are an effective form of learning. This is also in line with the social constructivism theory which emphasises the collaborative nature of learning through which reality is believed to be constructed through human activity and that learners create meaning through their interactions with each other and with the environment they live in (Vygotsky, 1978b). The above was demonstrated by the following quotes from the learners:

I agree with the use of easily accessible materials because even if I am at home bored, doing nothing, I might just intervene with these materials since I have the things and I know their uses, so I will be enjoying science every time even outside the classroom. It will even give me a chance of exploring more and learn new things like. (FGIL5)

I will even be able to assist other learners who maybe did not get a chance to do it.
(FGIL9)

These excerpts showed that the active involvement of learners in practical activities gave them an opportunity to learn with understanding. Learners showed that they understood things better when they learnt through practical activities. This echoes the views of Hodson (1992) who states that hands-on practical activities are an enjoyable exercise that promote understanding.

4.5.3 Capture interest and stimulate attitudes towards science

The learners in this study also commented on the influence of the use of easily accessible resources to carry out hands-on practical activities on their interest and attitudes towards science. They stated that their interest towards science was positively influenced in the way that they started to enjoy and eventually like the subject more than before the intervention, as they were actively involved. The participants stated that the practical activities captured their interest and as well as the type of materials that were involved in the activities.

In addition, these learners revealed that some of them had negative attitudes towards science and that they did not even like to attend science lessons, because they regarded it as a boring subject as there were no active lessons that let the learners do practical activities. However, they felt that if easily accessible resources were used to carry out hands-on practical activities, learners' attitudes would change as they would start to like the subject more. Research shows that practical activities are important because they have the potential to help learners develop useful skills, develop scientific concepts and encourage learners to enjoy learning science (Haigh, 2007). This also corroborates with the results of a study done by Asheela (2017) in Namibia, that doing practical activities using easily accessible resources captures learners' interest and even stimulates their level of questioning and thinking and thus enhances participation (Sedlacek & Sedova, 2017). For instance, these learners commented that:

Physical science will be more fun when we do hands-on practical activities and we will really like it. (FGIL8)

And we learners will start to love the subject and value it more. (FGIL9)

We might even want to continue to study Physical science although it was not the case and we even end up becoming scientists or physicians. (FGIL3)

These excerpts showed how the learners' interests and attitudes were captured by the use of easily accessible resources to carry out hands-on practical activities. These comments resonate with Atallah et al.'s (2010) assertion that real life experiences promote interest and confidence. However, Hodson (1992) cautions that hands-on practical activities may not necessarily improve learners' motivation; rather, some learners may find some practical activities boring. While Roberts (2004) warns that if not planned and carried out correctly, practical activities in fact have the potential to hinder learning. The findings of my study, however, contradict these scholars' concerns as learners were highly motivated using easily accessible resources that they were familiar with, from their homes and environment.

4.5.4 Linkage between indigenous/local knowledge and the subject

Regarding the use of traditional or local indigenous knowledge/practices as easily accessible resources during hands-on practical activities, it emerged from the learners' responses that the use or inclusion of indigenous practices gave learners a great chance to view science as real.

It attracted the learners' attention towards science, they understood the science concepts and phenomenon easily and thus improved their general subject performance. During lesson 1, learners were mentioning materials such as *oshikundu*, eggs, baking soda, vinegar, egg shells, used foils, sweets and cool drink, as they were asked to point out the materials that they thought could be accessed easily.

They further indicated that if learners' indigenous knowledge was included or considered during practical activities, it would help learners to be able to see the connection between what they knew and what they were learning in the classroom. O'Malley and Chamot (1990) and Keys (1999) indicate that learners' thinking may adapt faster if new knowledge is linked to prior knowledge through a range of techniques. Correspondingly, the findings of this study indicated that indigenous practices should be included in the lessons as it would highlight the relationship between science and culture and it open up opportunities for learners to learn different practices of different cultures. Similarly, Simasiku (2016) indicates in his study that using local materials leads to learners having a positive image of science; he further emphasises that indigenous knowledge helps learners to recall what they were taught in lessons. The learners further indicated

that they would understand and value their indigenous knowledge and practices and appreciate the way it was helping them to learn new knowledge. This was reflected in the following responses:

It promotes safety and a positive attitude towards learning of science because learners are used to the practices already. (FGIL3)

Helps learners to compare and link local knowledge to the one learned in class. (FGIL5)

Learners are used to the indigenous practices. (FGIL5)

Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class. (FGIL8)

Learners are familiar with the materials. (FGIL9)

These excerpts showed that learners appreciated the easily accessible resources as they gave them a chance to integrate their indigenous knowledge into their learning. This therefore stimulated their interest in science.

These findings resonate with Lotz-Sisitka (2012) who found that when easily accessible resources are used to mediate learning, it deepens the notion of inclusivity and makes the connection between what is being said and what is meaningful to the learners. Roschelle (1995) indicates that prior knowledge helps learners to make sense of their experiences and that teachers should understand how prior knowledge affects learning in the classroom, if not used in the correct way.

4.5.5 Additional information that emerged from the focus group interview

There were other issues that emerged from the focus group interview such as: costs and financial implications and the negative implications that learners thought was associated with the use of easily accessible resources to carry out hands-on practical activities. I now discuss these below.

4.5.5.1 Costs and financial implications

The findings indicated that using easily accessible resources to carry out hands-on practical would be an advantage to schools without laboratory apparatus and chemicals and it would save the government and parents, money. These learners also indicated that the inclusion of indigenous practices minimised financial implications in schools, therefore make learning easier for everyone.

One participant indicated that the use of local materials would also have a positive influence on the economy of the country:

If we use easily accessible resources, it will minimise the general cost of education ... in the country, thus benefiting the economy of the country because the government and other stakeholders will not spend a lot of money to buy materials. (FGIL3)

Learners simply meant that the inclusion of easily accessible resources is a way of capitalising. Easily accessible resources do not cost much, yet they assist in making learning enjoyable. Additionally, learners will understand the concepts well and thus their conceptions, dispositions and interest towards science will be influenced as the materials are familiar to them. This echoes with Johnstone (2010) as he argues that chemistry should be presented in a way that capitalises on what learners are familiar with.

4.5.5.2 Negative implications (challenges)

These learners also indicated that the use of easily accessible resources to carry out hands-on practical activities might also have negative implications for learning, because schools in different areas might have different materials. They also indicated that the inclusion of indigenous knowledge/practices might have negative implications if they are not handled with care because learners were not all from the same tribes and they had different indigenous knowledge and practices. For instance, two learners commented that:

You know that it is not all the schools are found in towns, some are in villages and they will not be able to access the same materials as those who are in town schools and also, they will not have shops to buy the cheapest materials that might be required. So, the knowledge that learners will get might be different and this will disadvantage the learners. (FGIL3)

Might negatively influence the learning as learners in different environments will be exposed to different materials. (FGIL5)

Learners from different tribes are disadvantaged. (FGIL8)

These excerpts showed how learners felt about their different indigenous knowledges since they belonged to different cultural groups. Learners highlighted that learners would not be exposed to the same materials because they did not live in the same areas and materials were different in

different areas. They thought that the fact that they were a multi-cultural class (and in general there are many schools with mixed tribes in a class), that it may thus not be possible to benefit all the learners when using easily accessible resources to carry out hands-on practical activities. Concurring, Simasiku (2016) states that one of the disadvantages of including local/indigenous knowledge in Physical Science is that learners may not be from the local environment and it might be difficult for them to understand the content.

4.6 CONCLUDING REMARKS

The chapter began with the presentation of quantitative results from the pre-and-post intervention questionnaire. From the questionnaires, it was clear that there were shifts observed between the pre-and-post interventions. It was clear from the results that the majority of learners were not sure about their learning of science because most learners responded by ticking the “not sure” box; but after the interventions, the number of learners that indicated “not sure” had decreased. The pre-and-post results revealed how the learners’ dispositions and interest changed as evidenced by a shift between the pre-and post-intervention questionnaires.

Five main themes emerged from the focus group interview: learners’ active involvement in learning with understanding through social interaction; capture interest and stimulate attitudes towards science; costs and financial implications; linkage between indigenous/local knowledge and the subject; and negative implications. These themes were discussed one by one in support or contrast to the literature reviewed. It was shown from the themes that the participants felt that the use of easily accessible resources would improve the learners’ interest and attitudes towards learning of Physical Science in general and that they would then have different views about science concepts and thus have a good sense of science.

Another theme that emerged concerned the inclusion of learners’ indigenous knowledge/practices. The participants revealed that the inclusion of indigenous knowledge helped learners understand science phenomenon more easily, as learners were able to link their existing knowledge.

In the next chapter, I present and analyse data collected from lesson observations and the stimulated recall interview.

CHAPTER FIVE: DATA ANALYSIS, PRESENTATION AND DISCUSSION (PHASE 2)

5.1 INTRODUCTION

In the previous chapter, I presented, analysed and discussed data from the pre-and post-questionnaires, as well as from the focus group interviews. In this chapter, I present, analyse and discuss qualitative data generated from observations and stimulated recall interviews. Within the discussion of the data from the observations and the stimulated recall interviews, I will weave in the learners' reflections on their experiences of being involved in this intervention. Although the case study class consisted of 35 who were involved in this intervention, I only used reflections from 20 learners – those who answered both the pre-and post-intervention questionnaires in particular. The data generated from the observations and learners' reflections were aimed at answering my research question 3.

How does carrying out hands-on practical activities using easily accessible resources influence (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making?

5.2 DATA FROM OBSERVATIONS

In this study, I observed four lessons that were taught by the teacher using easily accessible resources to do hands-on practical activities. As explained in Section 3.4.2, teacher Energy is an expert who has attended several workshops on easily accessible resources. The learners involved in this study were given codes (pseudonyms) to conceal their identities and to minimise any potential risks as shown in Table 5.1 below.

Table 5.1: Learner’s codes, gender and age

LEARNERS’ CODE	GENDER	AGE GROUP
RL1	Male	14-15
RL2	Female	14-15
RL3	Female	14-15
RL4	Male	14-15
RL5	Male	16-17
RL6	Male	14-15
RL7	Female	14-15
RL8	Female	14-15
RL9	Female	16-17
RL10	Female	16-17
RL11	Male	14-15
RL12	Male	16-17
RL13	Female	16-17
RL14	Female	14-15
RL15	Male	14-15
RL16	Male	14-15
RL17	Male	16-17
RL18	Female	14-15
RL19	Female	16-17
RL20	female	16-17

The code **RL1M** - Reflection Learner 1 Male; **QL1M** - Questionnaire Learner 1 Male; **OL1M** - Observation Learner 1 Male; **FGIL1M** - Focus Group Interview Learner 1 Male; **SRIL1M** - Stimulated Recall Interview Learner 1 Male.

In the first phase of the data analysis, I looked at the learners’ conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities. It was very important to observe lessons where easily accessible resources were used to carry hands-out practical activities because the aim was to find out if these influenced or not, learners’ conceptions, dispositions, interest and sense-making.

5.3 A DESCRIPTION OF THE LESSONS OBSERVED

The table below shows the topics taught during the four lessons and the basic competencies addressed.

Table 5.2: Sub-topics and the targeted basic competency

Lessons	Sub-topics	Basic Competencies
Lesson 1	Preparation and testing of carbon dioxide gas	Describe the preparation and test for carbon dioxide
Lesson 2	Preparation and testing of hydrogen and oxygen gases	Describe the preparations and tests for hydrogen and oxygen
Lesson 3	Pressure	Interpret the relationship between pressure, force and area Interpret the behaviour of gas particles in relation to pressure
Lesson 4	Brain teasers	To test for acidity nature of carbon dioxide Observe reactions of carbonates with acids Observe diffusion process

After I had observed all the four lessons, I wrote stories from the video clips in order to identify some episodes. Thereafter, I then developed categories from the episodes before I came up with the sub-themes (see Appendix D6).

The Table below shows the preliminary sub-themes and themes which emerged from the analysed data which was aimed at answering my research question. The themes are presented in Table 5.3 below with the supporting literature as well as theory.

Table 5.3: Themes and supporting literature and theory

THEMES	LITERATURE/THEORY
THEME 1: Factors influencing learners' conceptions and dispositions	
-Nature of learning environment	Maselwa & Ngcoza (2003)
-Learning through social interaction	Vygotsky (1978b)
-Learning with understanding	Liu & Matthews (2005)
-Availability of learning materials	Diez (2007)
-Linking of easily accessible resources to the classroom context	Bourdieu (1993)

	Atallah, Bryant & Dada (2010) Ngcoza et al. (2016).
THEME 2: Factors influencing learners' interest and sense-making	
- Conducive learning environment	Weick & Sutcliffe (2005)
- Making sense of concepts	Walker (2013)
- Aha moments as a sign of stimulated interest	Asheela (2017), Shifafure (2014),
- Stimulated Critical thinking	Kambeyo (2012); Kuhlane (2011)

I now discuss these themes below.

5.4 FACTORS INFLUENCING LEARNERS' CONCEPTIONS AND DISPOSITIONS

The main purpose of doing the lesson observations was to find out how the use of easily accessible resources to carry out hands-on practical activities influenced learners' conceptions, dispositions, interest and sense-making. In this section, I discuss the data responding to learners' conceptions and dispositions. I used Atallah et al.'s (2010) indicators of conceptions and dispositions to analyse this.

5.4.1 Nature of learning environment

From the lessons that I observed, learners could see and feel the difference in the learning conditions in which they learned Physical Science. For instance, during the first lesson after the teacher had finished greeting and welcoming the learner, one learner asked: *"What are we going to do with those local materials"*? Two other learners said the following: *"The classroom looks soo attractive today"* (another learner); *"We are doing very well and very ready for the activities"* (OL6).

TE responded and said: *"I am sure you will enjoy the lesson"* and learners replied that *"Yes teacher! We will definitely enjoy the lesson"*.

This observation indicated to me that the learners' feelings were stimulated by the learning environment. Learners were curious even before the teacher started with the first activity about what they are going to learn and how. This concurs with Atallah et al.'s (2010) indicator C2 and C3 which talks to the mental image of the subject and what is believed to be learned (see Table 5.3). Learners were feeling good and could not wait to see the materials being used to carry out hands-on practical activities.

This also came out in the second lesson presentation as one learner commented that the previous lesson was interesting to them and to other learners who were passing by. The learner commented that:

The lesson was very attractive, even learners who were passing by our class could see nice materials displayed on the working table and I am sure they even felt like being part of our class. (OL4M)

The learner continued to say that:

Most of the teachers in this school are not doing practical activities in their classes because there are no chemicals and other materials in the laboratory, so other learners also want to see what these local materials are used for and they also have a feeling that we are learning much better than them. (OL4M)

In addition, after the last lesson presentation, learners were asked if they had comments or wanted to say something about the lesson presentation and the use of easily accessible resources. One learner reflected that:

I would like to thank our presenter for dedicating her time to spend it with us. I also thank our teacher for inviting such an expert to really come and open our minds like this, especially the type of materials that we are familiar with, yet when they are displayed and used here is as if you are dreaming. They just made our learning easy and more attractive. (OL13F)

This excerpt highlighted how the learners appreciated having easily accessible resources involved in the learning of science, to the extent that they even saw the subject as an attractive and enjoyable one (see Figure 5.1). This also corresponds to Atallah et al.'s (2010) indicator pertaining to learners' conceptions that have been stimulated.



Figure 5.1: Different easily accessible resources used for the lesson presentations

5.4.2 Learning through social interactions

It emerged from the observations that social interactions had an influence on learners' conceptions and dispositions. Learners seemed to have developed positive conceptions and dispositions towards learning science because during the lesson one presentation, the learners' level of engagement was low, and they even seemed to hesitate taking turns in doing the activities. In contrast, as they moved on with the lessons, they became more involved to such an extent that the expert teacher was only facilitating and giving instructions while they were manipulating objects. Some learners even wanted to do everything and not give an opportunity to others. This showed me that the learners were now able to self-regulate (see Figure 5.2).

This echoed with the findings of the study conducted in the Eastern Cape, South Africa on learners' participation in the science expo where it emerged that learners who participated in the science expo developed positive dispositions to study science at school (Ngcoza, Sewry, Chikunda & Kahenge, 2016).



Figure 5.2: Grade 10 learners doing hands-on practical activities

5.4.3 Learning with understanding

Data revealed that when learners understood what they were learning, their conceptions and dispositions were influenced. From the questions that learners asked and the comments that they made especially on the different types of activities, it could be hypothesised that their views regarding the subject had shifted and so had their attitudes. Diez (2007) claims that learners' dispositions evolve as they engage in constant interaction with exposure to a particular kind of learning experience in a supportive and challenging environment. RL1 and RL2 reflected that:

Using easily accessible resources to carry out hands on practicals is really necessary because it helps learners to obtain more knowledge and understand the subject well. It will as well make learners change their behaviours towards physical science and they will start to like it and eventually pass it. (RL1M)

All learners in the country need to be exposed to the easily accessible resources and use them in their classes so that people don't be scared and hate physical science anymore, they should see the beauty of science and therefore they should change their behaviours. Teachers also need to be trained on how to use these materials so that science will become enjoyable. (RL2F)

These excerpts indicated to me that learners' dispositions were being influenced positively because it carried all the indications of stimulated dispositions as proposed by Atallah et al. (2010). In the table below, I match the indications given by the learners with Atallah et al.'s indicators.

Table 5.4: Atallah et al.'s (2010) indicators versus learners' indications

Atallah's indicators	Learners' indications
D1 Describing their ability in the subject (themselves as learners)	<i>To obtain more knowledge and understand the subject well</i>
D2 Describing their attitudes towards the subject	<i>Make learners to change their behaviours towards physical science and they will start to like it. They should see the beauty of science and therefore they should change their behaviours.</i>
D3 Describing the expectations about the subject (what will it help them achieve):	<i>And they will start to like it and eventually pass it</i>
D4 Describing the learning approaches used to study the subject (for example, deep/surface learning):	<i>Using easily accessible resources to carry out hands on practical activities</i>
D5 Describing the perceived value of the subject:	<i>They should see the beauty of science</i>
D6 Describing the evidence that they would provide to others as a "proof" that they have learned the subject:	<i>They will start to like it and eventually pass it</i>

It could be deduced from the learners' responses that there was a shift in their dispositions towards the learning of Physical Science.

5.4.4 Availability of learning materials

It emerged from data that the availability of learning materials had an influence on the learners' conceptions and dispositions. This is because if materials are available, it will give learners an opportunity to see and get involved with the materials, by carrying out some hands-on practical activities. In the case of the lessons that I observed in this study, the available easily accessible resources were used to carry out hands-on practical activities. This afforded the learners an opportunity to see and manipulate the materials, which made it easier for them to understand the competencies that were being learnt. This was supported by the comments made by the learners as they were busy with the hands-on practical activities of the marshmallow sweets and the pressure pump:

Ahaa ... so when you pump in, you are increasing the air particles in the container and thus pressure increase?... Now I see. (OL3F)

Ooo ... I thought we breathe out carbon dioxide! So, now it means carbon dioxide is only contained in the air that we are breathing out. (OL10F)

5.4.5 Linking of easily accessible resources to the classroom context

Another factor that emerged from the observations was that during the use of easily accessible resources to carry out hands-on practical activities, learners were able to link the easily accessible resources to the Physical Science content. That is, they were able to show the link between the context and the everyday knowledge. As an illustration, for example one learner asked about the following:

Mrs, I observed at home that when you make oshikundu and leave it for some hours, you will find that it is making some 'chiii' sound. Does that mean a reaction is taking place? ... meaning carbon dioxide is being produced? (OL8F)

Another episode that emerged was when the teacher was preparing the practical activity with eggs when she asked learners to identify some materials:

Teacher (holding the materials): *“Learners please tell me about these materials and where you see them in your environment?”*

Learners: *“There is vinegar, baking soda, eggs, some tomato bottles. Learners continued to say: “We see those things at home, also at Spar and ShopRite” (local shops).*

These findings were similar to the studies conducted by Asheela (2017), Shifafure (2014), Kambeyo (2012) and Kuhlane (2011) in which they found out that easily accessible resources enabled learners to enjoy learning and that they were able to make links to the materials used in their diverse contexts.

5.5 FACTORS INFLUENCING LEARNERS' INTEREST AND SENSE-MAKING

The main purpose of the observation was also to investigate how carrying out hands-on practical activities using easily accessible resources influences (or not) Grade 10 learners' conceptions, dispositions, interest and sense-making. In this section, I discuss factors which emerged from the observation that influenced learners' interest and sense-making.

5.5.1 Nature of learning environment

Similarly, for conceptions and dispositions, it emerged from the observations that learners' interest and sense-making shifted or were positively influenced by the nature of learning environment. For instance, OL14 commented that:

If the lessons of physical science could forever be having these types of materials used during teaching, we will enjoy coming to physical science and of course we will pass the exams very well because these materials are making our learning much easier.

This excerpt showed that some learners were more interested in learning by doing. This meant that when easily accessible resources were brought to the classroom to be used during the presentations, it captured learners' interest and how they made sense of science content, as they linked the materials to the subject content.

5.5.2 Making sense of concepts

During the first three lesson presentations, the expert teacher asked learners to write down all the scientific concepts that emerged from the hands-on practical activities that were conducted. Learners managed to write down some concepts without being given any examples or clues on how the concepts were supposed to be formulated (see Figure 5.5). As I was observing, I could see and hear constructive discussions regarding the different concepts. Some learners were even mentioning concepts such as Oshikundu as a method of producing a gas, which is one of the easily accessible resources that was used. The pictures below show the scientific concepts written by the learners in their groups.

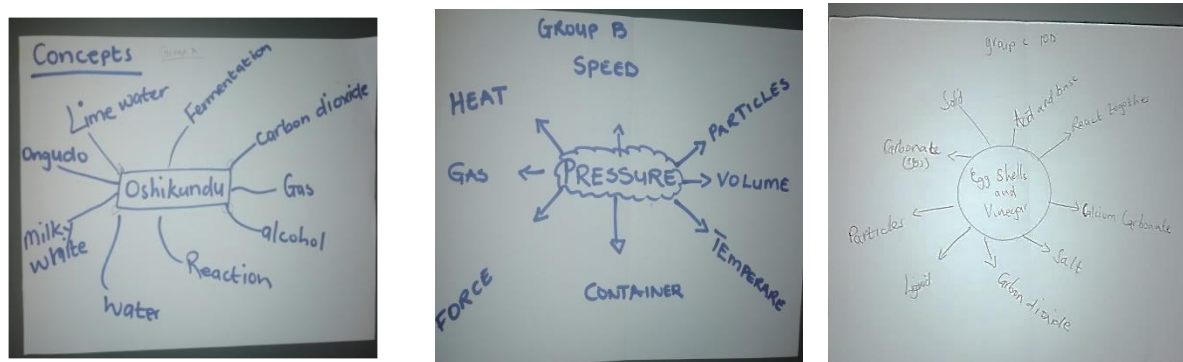


Figure 5.3: Mind maps of some concepts from the hands-on practical activities

Concepts such as alcohol and fermentation were a sign that the learners were thinking critically and asking questions because these concepts were not in their grade syllabus but are a bit more advanced.

5.5.3 ‘Aha’ moments as a sign of stimulated interest

During the class sessions, I observed many ‘aha’ moments that happened and I could see that learners’ interest was positively influenced. For example, learners reflected as follows in their journals:

Ahaaa ... which means, we do not exhale carbon dioxide, but carbon dioxide is part of the air that we exhale. (OL3)

Soo ... even if I go to parties, I do not need to through (sic) away some materials like aluminium foils, tomato bottles and some others. (OL8)

I thought the aluminium foil that we use at home is not the same as the Aluminium element that we learn at school. (OL9)

Some more reactions that I considered as ‘aha’ moments: “*Heee ... unbelievable*” after hearing a popping sound by hydrogen. “*Is this real?*” when observing the balloons filling with carbon dioxide produced from Oshikundu. Holding his mouth, a learner commented in this manner: “*Tah!! This is like magic, I can see the air particles that exert pressure to those sweets*” (OL5).

Walker (2013) explains that, ‘Aha’ moments are the learners’ sudden discovery and insights when they realise something new that has the potential to change the story. With all these comments and actions observed, I could really see how the learners’ interest was stimulated. During the conclusion of the third lesson, learners mentioned that they could not wait to have the next lesson. On day four when all the lessons were concluded, the learners even requested the expert teacher to make time again before they started with their examinations, so that she could come and do some more hands-on practical activities with them.

5.5.4 Stimulation of learners’ questions and thinking

It emerged from the observations that learners’ critical thinking was influenced positively by the use of easily accessible resources to carry out hands-on practical activities. For instance, I observed that some activities enabled learners to think about the local practices that they were familiar with

and link them to what was happening in the classroom. I mentioned in Section 5.3.5 a learner who asked about Oshikundu making a ‘*chii*’ sound. This episode showed me how learners were thinking critically to the extent that this learner even ended up linking what she was learning at that moment, to real life.

Another learner asked about the process of baking, as he was trying to link it with the way Oshikundu produced carbon dioxide and commented that:

I have seen my aunt using Oshikundu as she was backing (sic) fat cakes because she wanted to use backing soda, but shops were closed that time; so, which means baking soda and oshikundu does the same ... I mean can oshikundu also make the dough rise?
(OL7)

This suggested that not only did the learners link local materials to the classroom situation, but their level of thinking had also been influenced.

5.6 DATA GENERATED FROM THE STIMULATED RECALL INTERVIEW

The qualitative data presented here were generated from the stimulated recall interviews. These were conducted with four learners who were also part of the focus group interview discussed in Section 4.5. The stimulated recall interview was transcribed and thereafter, data were categorised in order to develop sub-themes. Thereafter, similar sub-themes were combined to form themes. I subsequently used these emerged themes to discuss my findings. Table 5.6 below shows the sub-themes and themes that emerged from the stimulated recall interviews and these are presented with the supporting literature and theory.

Table 5.5: Sub-themes, themes and supporting literature and theory

Themes	Literature and Theory
Theme 1: Easily accessible resources as mediational tools <ul style="list-style-type: none"> - Level of understanding - Availability of resources - Affordability of resources 	Gibbons (2003), Lemke (2001), Vygotsky (1978)
Theme 2: Integration of indigenous knowledge into science learning <ul style="list-style-type: none"> - Learners’ prior everyday knowledge 	Kambeyo (2012) Kuhlane (2011) Simasiku (2015) Roschelle (1995), Mukwambo, Ngcoza & Chikunda (2014)

- Cross-cultural knowledge	
Theme 3: Use of easily accessible resources during group work activities	Nyambe (2008), NCBE (2010), National Institute for Educational Development (2003), Nyambe & Wilmot
<ul style="list-style-type: none"> - Promote practical activities - Active involvement - Quality learning - Shared knowledge 	
Theme 4: Interest, feelings and motivation	Welch (2010), Agunbiade (2015), Maselwa & Ngcoza (2003), Lave & Wenger (1991)
<ul style="list-style-type: none"> - Capture interest - Change feelings - Motivated 	
Theme 5: Moving learners through the ZPD	Meira & Lerman, 2001, Newman and Holzman (1993), Newman & Holzman, (1997); Meira & Lerman, (2001). Lock (2005). Vygotsky, (1978b)
<ul style="list-style-type: none"> - Expert teacher helps the learners - More knowledgeable learners help the slow coming learners 	

I now discuss each these themes below.

5.6.1 Theme 1: Easily accessible resources as mediational tools

Data generated from the stimulated interviews revealed that the learners in this study viewed easily accessible resources as mediational tools that the teachers should use to open the learners' minds and for them to be able to understand the science concepts. They further explained that there were so many things that they did not understand before they were involved in the interventions. After they had seen and witnessed materials being used and took part in the hands-on practical activities, things just unfolded.

Learners also realised that there were materials (which are the easily accessible resources) around their environment which can be used to open learners' minds and change their level of understanding. For example, some learners commented that:

Me, I feel like these materials has (sic) fallen from heaven, they just made me believe that, yes! science is real ... I mean ... is fun because my mind has automatically opened, and I started to understand things. (SRIL3)

I must say that my head, my mind is now open, and I am ready for Physical Science examinations. (SRIL5)

Things are sooo ... easy now after I have seen and I took part in the hands-on practical activities. My understanding level is now shifted. I am able to remember things because I have seen them. (SRIL8)

These responses showed how these learners appreciated the shift in their understanding or learning of science being caused by the use of easily accessible resources. They indicated that they understood the science concepts better than before. According to the literature, the mental processing of ideas through learning is mediated by the tools between people with different knowledge and experience for the purpose of making sense of learning (Gibbons, 2003). Lemke (2001) also highlights that the scientific concepts are grasped through the incorporation of different modes of representations. This corresponds with the findings of this study, that the easily accessible resources shifted the learners' level of understanding of concepts.

Vygotsky (1978) reasons in his social constructivism theory, that humans have the capacity to use symbols as tools, not to control the physical environment but to mediate their own physical activity.

5.6.2 Theme 2: Integration of indigenous knowledge into science learning

The learners involved in this study revealed that the use of easily accessible resources to carry out hands-on practical activities, gave them a chance to use their indigenous knowledge. Learners also used the knowledge that they had learnt from the environment in order to understand the concepts.

Learners further indicated that they had knowledge of some of the easily accessible resources and even how they worked, they just did not know how their knowledge on the easily accessible resources, related to the classroom context. The learners believed that this knowledge could help them understand the science content well. This was supported by the excerpts below:

Both the teacher and learners are familiar with the materials that were used there. We already have knowledge on them. (SRIL3)

We will learn easily because things are not new to us, we know them ... and ... and some of them we use them at our homes. (SRIL5)

Culture is part of these materials and everyone in the class belongs to a certain culture. For example, Oshikundu is made in the Oshiwambo culture, but other cultures are also

familiar with that drink. Those who are not familiar will learn from others ... so ... it is easy for us to understand how carbon dioxide is made from Oshikundu. (SRIL8)

From these excerpts, it seemed that these learners were able to link their local knowledge to the classroom context. This resonated with the findings of a study conducted by Simasiku (2015) in Namibia in which he found out that indigenous knowledge enabled learners to link what they were taught in the science classroom to what was happening in the community or at home, thereby enhancing their understanding. His study also found out that the availability of local materials in the Physical Science lesson and starting from known to unknown concepts was one of the factors that enabled teachers to include indigenous knowledge in learning of science (Kuhlane, 2011).

5.6.3 Use of easily accessible resources during group work activities

The findings of this study revealed that the use of easily accessible resources enabled meaningful learning to take place even at home, where learners could do activities on their own and thus understand the concepts better. This resonates with Vygotsky (1978), as he describes the concept of self-regulation that is achieved through social interaction, which begins with children exploring their inner potential to imitate adults. In support of this, Karpov (2005) highlights that children acquire self-regulation through conscious mediation by the teacher in a general classroom environment and suggests that it is only when the teacher actively provides necessary tools for problem solving and unpacking tasks into manageable steps, that self-regulation is optimised.

Also, learners felt that since they worked in groups during the hands-on practical activities, they were able to share knowledge around the easily accessible resources and the contexts. For example, some learners mentioned that:

The teacher only needs to facilitate and give us instructions, but they don't need to do the activities. (SRIL3)

I would also suggest that learners should be involved more in the collection of the easily accessible resources. (SRIL8)

Learners will feel like owning their own learning when they are actively involved in doing most of the hands-on practical activities ... they will really feel good. (SRIL9)

Learner can also help each other in terms of sharing ideas as well as the materials from different cultures. I mean the learners who are struggling with Physical Science will learn from other learners who better understand the subject. (SRIL5)

From these excerpts it could be deduced that the learners involved in this study realised that the use of easily accessible resources to carry out hands-on practical activities afforded them an opportunity to share knowledge. These learners also commented that the approach was also a good way to actively involve them in their learning. SRIL3 added that “*Learners should be given a chance to manipulate the materials*”.

5.6.4 Interest, feelings and motivation

From the stimulated recall interviews, learners commented on the influence of easily accessible resources used to carry out hands-on practical activities on their interest, feelings about the subject, as well as motivation. For instance, they stated that hands-on practical activities captured their interest in learning science. They further outlined that even their feelings about Physical Science were stimulated. As a result, they felt good about the subject and they saw the relevance of it, which was not the case before the lesson presentations.

These ideas were supported by the excerpts below:

This was really an exciting moment I ever had, the moment that made me feel like ... wauuh, Physical Science can really be so amazing like this. (SRIL9)

I can't really describe the type of feelings I had after I was part of the hands-on practical activities. (SRIL8)

My feelings about Physical Science is now totally different from how I used to feel previously. It is amazing. (SRIL3)

Seeing reactions, gases being produced and hearing things like 'pop' sounds has really boosted my interest of learning science. (SRIL5)

Lessons were very enjoyable, very interesting activities were happening, which can even make someone change the career in to science. (SRIL9)

These excerpts showed that these learners developed more interest in learning science, to the extent that they even thought about changing or re-directing careers towards becoming scientists. They also echoed the views of Welch (2010) who reported that learners' perceptions of science improved

greatly after participating in an After-School Science Enrichment Programme. Similarly, Agunbiade (2015) also discovered that there was a significant shift in learners' interest, perceptions and their enjoyment of science, after learners participated in an after-school science enrichment programme.

Furthermore, these learners indicated that they felt motivated to like and learn science and viewed it as an enjoyable subject. For example, LH commented that:

Imagine you come to the class and sit down and listen to the teacher without doing any hands-on practical activities. ... This is so discouraging and not motivating. One will be motivated if you get involved in the activities and see things reacting while you are observing. (SRIL3)

From this excerpt, it could be deduced that learners became motivated when they were actively involved in the activities and applied scientific investigative skills such as prediction, explain, explore, observe and explain, as proposed by Maselwa and Ngcoza (2003).

5.6.5 Moving learners through the Zone of Proximal Development

Findings in this study revealed that the use of easily accessible resources to carry out hands-on practical activities enabled learners to understand the science concepts. For instance, some learners commented that:

Now we are able to do some hands-on practical activities on our own or at home. (SRIL8)

Our teacher can only facilitate because we are now able to handle the materials ourselves. (SRIL5)

For example, I was unable to tell how a 'pop' sound sounds like but now I know, and I can even produce the hydrogen or even carbon dioxide to test it with clear lime water. (SRIL9)

From these excerpts, it could be surmised that these learners felt that they were initially unable to do some things on their own. For example, one learner mentioned that she was not able to carry out a hands-on activity to produce a gas or to carry out a test on any gas. Other learners showed that the use of easily accessible resources had shifted them in a way that they were now able to do things which they were unable to do in the past. One learner even mentioned that they would now be able to do activities on their own even at home. This showed a move from the level of actual

development to the level of potential development, as determined through the help of the expert teacher as a more knowledgeable other and the easily accessible resources as mediational tools (Vygotsky, 1978b).

An activity or type of learning which affords learners an opportunity to shift their level of understanding and eventually enables them to learn independently and progress to a higher level, is a mediational activity that takes learners through the ZPD (Harrison & Muthivhi, 2014). Vygotsky (1978b) argues that effective learning occurs in the ZPD. Stott (2016) supports that by highlighting that there is no ZPD before learning activity takes place and thus calls it the ZPL. Through both the ZPD and ZPL, learners are taken through the activity by more knowledgeable others, as they scaffold them.

Scaffolding is the process by which someone supports another to work in the ZPD (Lock, 2005). ZPD is dynamically created and only emerges in the activity. In this view the ZPD is characterised as having transformative potential, a semiotic (signs and symbols) field for interaction and communication where learning leads to development (Newman & Holzman, 1997; Meira & Lerman, 2001). However, scholars such as Newman and Holzman (1997) have also criticised the notion of the ZPD as a fixed space, which the teacher must locate in order to teach successfully (Meira & Lerman, 2001).

5.7 CONCLUDING REMARKS

In this chapter, I presented qualitative data generated from the lesson observations, stimulated recall interview, as well as from the learners' reflections. The findings showed that initially learners did not have positive attitudes and conceptions about the learning of Physical Science as a subject. For example, the majority of learners indicated that they did not have an interest in learning Physical Science. After being involved in the intervention however, their conceptions, dispositions, interest and sense-making all changed positively.

In the next chapter, I present the summary of my findings, recommendations and conclusions.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

6.1 INTRODUCTION

The purpose of this study was to investigate the possibilities and challenges of carrying out practical activities using easily accessible resources in a Grade 10 Physical Science class. This study was triggered by the need of materials to be used during the learning of science as they can promote hands-on practical activities during Physical science lessons. Research shows that learners learn scientific concepts with understanding during practical activities (Millar, 2004) and the practical activities are important because they have the ability to help learners develop scientific concepts. Drawing from Skoumious and Passalis (2013), practical activities develop learners' skills that allow them to know how to communicate using science concepts.

The study employed a mixed method design, which is a combination of both quantitative and qualitative methods that were used to generate data for this study. Initially, data were generated from the pre-and post-intervention questionnaires, focus group, observation of lessons, stimulated recall interviews, as well as from the learners' journal reflections.

I employed the framework of social constructivism theory as my theoretical lens to analyse data. Both quantitative and qualitative approaches were used to investigate the possibilities and challenges of carrying out hands-on practical activities using easily accessible resources in Grade 10 Physical Science class. Quantitative data were presented in tables and graphs while the qualitative data were analysed inductively whereby sub-themes and themes were formed.

The study sought to answer the following research questions:

1. What are the Grade 10 Physical Science learners' initial conceptions, dispositions and interest towards science?

2. What are Grade 10 Physical Science learners' conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities?
3. How does carrying out hands-on practical activities using easily accessible resources influence (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense making?

In this chapter, I summarise the findings of my study in relation to my research questions so that I can explain to what extent these were answered. I also provide recommendations and areas for further research. I also acknowledge the limitations of my study and conclude the chapter with general reflections on the chapter.

6.2 SUMMARY OF FINDINGS

Research question 1:

What are Grade 10 Physical Science learners' initial conceptions, dispositions and interest towards science?

In response to this research question, the results presented in Chapter Four (see Section 4.3) were used. It was revealed that the Grade 10 learners' conceptions, dispositions and interests towards science were influenced positively by the use of easily accessible resources to carry out hands-on practical activities. It came out that before the intervention, learners were not interested in learning science and their attitudes toward science learning were not good. They did not feel like learning science because they viewed it as a boring subject. After the intervention, however, learners developed positive attitudes towards Physical Science.

The results further indicated that most of the learners felt that they learnt better by doing as indicated by Vygotsky (1978). Learners expressed that if they continued to use the easily accessible resources during the physical science lessons, they would develop a greater interest in the subject. Data revealed that the learners felt positive about science in general subsequent to the intervention (see Table 4.3).

Research question 2:

What are Grade 10 Physical Science learners' conceptions, dispositions and interest in the use of easily accessible resources when doing hands-on practical activities?

The data responding to the research question two are also presented in Chapter Four (see Section 4.5). It emerged from the data that the Grade 10 learners' conceptions, dispositions and interest in the use of easily accessible resources was positive. Learners revealed that they felt that if easily accessible resources were used during the lessons, it would make their learning easier because they were involved with the easily accessible resources. This gave them a chance to be involved in practical tasks and learn through interactions. This insight is in line with Vygotsky's (1978) social constructivism theory which emphasises the collaborative nature of learning through which reality is believed to be constructed through human activity.

It emerged from data that the learners felt that the use of easily accessible resources to carry out hands-on practical activities would improve their interest and attitudes towards learning of Physical Science in general and that they would have different views about science concepts and a good sense of science. Literature says that practical activities allow learners to work hands-on and learn to make decisions (Millar, 2004). This concurs with the findings of my study that learners changed their views and attitudes towards science, just after they were involved in the hands-on practical activities.

Research question 3:

How does carrying out hands-on practical activities using easily accessible resources influence (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making?

Learners in this study indicated that the use of easily accessible resources to carry out hands-on practical activities changed their conceptions, dispositions, interest and sense-making. They revealed that the use of easily accessible resources to carry out hands-on practical activities, afforded them an opportunity to use their indigenous knowledge, which they had learned from the environment in order to understand the concepts.

It was also revealed in the study that the use of easily accessible resources, ensured that learning could even happen at home; this meant that they would be able to engage with the materials anywhere – thus learning was not only limited to taking place in the classroom but within their outside environment. These insights are in line with Vygotsky's (1978) social constructivism, which focuses on the social aspect of learners gaining information within their environment (Liu & Matthews, 2005). Vygotsky believes that the environment contains many opportunities for learners to gain knowledge (Chalesworth & Lind, 2007; Kim, 2006).

The data from this study also provided some insights on how to enable learners to think about the local practices that they are familiar with and link them to what was happening in the classroom. In this way, learners in this study were able realize the importance of their indigenous knowledge in their education. All in all, learners were in favour of the use of easily accessible resources to carry out hands-on practical activities during science lessons. This caused the positive influence on their conceptions, dispositions, interest and sense-making.

6.3 RECOMMENDATIONS

Since this research focused on the use of easily accessible resources to carry out hands-on practical activities in Grade 10 Physical Science, I suggest similar studies in other subjects such as Biology, Life Sciences and Agriculture in different grades. I would also recommend that science teachers should make use of easily accessible resources to carry out hands-on practical activities and that learners should be involved in the collection of the easily accessible resources, so that they are exposed to them. Lastly, I recommend that the Education Advisory team should plan to conduct workshops to train teachers, using more knowledgeable individuals.

6.4 AREAS FOR FURTHER RESEARCH

This research prompted many possibilities of further researches in the field of easily accessible resources that could be used to carry out hands-on practical activities in science subjects. It would be interesting to carry out further research on the influence of using easily accessible resources on the learners' performance. It is also imperative to conduct an extensive research on the influence of using easily accessible resources on a specific topic in Physical Science in order to identify the easily accessible resources appropriate for specific topics. Furthermore, I see the need for further

research on the commonality of the easily accessible resources applicable in different regions in Namibia, as far as Physical science is concerned. It was also pointed out by the learners as a challenge that, due to differences in living areas and cultures, learners may not obtain the same knowledge, as different easily accessible resources may be used. Another possible further research could be based on the curriculum developers. An investigation could be done on how easily accessible resources can be integrated into the science curriculum at large.

6.5 LIMITATIONS OF THE STUDY

The findings of this study were limited only to a Grade 10 class in one school in the Otjozondjupa region in Namibia. Therefore, these findings cannot be generalised to the whole school or to the whole Otjozondjupa region or whole country. For instance, only 20 post-intervention questionnaires were returned by the learners and this affected how representative the findings are for all the learners in the class. However, the data from the questionnaires were complemented and triangulated with data from reflections, observations and interviews.

Another limitation was that I was a teacher at the school where I conducted this research. My position as a teacher in the school could have influenced the learners' participation in the study but that was not the case in this study. This was because it was explained well from the outset that their participation was voluntary and that they had the right to withdraw at any time.

The last limitation had to do with time constraints. Being a subject teacher for Grade 10 and 12, it was not easy to get enough time for the study. This was because both grades had to write external end of year examinations in October. This suggests that they were expected to complete these two syllabi before July, so, valuable time was spent attending to the teaching of these two grades. However, despite these limitations, some useful insights on the use of easily accessible resources to carry out hands-on practical activities emerged in this study.

If I were to do this study again, I would increase the number of participants of the study. It would have been useful if I could have had enough audio recorders for each group during the practical activities so that I was able to capture all the discussions. This would improve the quality of data from observations.

6.6 REFLECTIONS

This research journey started in 2016 when I was doing final year of my BEd Honours degree at Rhodes University. While in my final year, one of the Master's students conducted her research on the use of easily accessible resources *with* us. During the journey of her study, I gained interest in looking into easily accessible resources while focusing on learners. It was something that I had never thought about, but when I got involved in this student's study, it grabbed my whole attention. I became very curious to research more about the use of easily accessible resources to carry out hands-on practical activities and the influence it might have on learners' conceptions, dispositions, interest and sense-making towards learning Physical Science

This research then started with the most difficult step of writing a proposal and application for the ethical clearance. It took me the whole of my first year waiting for the ethical clearance letter from the university's ethical clearance committee. Since my research was on the learners, this was not an easy step for me but nonetheless, I did not give up because I had a desire to do this study from the beginning.

When my proposal was approved, I was very happy that the journey into the real research world had opened for me. I got into it with the desire to contribute to the field of practical activities in Physical Science as a subject. The entire journey has been a wonderful learning experience for me and it has just encouraged my patience towards practical activities by allowing me to learn more about the use of easily accessible resources.

6.7 CONCLUSION

In this chapter, I summarised and discussed the findings of this study in relation to the research questions. I briefly highlighted the main findings, the recommendations, the limitations of the study and reflections of my research journey. The study revealed that most of the Grade 10 learners' conceptions, dispositions, interest, as well as sense-making were positively influenced after they took part in the intervention. The learners involved in this study pointed out that after they took part in the activities, they viewed Physical Science as an interesting and fun subject. That is, their attitudes towards learning of science changed positively.

The study highlighted that easily accessible resources make it possible for learning to take place through social interactions as learners actively participate in groups and learn by doing. The thesis ended by concluding that other researchers need to research more on the use of easily accessible resources to carry out hands-on practical activities, in order to help in improving the quality of science learning in Namibia and worldwide.

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Appendices

Appendix A1: Ethical clearance approvals



Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za

www.ru.ac.za/research/research/ethics

2 October 2018

Martha Ndevahoma
casce2@gmail.com

Dear Martha Ndevahoma

Re: HUMAN SUBJECTS ETHICS APPLICATION
Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.
Reference number: 10195142
Submitted: 4/22/2018

This letter confirms that the above research proposal has been reviewed by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) sub-committee.

Thank you for the gatekeeper's permission. The committee's decision is Approved.

Please note that ethics approval will only be valid until 31 December 2018. An annual progress report is required in order to renew approval for the following year.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely,



Prof Jo Dames
Chair: Human Ethics sub-committee, RUESC- HE

Appendix A2: Final human ethics clearance approval



RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION FACULTY • PO Box 94, Grahamstown, 6140
Tel: (046) 603 8385 / (046) 603 8393 • Fax: (046) 622 8028 • e-mail: d.wilmot@ru.ac.za

PROPOSAL APPROVAL

The minute of the EHDC meeting of 1 February 2018 reflects the following:

**2018.1.04 CLASS B RESTRICTED MATTERS
MASTER OF EDUCATION RESEARCH PROPOSALS**

To consider the following research proposal for the degree of Master of Education in the Faculty of Education:

Martha Kashike Ndevahoma (15N0008)

Topic: Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.

Supervisors: Associate Professor Ken Ngcoza and Dr S Tshiningayamwe

Decision: Approved

This letter confirms the approval of the above proposal was noted at the meeting of the Faculty of Education Higher Degrees' Committee on 19 July 2018.

The proposal demonstrates an awareness of ethical responsibilities and a commitment to ethical research processes. The proposed research involves minors or vulnerable groups which requires an application to the Rhodes University Ethical Standard Committee to receive ethical clearance.

Sincerely

Professor C Grant
Chair of the EHDC, Rhodes University
30 July 2018

Appendix B1: Gate keeper's permission (The regional director)



REPUBLIC OF NAMIBIA
OTJOZONDJUPA REGIONAL COUNCIL



DIRECTORATE OF EDUCATION, ARTS AND CULTURE

OFFICE OF THE ACTING DIRECTOR

"Committed and Dedicated For Quality Education"

Tel no: 264 67 308000
Fax no: 264 67 304871
Ref.no. S/P
Enq: Ms. Flora ||Hoes

Private Bag 2618
Erf. 280, Sonweg Street
Otjiwarongo
NAMIBIA

27 September 2018

Rhodes University
Grahamstown
South Africa

Attention: Prof Kenneth Ngcoza & Dr. Sirkka Tshiningayamwe

**REQUEST FOR PERMISSION TO CONDUCT EDUCATIONAL RESEARCH AT A
SCHOOL IN OTJOZONDJUPA REGION**

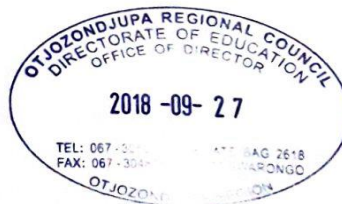
Your letter forwarded to our office bears reference and is hereby acknowledged.

Permission is hereby granted to Ms. Martha Kashike Ndevahoma a Master student to collect data for the academic research development in our schools.

Consult with Principals at schools and present this letter. No school activities must be interrupted during the execution of this exercise.

Thanking you in anticipation.

.....
Ms. J. Mutenda
Acting Director
Otjozondjupa Region



Appendix B2: Gate keeper's permission (The school principal)

The Principal

[REDACTED]

Okahandja
Namibia

[REDACTED]

31 August 2018

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Martha Kashike Ndevahoma, and I am a master student at Rhodes University (RU) in Grahamstown, South Africa, This research will be conducted under the supervision of Prof Kenneth Ngozoa and Dr Sirkka Tshiningayamwe.

My provisional title: Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.

The research I wish to conduct for my master-full thesis requires me to observe Physical science teaching in a grade 10 class and interview learners of the class twice.

This letter serves to seek formal consent to approach the grade 10 learners, and the parents of the learners as participants for this research. For this reason, I request your permission to conduct my research in your school ([REDACTED]) as from September to October 2018 as outlined in my research proposal.

I attach a copy of my research proposal which includes copies of the consent and assent forms to be used in the research process. Once I have received ethical clearance from Rhodes University, I will provide you with the ethical clearance letter. As part of this I undertake to ensure that the name of the school and all participants will be replaced with pseudonyms and that all the data I collect as part of the research will be accessible only to myself and my supervisors.

Upon completion of my study, I undertake to provide you with access to the research findings. If you require any further information, please do not hesitate to contact me on 0812603638 or at casce2@gmail.com.

Thank you for your time and consideration in this matter.

Yours sincerely



Martha Kashike Ndevahoma (Rhodes University)

Appendix B3: Permission letter to the Director

**The Director of Education
Otjozondjupa Educational Region
Private Bag 2618
Tel: 067-308000
Otjiwarongo
Namibia**

31 August 2018

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT A SCHOOL IN YOUR REGION

My name is Martha Kashike Ndevahoma, and I am a master student at Rhodes University (RU) in Grahamstown, South Africa, This research will be conducted under the supervision of Prof Kenneth Ngcoza and Dr Sirkka Tshiningayamwe.

My provisional title: Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.

The research I wish to conduct for my master- full thesis requires me to observe Physical science teaching in a grade 10 class and interview learners of the class twice).

This letter serves to seek formal consent to approach the grade 10 learners, and the parents of the learners as participants for this research. For this reason, I request your permission to conduct my research at J.G van der Wath Secondary School in Okahandja as from May to June as outlined in my research proposal.

I attach a copy of my research proposal which includes copies of the consent and assent forms to be used in the research process. Once I have received ethical clearance from Rhodes University, I will provide you with the ethical clearance letter. As part of this I undertake to ensure that the name of the school and all participants will be replaced with pseudonyms and that all the data I collect as part of the research will be accessible only to myself and my supervisor.

Upon completion of the study, I undertake to provide you with access to the research findings. If you require any further information, please do not hesitate to contact me on 0812603638 or at casce2@gmail.com.

Thank you for your time and consideration in this matter.

Yours sincerely



Martha Kashike Ndevahoma (Rhodes University)

Appendix B4: Permission letter to the principal

The Principal

[REDACTED]

**Okahandja
Namibia**

[REDACTED]

31 August 2018

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Martha Kashike Ndevahoma, and I am a master student at Rhodes University (RU) in Grahamstown, South Africa, This research will be conducted under the supervision of Prof Kenneth Ngcoza and Dr Sirkka Tshiningayamwe.

My provisional title: Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.

The research I wish to conduct for my master-full thesis requires me to observe Physical science teaching in a grade 10 class and interview learners of the class twice.

This letter serves to seek formal consent to approach the grade 10 learners, and the parents of the learners as participants for this research. For this reason, I request your permission to conduct my research in your school ([REDACTED]) as from September to October 2018 as outlined in my research proposal.

I attach a copy of my research proposal which includes copies of the consent and assent forms to be used in the research process. Once I have received ethical clearance from Rhodes University, I will provide you with the ethical clearance letter. As part of this I undertake to ensure that the name of the school and all participants will be replaced with pseudonyms and that all the data I collect as part of the research will be accessible only to myself and my supervisors.

Upon completion of my study, I undertake to provide you with access to the research findings. If you require any further information, please do not hesitate to contact me on 0812603638 or at casce2@gmail.com.

Thank you for your time and consideration in this matter.

Yours sincerely



Martha Kashike Ndevahoma (Rhodes University)

Appendix C1: Letter to participants

Dear Participant

Re: Invitation to participate in a research study

You are invited to participate in a research study entitled. *Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges*. The aim of this research is to explore how carrying out hands-on practical activities using easily accessible resources influences (or not) grade 10 Physical Science learners' sense-making, conception and dispositions. Your participation is important to present the lessons where easily accessible resources are used while I am doing the observation.

The research will be undertaken through questionnaires, semi-structured interviews (before and after the intervention), observations (videotaped lessons) and learners' journal reflections. Your participation in the research is anonymous and your identity will not be revealed. The collection of this data will require between three to four weeks.

If you agree to participate, I will explain in more detail what would be expected of you and provide you with the information you need to understand the research. These guidelines would include potential risks, benefits, and your rights as a participant. Once this study has been approved by the Ethics Committee of the Faculty of Education you will be sent the letter of ethical approval.

Participation in this research is voluntary and a positive response to this letter of invitation does not oblige you to take part in this research. To participate, you will be asked to sign a consent form to confirm that you understand and agree to the conditions, prior to any presentation and observation commencing. Please note that you have the right to withdraw at any given time during the study.

Thank you for your time and I hope that you will respond favourably to my request.

Yours sincerely,



Martha Kashike Ndevahoma

Med Student (Rhodes University)



Prof Kenneth M. Ngcoza

Appendix C2: Consent letter to parents

31 AUGUST 2018

Dear Parent

Your child is invited to participate in a study entitled: *Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges.*

My name is Martha Kashike Ndevahoma, a Master's degree student at Rhodes University (RU) in Grahamstown, South Africa.

The research I wish to conduct for my master full thesis requires me to observe Physical science teaching at a high school and interview learners of the class twice). My study also requires doing video recording during the lesson observations. In this case, your child will be in the class where observation will take place and therefore will as well be interviewed and be required to complete a questionnaire.

The aim of this research is to explore whether or not carrying out hands-on practical activities using easily accessible resources influences grade 10 Physical Science learners' sense-making and dispositions. . Your child participation is thus important.

There are no foreseeable risks to your child by participating in the study. Your child will receive no direct benefit from participating in the study other than educational related ones. Your child will not receive any payment for being part of the study. Your child participation is voluntarily and can refuse to be part of the class or withdraw anytime without any penalty. As a parent you can deny your child not to take part in the study or withdraw your consent at any time without any penalty or reason.

The name of your child will not appear in the report and the identity will be kept confidential.

Your signatures indicate that you agree for the child to participate and you understand all the ethics involved.

Name of child: _____


Signature: _____

_____	_____	_____
Parent/guardian's name	signature	Date

Martha Kashike Ndevahoma		_____
--------------------------	-------------------------------------------------------------------------------------	-------

Researcher's name	Researcher's signature	Date
-------------------	------------------------	------

Informed consent form

Research Project Title:	Practical activities using easily accessible resources in a Grade 10 Physical Science classroom: possibilities and challenges	
Principal Investigator(s):	Martha Kashike Ndevahoma	
Participation Information		
<ul style="list-style-type: none"> • I understand the purpose of the research study and my involvement in it • I understand the risks and benefits of participating in this research study • I understand that I may withdraw from the research study at any stage without any penalty • I understand that participation in this research study is done on a voluntary basis • I understand that while information gained during the study may be published, I will remain anonymous and no reference will be made to me by name or student number • I understand that questionnaires, interviews, Observation and journal reflections may be used. • I understand and agree that the interviews will be recorded electronically • I understand that I will be given the opportunity to read and comment on the transcribed interview notes. • I confirm that I am not participating in this study for financial gain 		
Information Explanation		
The above information was explained to me by Martha Kashike Ndevahoma		
The above information was explained to me in English and I am in command of this language:		
Voluntary Consent		
I,		
Here by voluntarily consent to participate in the above-mentioned research.		
Signature:		Date: / /
Investigator Declaration		
I, Martha Kashike Ndevahoma, declare that I have explained all the information to the participant and have truthfully answered all questions ask me by the participant.		
Signature: 		Date: 31 / 08 / 2018

Appendix D1: Questionnaire

WHAT DO YOU THINK ABOUT SCIENCE?

Pre-intervention questionnaire

This survey is completely confidential, and your participation is voluntary.

Gender: Male _____ Female _____

Religion: _____

Name: _____ Nick

Name: _____

Grade: _____

Please indicate your level of agreement with each of the following statements by putting a cross (X) in your best response.

Dui asseblief jou vlak van ooreenstemming met elk van die volgende uitdrukkings deur n kruis (X) te maak onder jou beste reaksie.

	ITEMS	RESPONSE				
		Strongly Agree/ Stem sterke saam	Agree/ Stem saam	Not Sure/ Nie seker nie	Disagree/ Verskil	Strongly Disagree/ Stem heeltemal nie saam nie
1	Even though science is regarded as a difficult I am sure I can understand it. <i>Al word wetenskap as moeilik danskou is ek seker ek kan dit verstaan.</i>					
2	I am not confident about understanding difficult science concepts. <i>Ek het geen selfvertoue oor die verstanding van wetenskap konsepte.</i>					
3	I am sure I can do well in science tests. <i>Ek is seker ek kan goed doen in wetenskap toetse.</i>					
4	No matter how much effort I put in, I cannot learn science with understanding. <i>Maak nie saak hoeveel moeite ek in sit nie, ek gee maklik op of doen net die maklik gedeeltes.</i>					

5	When science activities are too difficult, I give up or do the easy parts. <i>As wetenskap aktirviteite te moeilik is, gee ek op of doen net die maklike gedeeltes.</i>					
6	When science activities are too difficult, I do not give up. <i>As wetenskap aktirviteite te moeilike is, gee ek glad nie op nie.</i>					
7	During science activities I prefer to ask other people for the answer rather than think for myself. <i>Gedurende n wetenskap aktirviteite verkies ek om ander mense vir die antwoord te vra as om liever vir myself te dink.</i>					
8	During science activities I prefer think for myself first rather than ask other people. <i>Gedurende n wetenskap aktiwiteite verkies ek om eers op my eie aan die antwoord te dink voor ek iemand anders gaan vra.</i>					
9	When I find science content knowledge difficult, I do not try to learn it. <i>As ek wetenskap inhoud kennis moeilike vind, prober ek nie om dit te leer nie.</i>					
10	When I find science content knowledge difficult, I try to learn it. <i>As ek wetenskap inhoud kennis moeilike vin, prober ek dit leer.</i>					
11	When learning new science concepts, I attempt to understand them./ <i>Wanneer ek nuwe wetenskap woordeskat leer, probber ek om dit te verstaan.</i>					
12	When learning new science concepts, I try to memorize them. <i>Wanneer ek nuwe wetenskap woordeskat leer, probber ek on dit te memoriseer.</i>					
13	When learning new science concepts, I connect them to my previous experiences. <i>Wanneer ek nuwe wetenskap woordeskat leer, verbind ek hule met my vorige ondervindings/ ervarings.</i>					
14	When I do not understand a science concept, I find relevant resources that will help me <i>Wanneer ek nie n wetenskap konsep verstaan nie, vind ek relevante bronne wat my sal help.</i>					
15	When I do not understand a science concept, I discuss it with the teacher to clarify my understanding.					

	<p><i>Wanneer ek nie n wetenskap konsep verstaan nie, bespreek ek dit met my onderwyser om die konsep vir myself duidelik te maak.</i></p>					
16	<p>When I do not understand a science concept, I discuss it with other learners to clarify my understanding. <i>Wanneer ek nie n wetenskap kansep verstaan nie, bespreek ek dit met die ander leerling om dit vir myself duidelik te maak.</i></p>					
17	<p>During the learning process, I attempt to make connections between the concepts that I learn.</p> <p><i>Gedurende die leerproses, probeer ek verbindings tussen die konsepte maak wat ek leer.</i></p>					
18	<p>When I make a mistake, I try to find out why.</p> <p><i>As ek n fout begaan, probeer ek uitvind hoekom.</i></p>					
19	<p>When I make a mistake, I give up easily.</p> <p><i>As ek n fout began, gee ek maklik op.</i></p>					
20	<p>When I meet science concepts that I do not understand, I still try to learn them.</p> <p><i>Wanneer ek wetenskap konsepte kry wat ek nie verstaan nie, probeer ek nogsteeds om hulle te leer.</i></p>					
21	<p>When new science concepts that I have learned do not agree (conflict) with my previous understanding, I try to understand why.</p> <p><i>Wanneer nuwe wetenskap kansepte wat ek geleer het nie met my vorige verstanding ooreenstem nie, probeer ek verstan hoekom.</i></p>					
22	<p>When new science concepts that I have learned do not agree (conflict) with my previous understanding, I give up.</p> <p><i>Wanneer nuwe wetenskap kansepte wat ek geleer het nie met my vorige verstanding ooreenstem nie, gee ek op</i></p>					
23	<p>I think learning science is important because I can use it in my daily life</p> <p><i>Ek dink om wetenskap te leer is belangrik, want ek kan dit in my daaglikse lewe gebruik.</i></p>					
24	<p>I think learning science is important because it stimulates my thinking</p> <p><i>Ek dink om wetenskap te leer is gelangrik, want dit stimuleer my denke.</i></p>					
25	<p>Science is important for our daily lives.</p> <p><i>Wetenskap is belangrik vir ons daaglikse lewens.</i></p>					
26	<p>I think it is important to participate in inquiry/investigative activities in science.</p> <p><i>Ek dink dit is belangrik om deel te neem in ondersoek/ondersoekende aktiwiteite.</i></p>					
27	<p>It is important to have the opportunity to satisfy my own curiosity when learning science.</p>					

	<i>Dit is belangrik om die geleentheid te he om my eie nuuskierigheid te bevredig wanneer ek wetenskap leer.</i>					
28	I participate in science class only to get good marks. <i>Ek neem net deel in die wetenskap klas om goeie punte te kry.</i>					
29	I participate in science class to perform better than other students. <i>Ek neem deel in die wetenskap klas om beter as die ander student te prestreer.</i>					
30	I participate in science class so that other students think I am smart. <i>Ek neem deel in die wetenskap klas sodat die ander student kan dink ek is slim.</i>					
31	I participate in science class so that the teacher pays attention to me. <i>Ek neem deel in die wetenskap klas sodat die onderwyser aandag aan my kan skenk.</i>					
32	During a science class, I feel most fulfilled when I attain a good score in a test. <i>Gedurende n wetenskap klas, voel ek hoogs tevrede as ek n goeie punt in n toets behaal het.</i>					
33	I feel most fulfilled when I feel confident about the content knowledge in a science. <i>Ek voel hoogs tevrede wanneer ek selfvertroue het oor die kennis van my inhoud in wetenskap.</i>					
34	During a science class, I feel most fulfilled when I am able to solve a difficult problem. <i>Gedurende n wetenskap klas voel ek baie tevrede as ek self n problem kan op los.</i>					
35	During a science class I feel most fulfilled when the teacher accepts my ideas. <i>Gedurende n wetenskap klas voel ek tevrede met myself as die onderwyser my idees aanvaar.</i>					
36	During the science class I feel most fulfilled when other students accept my ideas. <i>Gedurende n wetenskap klas voel ek hoogs tevrede wanneer ander student my idees aanvaar.</i>					
37	I like working alone in science class. <i>Ek hou daarvan om alleen die wetenskap klas te werk.</i>					
38	Science open doors for job opportunities. <i>Wetenskap maak deure oop vir nuwe werksgeleenthede</i>					
39	Our country needs scientists to improve people's lives. <i>Ons land het wetenskaplikes nodig om mense se lewens te verbeter.</i>					
40	The way science is taught at school is boring.					

	<i>Die manier waarop wetenskap in skool aangebied word is vervelig.</i>					
41	I sometimes have a negative attitude towards science. <i>Ek het soms n negatiewe houding teenoor wetenskap.</i>					
42	I would like to understand more about scientific explanations for things. <i>Ek sou graag meer wou verstaan oor die wetenskaplike verduidelikings vir dinge.</i>					
43	I would like to study science more deeply than I do now. <i>Ek sou graag wetenskap in diepte wou studier meer as wat ek nou doen.</i>					
44	I will seriously consider doing a career in science after I leave school. <i>Ek sal ernstig n loop baan in wetenskap oorweeg nadat ek skool verlaat.</i>					
45	I like learning new things and being involved. <i>Ek hou daarvan om nuwe dinge te leer en om betrokke te wees.</i>					

Appendix D2a: Focus group interview questions

Focus group interview

Type of questioning: Open-ended questions with prompting

Phase 1: I will address the following points before the interview starts or before start with video play:

- Explain the purpose of the interview.
- Assurance of confidentiality of the recorded data.
- Purpose of video recording.
- Right to have the evidence to be destroyed
- A learner may ask questions for any clarification
- A researcher will ask some questions for clarity.

Phase 2: Interview schedule (Semi-structured)

1. What do you think what is the role of hands-on practical activities during science lessons?
2. What are your views on the use of easily accessible resources during hands-on practical activities in science lessons?
3. How can learning be promoted during hands-on practical activities using easily accessible resources?
4. What are your views on the use of traditional or local indigenous practices as easily accessible resources during hands-on practical activities?
5. Do you have anything else that you would like to share with me regarding the use of easily accessible resources to carry hands-on practical activities?

Appendix D2b: Interview transcript (FGI)

Focus Group interview (FGI)

1. What do you think is the role of hands-on practical activities during science lessons?

Nickname	Response
Hunter	Me Hunter thinks that it plays an important role in the understanding of kids because it is scientifically proven that learners understand things better after they have being taught by seeing it or by doing it themselves like for example, aaaah the wave lesson we have been taught how water waves form when you throw a stone in the water. It helps the kids to understand and be able to do the activity themselves ...yah.
Ashley	Ashley think that it is very important because some learners don't just learn from reading, they learn from doing things themselves, soo., it might confuse them for example if they read that hydrogen makes a "pop sound" yet they have never done an experiment to real see and hear that yes, it is true hydrogen makes a pop sound. The learners won't forget that pop sound after hearing it rather than just reading. Not everyone will know things before they see or hear them. Physical science will be more fun when we do hands-on practical activities and we will really like it.
Lungie	I Lungie, personally agree with my colleagues here because what they said is like we will be more interested in learning physical science here because it has more practical activities. Certain topics will be more fun of course and we will feel exited and more eager to come to class when its physical science lesson.

Vergix	I, vergix agree with Ashley that, or me personally agree that, mhhhh. it is more easier for us to deal with things like in class rather than just reading things and like continuing with the next topic. I personally feel that it is better to do things myself practically than reading without understanding what I am reading
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2. What are you view on the use of easily accessible resources during hands-on practical activities in Physical Science lessons?

Nickname	Response
Hunter	I, Hunter, my views are that it is really good if we can easily access equipment or materials or chemicals from the nature rather than go buy. Some schools don't have laboratory, some have laboratories but like our school, may be they don't have chemicals to do practical. For example if you are to test for starch in a plant, you might not have chemicals required and so we can easily get plants or anything needed for that activity.
Ashley	I Ashley think that it is very good and important if we use easily accessible resources because not all the schools have enough money to pay for the chemicals to use, mhh... and , plus they say science is all around us, so why not using those materials to see that yes, Science is really around us. Learners will even learn much easier because these are the things they know and see and use every day of their lives. For example if we use toothpaste to explain bases, I will know it forever in my life that toothpaste is a base, even if I am using it, I know and I can even tell my friends from other schools who did not know this and this information might help them to pass their examinations too. Mhhh.. yah. You know, it is difficult to understand things that you don't know, mhh, like, like.. aaa..like we can even talk about hydrogen peroxide and you even know that you will hardly see such thing and you can't even use it for anything, it is just a chemical with a difficult name.
Lungie	From my point of view I think it will be very important because some schools don't have enough finances to buy materials that they need and the government might not be able to cater for all the needs of the schools. So it is very important to find and use staffs from nature
Vergix	Me Vergix agree with all what my colleagues said because those are the facts that the easily accessible resources will be helpful during learning because learners are familiar with the materials.

3. How can learning be promoted during hands-on practical activities using easily accessible resources?

Nickname	Response
Hunter	I Hunter think that learning is... yes fun but not when it is done by writing things on the chalkboard only... no no, I don't agree with that. I prefer teachers to write down, and plus, learners should do the things, they should visualize in order to get insight understanding of what they are being taught, and they should manipulate so that they will always remember, in fact they will know what it is. They will permanently stay with such knowledge. The reason why some kids think that physical science is boring subject is because they expect to do activities, they expect to get involved actively but it does not happen always. Physics is an everyday thing, it is part of our lives, we just need to understand it.
Ashley	I Ashley agree with Hunter because learning is yes taking place on the board but doing it yourself helps you understand things well, I mean why learn something that you can't even experiment yourself? you as a learner need to be involve in learning. You will just learn it all the years yet you never done it like practically hands-on. So, what is the use? You know...! we are always expected to memorise all this things like, H2O for example but if you do it practically, it will laterally be in your head, you will remember things without a need to memorise, you know we just memorise just to get the marks although we don't understand things... hahahah
Lungie	Ahaa, I have nothing to add, but yah! I think learners will pass really good if they get more involved in hands-on practical activities especially that they use materials that are around them. Because Physics is a fun subject, it just becomes boring sometimes. But having materials to be used during learning it will make it easier to understand the topic well.
Vergix	I Vergix find it very boring like coming to class and just listening to the teacher on teacher writing notes but you don't understand. For example learning Fibres, If I have to comment on it, I will say I don't understand anything at all because it's just like reading to know the different fibres without really knowing the difference like which one is which? If we get some local materials and bring to class, then we can see that, Ahaa, this is Linen and this is Silk for example, so I can differentiate them and I will forever know them. So bringing easily accessible materials to class will really positively promote learning because we understand things well. and us learners will start to love the subject and value it. If teacher cannot find materials, they can even ask learners to bring because they are also available at our places

4. What are your views on the use of traditional or local indigenous practices as easily accessible resources during hands-on practical activities?

Nickname	Response
Hunter	I Hunter think that it is a great idea because it defines easily accessible resources because those things are made from natural materials that are always available and some are even renewable. They can be found anywhere and you are likely not to pay for them. Local indigenous practices are even safe to deal with because they hardly involve chemicals. Learners are more comfortable with those practices because is what they know already and they know how to make and deal with them. So learners will be learning everywhere, at home and at school because they use same things.

Ashley	I Ashley agree with this. It is a very good idea because we use these things every day, we mostly use traditional stuffs at our houses, in schools we mostly use things from shops... western things, how are we supposed to know those things? Definitely we memorise, but with our own practices, learning will be easier.
Lungie	I Lungie, think learning will be much more easier because the traditional practices and local materials, children already know how to deal with them comparing with chemicals in the school laboratories. So, the learners understanding of science will improve more.
Vergix	Mhhh... haha., mhhh, I think I am mis-understanding local or traditional indigenous practice? But with a little bit that I understand, I think it will help learners to understand better as long as teachers will accommodate all the cultures and also consider what the school will provide to prevent learners or parents from buying those things. Then, we will pass with flying colours.

5. Do you have anything else that you would like to share with me regarding the use of easily accessible resources to carry out hands-on practical activities?

Nickname	Response
Hunter	I Hunter want to add on the easily accessible resources I think that is a really great thing because it does multiple tasks like they are safe for us to use and it helps the planet because we are practically reusing something instead of throwing away. That helps a lot
Ashley	I Ashley really agree with the use of easily accessible materials because even if I am at home bored, doing nothing, I might just intervene with these materials since I have the things and I know their uses, so I will be enjoying science every time even outside the classroom. It will even give me a chance of exploring more and learn new things like, I wonder what will happen if I mix this and that? Or I can be comparing materials like the example that was given by Vergix on polymers.
Lungie	I Lungie, I think it is a great idea of using easily accessible materials because they will help us understand more because they are all around us, they are all around us and we can easily access them. This will help us even value things that are in our environment. We might even want to continue to study Physical science although it was not the case and we even end up becoming scientists or physicians.
Vergix	Mhhh... I mostly agree with what hunter said, not really that we are recycling but from that process you can really learn something knew by doing the experiments. And our education will not be too costly because we use things that are easily accessible and not everything is to be bought. So, parents will also be relaxed in terms of spending their money... mhhhh...it might also influence the learning of science negatively because different environment has different materials, so learners may not be exposed to the same materials although there are in the same grade.

1. What do you think is the role of hands-on practical activities during science lessons?

Categories	Sub-theme	Themes
<p>learners understand things better after they have being taught by seeing it or by doing it themselves (H)</p> <p>It helps the kids to understand and be able to do the activity themselves (H)</p> <p>some learners don't just learn from reading, they learn from doing things themselves (A),</p> <p>it might confuse them for example if they read that hydrogen makes a "pop sound" yet they have never done an experiment to real see and hear that yes, it is true hydrogen makes a pop sound (A).</p> <p>The learners won't forget that pop sound after hearing it rather than just reading. Not everyone will know things before they see or hear them (A)</p> <p>it is more easier for us to deal with things like in class rather than just reading things and like continuing with the next topic (V).</p> <p>I personally feel that it is better to do things myself practically than reading without understanding what I am reading (L).</p>	<p>-Learners learn better by doing hands-on practical Activities</p> <p>-Improve learners' understanding</p> <p>-Promote learners' active involvement in their learning</p> <p>-Promote learners' scientific process skills</p> <p>-Encourage learning with understanding</p>	<p>Hands-on practical activities help learners learn better and improve understanding through social interaction</p> <p>Hands-on practical activities promotes scientific skills and encourage learning with understanding.</p>

<p>Physical science will be more fun when we do hands-on practical activities and we will really like it.</p> <p>we will be more interested in learning physical science here because it has more practical activities.</p> <p>Certain topics will be more fun of course and we will feel excited and more eager to come to class when its physical science lesson.</p>	<p>Hands on practical activities make Science more fun and interesting.</p> <p>Promote positive attitudes towards certain topics in science</p>	
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2. What are your view on the use of easily accessible resources during hands-on practical activities in Physical Science lessons?

Categories	Sub-theme	Themes
<p>that it is really good if we can easily access equipment or materials or chemicals from the nature rather than go buy (H).</p> <p>Some schools don't have laboratory, some have laboratories but like our school, may be they don't have chemicals to do practical (H).</p> <p>that it is very good and important if we use easily accessible resources because not all the schools have enough money to pay for the chemicals to use (A),</p> <p>It will be very important because some schools don't have enough finances to buy materials that they need and the government might not be able to cater for all the needs of the schools (L).</p>	<ul style="list-style-type: none"> - The use of easily accessible resources saves government and parents' money - It is an advantage mostly to schools without laboratory apparatus and chemicals. 	

<p>Learners will even learn much easier because these are the things they know and see and use every day of their lives (A).</p> <p>agree with all what my colleagues said because those are the facts that the easily accessible resources will be helpful during learning because learners are familiar with the materials (V).</p> <p>I will know it forever in my life that toothpaste is a base, even if I am using it, I know and I can even tell my friends from other schools who did not know this and this information might help them to pass their examinations too. Mhhh. yah. You know, it is difficult to understand things that you don't know (A)</p>	<ul style="list-style-type: none"> - Understanding will improve - learning will be easier because learners are familiar to the materials - Learners will be able to assist one another. - Learning will take place anywhere. - Learners will understand the concepts well and thus results in good performance. 	
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3. How can learning be promoted during hands-on practical activities using easily accessible resources?

Categories	Sub-theme	Themes
<p>learning is yes taking place on the board but doing it yourself helps you understand things well, I mean why learn something that you can't even experiment yourself? you as a learner need to be involve in learning. It helps learners to see that things are making sense and science is fun (H)</p> <p>example but if you do it practically, it will laterally be in your head, you will remember things without a need to memorise(A).</p>	<ul style="list-style-type: none"> -Promote active involvement of learners in learning - Makes it easier to understanding of concepts - Promote sense-making of the subject 	

<p>But having materials to be used during learning it will make it easier to understand things well (L).</p> <p>I prefer teachers to write down, and plus, learners should do the things, they should visualize in order to get insight understanding of what they are being taught, and they should manipulate so that they will always remember, in fact they will know what it is. They will permanently stay with such knowledge (H).</p> <p>I think learners will pass really good if they get more involved in hands-on practical activities especially that they use materials that are around them (L).</p> <p>, so I can differentiate them and I will forever know them. So bringing easily accessible materials to class will really positively promote learning and us learners will start to love the subject and value it (V).</p>	<p>-Minimising the memorizing way of learning</p> <ul style="list-style-type: none"> - Help learners make sense of what they are learning. - Using of local materials promote visualization and manipulation in the learning of science - Improve passing rate - Improve learners' interest in the subject - Promote positive learning and value of the subject 	
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4. What are your views on the use of traditional or local indigenous practices as easily accessible resources during hands-on practical activities?

Categories	Sub-theme	Themes
<p>agree with this. It is a very good idea because we use these things every day, we mostly use traditional stuffs at our houses, in schools we mostly use things from shops... western things. but with our own practices, learning will be easier (A)</p> <p>the learners understanding of science will improve more (L).</p>	<ul style="list-style-type: none"> - Local indigenous practice will make learning to become easier - Learners re used to the indigenous practices 	

<p>I think it will help learners to understand better as long as teachers will accommodate all the cultures and also consider what the school will provide (V).</p> <p>Local indigenous practices are even safe to deal with because they hardly involve chemicals. Learners are more comfortable with those practices because is what they know already and they know how to make and deal with them (H).</p> <p>the traditional practices and local materials, children already know how to deal with them comparing with chemicals in the school laboratories (L).</p> <p>They can be found anywhere and you are likely not to pay for them (H). to prevent learners or parents from buying those things (V).</p> <p>So learners will be learning everywhere, at home and at school because they use same things (H).</p> <p>Then, we will pass with flying colours (V).</p>	<ul style="list-style-type: none"> - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class - Promote safety and positive attitude towards learning of science because learners are used to the practices already. - Helps learners to compare and link local knowledge to the one learned in class - The inclusion of indigenous practices minimize financial implications, therefore make learning easier for everyone - Learning will take place everywhere even outside the classroom or at home - Learners' performance improves 	
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5. Do you have anything else that you would like to share with me regarding the use of easily accessible resources to carry out hands-on practical activities?

Categories	Sub-theme	Themes
<p>agree with the use of easily accessible materials because even if I am at home bored, doing nothing, I might just intervene with these materials since I have the things and I know their uses, so I will be enjoying science every time even outside the classroom. It will even give me a chance of exploring more like (A).</p> <p>We might even want to continue to study Physical science although it was not the case and we even end up becoming scientists or physicians (L).</p> <p>I think it is a great idea of using easily accessible materials because they will help us understand more because they are all around us, they are all around us and we can easily access them. This will help us even value things that are in our environment(L).</p> <p>And our education will not be too costly because we use things that are easily accessible and not everything is to be bought. So, parents will also be relaxed in terms of spending their money (V).</p> <p>not really that we are recycling but from that process you can really learn something knew by doing the experiments (H).</p> <p>I will even be able to assist other learners who did not get a chance to do it (A).</p> <p>I think that is really a great thing because it does multiple tasks like they are safe for us to use (H)</p>	<ul style="list-style-type: none"> - Science will become fun as it will be around us and we as learners will get a chance to explore more - Promotes environmental awareness in learners - More learners will develop positive attitudes towards science and will be interested in becoming scientists - Learners will have positive feelings about the subject and its values - Minimise the general cost of education in the country, thus benefiting the economy of the country - Promote practical activities in schools as well as environmental awareness - Safety is guaranteed when one is doing practical activities 	

<p>It helps the planet because we are practically reusing something instead of throwing away. That helps a lot (H).</p> <p>mhh it might also influence the learning of science negatively because different environment has different materials, so learners may not be exposed to the same materials although they are in the same grade (V).</p>	<ul style="list-style-type: none"> - Encouraging people to re-use materials into useful things/ activities - Might negatively influence the learning as learners at different environment will be exposed to different materials 	
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Categories	Sub-theme	Themes
<p>learners understand things better after they have being taught by seeing it or by doing it themselves (H)</p> <p>It helps the kids to understand and be able to do the activity themselves (H)</p> <p>some learners don't just learn from reading, they learn from doing things themselves (A),</p> <p>it might confuse them for example if they read that hydrogen makes a "pop sound" yet they have never done an experiment to real see and hear that yes, it is true hydrogen makes a pop sound (A).</p> <p>The learners won't forget that pop sound after hearing it rather than just reading. Not everyone will know things before they see or hear them (A)</p>	<ul style="list-style-type: none"> -Learners learn better by doing hands-on practical Activities -Improve learners' understanding -Promote learners' active involvement in their learning -Promote learners' scientific process skills -Encourage learning with understanding 	<p>Encourage learning with understanding through social interaction</p> <p>Promote science process skills</p>

<p>it is more easier for us to deal with things like in class rather than just reading things and like continuing with the next topic (V).</p> <p>I personally feel that it is better to do things myself practically than reading without understanding what I am reading (L).</p> <p>learning is yes taking place on the board but doing it yourself helps you understand things well, I mean why learn something that you can't even experiment yourself? you as a learner need to be involve in learning. It helps learners to see that things are making sense and science is fun (H)</p> <p>example but if you do it practically, it will laterally be in your head, you will remember things without a need to memorise(A).</p> <p>But having materials to be used during learning it will make it easier to understand things well (L).</p> <p>agree with this. It is a very good idea because we use these things every day, we mostly use traditional stuffs at our houses, in schools we mostly use things from shops... western things. but with our own practices, learning will be easier (A)</p> <p>the learners understanding of science will improve more (L).</p> <p>I think it will help learners to understand better as long as teachers will accommodate all the cultures and also consider what the school will provide (V).</p>	<ul style="list-style-type: none"> -Promote active involvement of learners in learning - Makes it easier to understanding of concepts - Promote sense-making of the subject -Minimising the memorizing way of learning - Local indigenous practice will make learning to become easier - Learners re used to the indigenous practices - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class 	<p>Emerging scientific concepts</p>
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Categories	Sub-theme	Themes
<p>Physical science will be more fun when we do hands-on practical activities and we will really like it.</p> <p>we will be more interested in learning physical science here because it has more practical activities.</p> <p>Certain topics will be more fun of course and we will feel excited and more eager to come to class when its physical science lesson.</p> <p>, so I can differentiate them and I will forever know them. So bringing easily accessible materials to class will really positively promote learning and us learners will start to love the subject and value it (V).</p> <p>agree with the use of easily accessible materials because even if I am at home bored, doing nothing, I might just intervene with these materials since I have the things and I know their uses, so I will be enjoying science every time even outside the classroom. It will even give me a chance of exploring more like (A).</p> <p>We might even want to continue to study Physical science although it was not the case and we even end up becoming scientists or physicians (L).</p>	<ul style="list-style-type: none"> - Hands on practical activities make Science more fun and interesting. - Promote positive attitudes towards certain topics in science - Improve learners' interest in the subject - Promote positive learning and value of the subject - Promote safety and positive attitude towards learning of science because learners are used to the practices already. - Science will become fun as it will be around us and we as learners will get a chance to explore more 	<p>Interest and attitudes toward science</p>

	<ul style="list-style-type: none"> - Promotes environmental awareness in learners - More learners will develop positive attitudes towards science and will be interested in becoming scientists 	
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Categories	Sub-theme	Themes
<p>Learners will even learn much easier because these are the things they know and see and use every day of their lives (A).</p> <p>I agree with all what my colleagues said because those are the facts that the easily accessible resources will be helpful during learning because learners are familiar with the materials (V).</p> <p>I think it is a great idea of using easily accessible materials because they will help us understand more because they are all around us, they are all around us and we can easily access them. This will help us even value things that are in our environment(L).</p> <p>Local indigenous practices are even safe to deal with because they hardly involve chemicals. Learners are more comfortable with those practices because is what they know already and they know how to make and deal with them (H).</p>	<p>Understanding will improve</p> <ul style="list-style-type: none"> - learning will be easier because learners are familiar to the materials - Learners will be able to assist one another. - Learning will take place anywhere. - Learners will have positive feelings about the subject and its values 	<p>Linkage between Indigenous knowledge and the subject</p>

<p>the traditional practices and local materials, children already know how to deal with them comparing with chemicals in the school laboratories (L).</p> <p>So learners will be learning everywhere, at home and at school because they use same things (H).</p>	<ul style="list-style-type: none"> - Learning will take place everywhere even outside the classroom or at home - Helps learners to compare and link local knowledge to the one learned in class - 	
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Categories	Sub-theme	Themes
<p>that it is really good if we can easily access equipment or materials or chemicals from the nature rather than go buy b(H).</p> <p>Some schools don't have laboratory, some have laboratories but like our school, maybe they don't have chemicals to do practical (H).</p> <p>that it is very good and important if we use easily accessible resources because not all the schools have enough money to pay for the chemicals to use (A).</p> <p>it will be very important because some schools don't have enough finances to buy materials that they need and the government might not be able to cater for all the needs of the schools (L).</p> <p>They can be found anywhere and you are likely not to pay for them (H). to prevent learners or parents from buying those things (V).</p> <p>And our education will not be too costly because we use things that are easily accessible and not everything is to be bought. So, parents will also be relaxed in terms of spending their money (V).</p>	<ul style="list-style-type: none"> - The use of easily accessible resources saves government and parents' money - It is an advantage mostly to schools without laboratory apparatus and chemicals. 	<p>Costs and financial implications in learning</p>

	<ul style="list-style-type: none"> - The inclusion of indigenous practices minimize financial implications, therefore make learning easier for everyone - Minimise the general cost of education in the country, thus benefiting the economy of the country 	
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Categories	Sub-theme	Themes
<p>I will know it forever in my life that toothpaste is a base, even if I am using it, I know and I can even tell my friends from other schools who did not know this and this information might help them to pass their examinations too. Mhhh. yah. You know, it is difficult to understand things that you don't know (A)</p> <p>I prefer teachers to write down, and plus, learners should do the things, they should visualize in order to get insight understanding of what they are being taught, and they should manipulate so that they will always remember, in fact they will know what it is. They will permanently stay with such knowledge (H).</p>	<ul style="list-style-type: none"> - Learners will be able to assist one another. - Learning will take place anywhere. - Learners will understand the concepts well and thus results in good performance. - Help learners make sense of what they are learning. - Using of local materials promote visualization and manipulation in the learning of science 	

<p>I think learners will pass really good if they get more involved in hands-on practical activities especially that they use materials that are around them (L)</p>	<ul style="list-style-type: none"> - Improve passing rate - Improve learners' interest in the subject 	
<p>Categories</p>	<p>Sub-theme</p>	<p>Themes</p>
<p>not really that we are recycling but from that process you can really learn something knew by doing the experiments (H).</p> <p>I think that is really a great thing because it does multiple tasks like they are safe for us to use (H)</p>	<ul style="list-style-type: none"> - Promote practical activities in schools as well as environmental awareness - Safety is guaranteed when one is doing practical activities - Encouraging people to re-use materials into useful things/ activities 	

<p>Categories</p>	<p>Sub-theme</p>	<p>Themes</p>
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<p>it helps the planet because we are practically reusing something instead of throwing away. That helps a lot (H)</p> <p>mhh it might also influence the learning of science negatively because different environment has different materials, so learners may not be exposed to the same materials although they.... are in the same grade (V).</p> <p>You know that it is not all the schools are found in towns, some are in villages and they will not be able to access the same materials as those who are in town schools and also, they will not have shops to buy the cheapest materials that might be required. So, the knowledge that learners will get might be different and this will disadvantage the learners.</p>	<p>Might negatively influence the learning as learners at different environment will be exposed to different materials</p>	
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Themes	Literature and Theory
<p>Theme Learning with understanding through social interaction</p> <ul style="list-style-type: none"> - Improve learners' understanding - Learners learn better by doing - learners' scientific process skills - learning will be easier - Minimize memorizing way of learning - Local indigenous practice will make learning to become easier - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class 	
<p>Theme 2: Learners' active involvement in learning</p> <ul style="list-style-type: none"> - Learners will understand the concepts - Learners will be able to assist one another. - Safety is guaranteed when one is doing practical activities - Learning will take place anywhere. - Promote practical activities in schools as well as environmental awareness 	
<p>Theme 3: Capture interest and stimulate attitudes towards science</p> <ul style="list-style-type: none"> - develops positive attitudes towards science - will be interested in becoming scientists - Hands on practical activities make Science more fun and interesting. 	

<ul style="list-style-type: none"> - Promote positive attitudes towards certain topics in science - Science will become fun as it will be around us and learners will get a chance to explore more - Promotes environmental awareness in learners - Learners will have positive feelings about the subject and its values 	
<p>Theme 4: Linkage between indigenous/local knowledge and the subject</p> <ul style="list-style-type: none"> - learners are familiar to the materials - Local indigenous practice will make learning to become easier - Learners re used to the indigenous practices - Learners understand the concepts better as they link their local/ indigenous practices to what they learn in class - Promote safety and positive attitude towards learning of science because learners are used to the practices already. - Helps learners to compare and link local knowledge to the one learned in class 	
<p>Theme 5: Costs and financial implications</p> <ul style="list-style-type: none"> - An advantage to schools without laboratory apparatus and chemicals. - saves government and parents' money - The inclusion of indigenous practices minimise financial implications, therefore make learning easier for everyone - Minimise the general cost of education in the country, thus benefiting the economy of the country 	
<p>Theme 6: Negative implications</p> <ul style="list-style-type: none"> - Might negatively influence the learning as learners at different environment will be exposed to different materials - Learners from different tribes are disadvantaged 	

Appendix D3a: Stimulated recall interview

INSTRUMENT 2B

APPENDIX: STIMULATED RECALL INTERVIEW FOR THE LEARNERS

Type of interview: Stimulated recall interviews (SRI)

Type of questioning: Open ended questions with prompting

Phase 1: I will address the following points before the interview starts or before start with video play:

- Explain the purpose of the interview.
- Assurance of confidentiality of the recorded data.
- Purpose of video recording.
- Right to have the evidence to be destroyed
- A teacher may ask questions for any clarification
- A researcher will ask some questions for clarity.
- The participant has right to replay the video or stop the video for back replay.

Phase 2: Video play

Possible interactions during the video play is expected

Phase 3: Video replay and discussions

For the SRI, the questions will emerge from the episodes watched and these will be informed by my theoretical framework, that is, Vygotsky's social constructivism.

Some of the questions:

- How did you feel about being part of the class when easily accessible resources were used to carry out hands-on practical activities?
- How did you find the lesson presentation generally?
- Did you find the use of easily accessible resources useful/not useful for learning? Tell me more?
- What do you think could be done better for improvement next time?
- What are your general comments and encouragements to teachers and learners regarding the use of easily accessible resources during teaching and learning.
- Do you have anything else would you like to share with me as far as the use of easily accessible resources to carry out hands-on practical activities is concerned?

Phase 4: the interview concluding phase

I will thank the participants for the availing themselves and positively contributed to my research project.

Appendix D3b: Stimulated recall interview transcript

Research Question: How does carrying out hands-on practical activities using easily accessible resource influence (or not) grade 10 Physical Science learners' conceptions, dispositions, Interest and sense making?

Comments on the videos

Hunter: That was very fun moment, because we really got to see things. I gained more knowledge and really got to understand things better. Lessons were pretty cool and real

Ashley: was a very good experience because we have proved a lot of thing. My concentration was boosted because normally Its difficult to concentrate

Busi: It was really an exciting moment, we can even see how learners were so much involved. Seeing things that are just from the environment and they really make reactions happening.

Josey: The whole experience we got is awesome, we explored, we had fun and yes it was supper exciting. There is a big difference from how we learn in class and how we learned during the presentations. Learning was really transformed into something that I can't describe.

1. How did you feel about being part of the class when easily accessible resources were used to carry out hands-on practical activities

Participants	Response
Hunter/Joay	It is really helpful and an awesome opportunity to be part of the group that had such wonderful moment. In fact I strongly feel that other learners should also be given this opportunity so that they are not left behind. They should also get the understanding that we got so that we are all able to pass well at the end of the year because the practical activities are really opening our minds. I do not think or believe that one can really forget something that you have seen happening or done yourself, so when we find questions in the examination that are related to what we have done, we will really remember (even 99%) and write it down because it is something you visualized and manipulated rather than when you just memorise from the book. When I saw local materials being used, I could see the importance of them and how they are part of our education. It is really good seeing the local materials playing scientific phenomenon. They are cheap, friendly and they are found anywhere anytime. You can just pick them up anywhere, things like cans, egg shells etc
Ashley	I really felt privileged because other learners from other classes could not get this opportunity and experience what I have experienced. For example seeing with my eyes how carbon dioxide is turning lime water milky will make me to have quality knowledge comparing to a certain learner who will just learn that from the summary book or just

	heard from the teacher. I really feel enriched in my mind because even when I am studying, I can even carry out the activities myself at home in order to understand things better.
Lungie/Busi	I'm not really sure if there is a word that I can use to describe how I feel. I felt honoured, privileged. mhhh. I felt important because I got to be part of the experiments and witness things happening and you know sometimes there are certain people who even end up studying science yet they never had this chance of doing hands-on practical activities especially using the easily accessible resources because if there are no chemicals and other materials in the lab, that's it. Doing practical activities even boost your knowledge because as you are studying you try to visualize and it is not all of us that our imagination can really be so nice. Using the easily accessible resources can even help you to understand this that you were unable to understand on your own. So when I saw something than it makes things easier for me to even prepare for my exams.
Vergix/Jossey	Super excited, I felt really honoured in the first place to be among the group that got such opportunity. I learn new things, I got to understand things better because when you see and manipulate. I assure you that what I have learned from the lab all these days has been rich and if I place all this information in my external exams, my marks will definitely improve. If all learners could learn in this way of involving in practical activities using local available materials, generally Namibia will have lot of scientists because almost everyone would want to further his or her studies in the fields of sciences. I may say that having to do practical activities will influence the learners performance and mostly that we use materials that are already familiar to the learners.

2. How did you find the lesson presentation generally?

Participants	Response
Hunter	The lesson presentations were really interesting, we thought we would be sleeping there but, yho! the presentations were fun and an eye opener or I may say mind opener. I am sure sure learners will remember things easily. For example when we tested for hydrogen, all learners head that "pop" sound and I am sure no one will forget about that sound. Even in the examination, learners will remember that sound. The presentations with all those practical activities made me science enthusiasm; my feelings about science are enriched.
Ashley	It was super fun to have all those practical activities during the presentations. I have learned a lot and I am so motivated that I even want to bring more materials from home

	as well as from the environment. So I found the lessons very helpful in terms of getting to understand the things well
Lungie/Busi	I feel so excited. I got very eager to learn and know more. I even feel that we are better off than those learners who did not get this opportunity. It will be more exciting if we can do more practical activities because this will help us to remember more things during the examinations. I tell you Mrs..!, science is horrible without practical; activities. These activities helped us to gain rich knowledge. All things that we struggled to understand, we understand them now.
Vergix/Jossey	From these activities, I will be able to tackle the examination from any corner with this knowledge from the easily accessible resources (EAR). you know learners learn best by doing . it makes science very interesting and for me my knowledge is even expanded.

3. Did you find the use of easily accessible useful/not useful for learning? Tell me more.

Participants	Response
Hunter	Schools should not wait for the government to provide the materials. Schools and government should save money for some other things because we have just proved that we can take easily accessible resources (EAR) which we can access easily and will understand how they work. We will understand science more because learners already know these materials. Importantly, these materials are safe and most of them are environmentally friendly.
Ashley	I agree with my colleague, plus those materials are those that we can get from everywhere, we don't need to buy them either, we use them in everyday life, so it will be easier to understand things unlike when we learn things that we are not familiar with. With the easily accessible resources, we already have knowledge on them.
Lungie/Busi	Easily accessible materials are very useful because if the government is nor providing materials, the school does not have to spend money to buy material but, we can use the easily accessible materials which even make the investigations go faster because both the teacher and learners are familiar with the materials. We already have exciting knowledge on them. These materials saves government, schools and parents money. They can be found cheaper or non-costly.
Vergix/Jossey	Culture is part of these materials and everyone in the class belongs to a certain culture, so, we will learn easily because things are not strange to us. We know them and we use

	them at our houses. So they are very important because they will contribute a lot to our learning and will even make science learning more enjoyable.
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4. What do you think could be done better for improvement next time?

Participants	Response
Hunter	Learners should get involved in the collection of the easily accessible resources (EAR) because I believe that learners can access a lot of materials then the teacher as a one person. Learners are a lot and lives in different locations. They will even bring unique materials.
Ashley	I think it will be good if always learners should do the activities, every learner in the class should get a chance to manipulate the materials. Learners are familiar with the materials, so they will not be scared of handling them compared to laboratory apparatus and chemicals which we are not familiar with and are scared to work with. If we are encouraged to do ourselves, we will become responsible and thus will learn things easier and not forgetting. More especially learners who are coming slowly in physical science.
Lungie/Busi	Learners who do not understand physical science well should be mostly the one to carry out the practical activities using easily accessible resources because this will help them gain the knowledge and interest in the subject. The teacher need to facilitate and instruct the learners only.
Vergix/Jossey	I would also suggest that learners should also be involved in the collecting of the materials. A learner will be excited if his/her material that he brought to class is used for effective learning. Learners will even be proud and I tell you, it is hard to forget such things. Learners will feel like owning their own education which is a good feeling really. Learners can also help each other in terms of sharing materials of different culture

5. What are your general comments and encouragements to teachers and learners regarding the use of easily accessible resources during teaching and learning?

Participants	Response
Hunter	The easily accessible resources (EAR) are friendly to use. They should be used so that Physical Science becomes fun. Most of the learners' takes it as a boring subject because they don't get involved into practical activities all times to share and observe new ideas. EAR will make learners feel good about the subject. The best way for schools to

	carry out hands-on practical activities. It makes learners learn best and understand more because they are familiar with the EAR. So, they already have knowledge on the materials.
Ashley	It is good to go share this knowledge with other learners. They need to know that science does not depend in books neither in the laboratory. It is all around us. They should make it an interesting subject
Lungie/Busi	They should try out practical activities because materials are available every were. We can even do a campaign to share this with other schools. They should attract learners' interest and eagerness to learn science by involving the EAR. This will even improve learners performance and improve the economy of the country because the government does not have to pay for the materials to be used in school.
Vergix/Jossey	Since we are now aware of EAR, we can collect some materials so that we can go show other schools the idea. All Namibian children deserve quality education, so if we do not share this idea with others, it will seem as if we are denying them quality education.

6. Do you have anything else would you like to share with me as far as the use of easily accessible resources to carry out hands-on practical activities is concerned?

7.

Participants	Response
Hunter	That was really the best idea to bring EAR to the classroom because learners got to really involve actively in a social manner. This helps them understand the content more without limits. One can even do these practical activities at home. It helps learners become innovative and independent in terms of creating their own active learning.
Ashley	When learners do more and more activities, with the rightful materials that helps them to understand things, they will reach a point where they do not even need teacher to instruct them. They will not require any assistance from the experts.
Lungie/Busi	No need for laboratories, the environment is science, one does not have to create science, it is already within. we just need to find ways to make it more fun and an enjoyable subject.
Vergix/Jossey	All that my colleague said is very valid. Let us use easily accessible resources to make the learning of science become easier and smooth

Categories	Sub-Themes	Themes
forget something that you have seen happening or done yourself, so when we find questions in the examination that are related to what we have done, we will really.	Visualisation	

<p>something you visualized and manipulated rather than when you just memorise from the book.</p> <p>when I am studying, I can even carry out the activities myself at home in order to understand things better.</p>	<p>Manipulation of materials</p>	
<p>When I saw local materials being used, I could see the importance of them and how they are part of our education.</p> <p>the local materials playing scientific phenomenon</p> <p>Doing practical activities even boost your knowledge because as you are studying you try to visualize and it is not all of us that our imagination can really be so nice. Using the easily accessible resources can even help you to understand this that you were unable to understand on your own</p> <p>I will be able to tackle the examination from any corner with this knowledge from the easily accessible resources (EAR).</p>	<p>EAR as mediational tools</p>	
<p>I felt important because I got to be part of the experiments and witness things happening and you know sometimes there are certain people who even end up studying science yet they never had this chance of doing hands-on practical activities especially using the easily accessible resources because if there are no chemicals and other materials in the lab</p> <p>“pop” sound and I am sure no one will forget about that sound. Even in the examination, learners will remember that sound.</p> <p>because this will help us to remember more things during the examinations</p> <p>every learner in the class should get a chance to manipulate the materials.</p> <p>The best way for schools to carry out hands-on practical activities.</p> <p>All Namibian children deserve quality education</p> <p>learners got to really involve actively in a social manner.</p>	<p>Effective/quality learning</p> <p>Active involvement</p>	
<p>when I saw something than it makes things easier for me to even prepare for my exams.</p> <p>I learn new things, I got to understand things better because when you see and manipulate. I assure you that what I have learned from the lab all these days has been rich and if I place all this information in my external exams, my marks will definitely improve.</p> <p>I tell you Mrs..!, science is horrible without practical; activities. These activities helped us to gain rich knowledge. All things that we struggled to understand, we understand them now.</p>	<p>Help learners move through the ZPD</p>	

<p>Learners who do not understand physical science well should be mostly the one to</p> <p>carry out the practical activities using easily accessible resources because this will help them gain the knowledge and interest in the subject.</p> <p>More especially learners who are coming slowly in physical science.</p> <p>One can even do these practical activities at home. It helps learners become innovative and independent in terms of creating their own active learning.</p> <p>they will reach a point where they do not even need teacher to instruct them. They will not require any assistance from the experts.</p>		
<p>They are cheap, friendly and they are found anywhere anytime. You can just pick them up anywhere, things like cans, egg shells etc</p> <p>. I may say that having to do practical activities will influence the learners performance and mostly that we use materials that are already familiar to the learners.</p> <p>Schools should not wait for the government to provide the materials. Schools and government should save money for some other things</p> <p>accessible resources (EAR) which we can access easily and will understand how they work</p> <p>if the government is nor providing materials, the school does not have to spend money to buy material but</p> <p>These materials saves government, schools and parents money. They can be found cheaper or non-costly.</p> <p>Learners should get involved in the collection of the easily accessible resources</p> <p>learners can access a lot of materials then the teacher as a one person. Learners are a lot and lives in different locations</p> <p>Learners are familiar with the materials, so they will not be scared of handling them</p> <p>because they are familiar with the EAR.</p> <p>should try out practical activities because materials are available every were</p> <p>and improve the economy of the country because the government does not have to pay for the materials to be used in school.</p>	<p>Availability of materials</p> <p>The cost</p>	

<p>With the easily accessible resources, we already have knowledge on them.</p> <p>both the teacher and learners are familiar with the materials. We already have exciting knowledge on them</p> <p>Culture is part of these materials and everyone in the class belongs to a certain culture,</p> <p>will learn easily because things are not strange to us. We know them and we use them at our houses</p> <p>So, they already have knowledge on the materials.</p>	<p>Inclusion of Indigenous knowledge</p> <p>Learners' prior knowledge</p>	
<p>So I found the lessons very helpful in terms of getting to understand the things well</p> <p>my knowledge is even expanded.</p> <p>will understand science more because learners already know these materials.</p> <p>we will become responsible and thus will learn things easier and not forgetting</p> <p>It makes learners learn best and understand</p> <p>This will even improve learners performance</p> <p>do more and more activities, with the rightful materials that helps them to understand things</p>	<p>Improve/ shift the level of understanding</p>	
<p>The presentations with all those practical activities made me science enthusiasm; my feelings about science are enriched.</p> <p>it makes science very interesting and for me</p> <p>will contribute a lot to our learning and will even make science learning more enjoyable.</p> <p>They should be used so that Physical Science becomes fun.</p> <p>EAR will make learners feel good about the subject.</p> <p>science does not depend in books neither in the laboratory. It is all around us.</p> <p>They should make it an interesting subject</p> <p>we just need to find ways to make it more fun and an enjoyable subject.</p>	<p>Stimulated feelings about learning science</p>	
<p>I have learned a lot and I am so motivated that I even want to bring more materials from home</p>	<p>Feel motivated, encouraged to learn science</p>	

<p>feel so excited. I got very eager to learn and know more</p> <p>attract learners' interest and eagerness to learn science</p> <p>No need for laboratories, the environment is science, one does not have to create science, it is already within</p> <p>use easily accessible resources to make the learning of science become easier and smooth</p>		
<p>generally Namibia will have lot of scientists because almost everyone would want to further his or her studies in the fields of sciences</p> <p>do a campaign to share this with other schools.</p> <p>collect some materials so that we can go show other schools the idea.</p>	<p>Influence career choices</p> <p>Shared knowledge</p>	
<p>The teacher need to facilitate and instruct the learners only.</p> <p>I would also suggest that learners should also be involved in the collecting of the materials.</p> <p>Learners will feel like owning their own education which is a good feeling really.</p> <p>Learners can also help each other in terms of sharing materials of different culture</p>	<p>Promote learner centered approach</p>	

Appendix D4: Observation worksheets

Name:

Activity 1: Preparation of Carbon dioxide gas from the traditionally brewed non-alcoholic *Oshiwambo* beverage called *Oshikundu*

What we need:

- Pre-prepared Oshikundu
- Oshipifo
- Water
- Three plastic/glass bottles of the same size
- Three Balloons
- Omahangu flour
- Sorghum flour/ongudo

Procedures

1. Prepare the non- alcoholic beverage prior
2. Dilute the oshikundu with water
3. Fill the bottles with oshikundu
4. Place the balloons on the top of the bottles
5. Leave the bottles for reasonable time
6. Observe what is happening

Write your prediction and explain what you think will happen to the traditionally brewed non-alcoholic Oshiwambo drink (oshikundu) after some hours

PREDICTIONS	EXPLANATIONS FOR PREDICTIONS
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1. Observe what happened to the oshikundu after a couple of hours.

OBSERVATION	EXPLANATIONS FOR OBSERVATION
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2. Write your Conclusion

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Appendix D5: Summary of practical activities

Practical activities conducted	Easily accessible resources used
<p>Lesson 1: Preparation and testing of carbon dioxide gas</p> <ul style="list-style-type: none"> • Preparation of carbon dioxide from the oshiwambo traditionally brewed Oshikundu • Exhaled air • Having fun with coca cola cooldrink • The reaction between egg shells and an acid 	<ul style="list-style-type: none"> ▪ Water ▪ Mahangu flour ▪ Sorghum germinated seeds (ongudo) ▪ Already fermented oshikundu ▪ Hot water (below boiling point) ▪ Cold water (at room temperature) ▪ Bucket ▪ 4 * plastic bottles (750 ml) ▪ 4 * balloons ▪ 3 * test tubes <ul style="list-style-type: none"> ▪ 3 * plastic straws ▪ Lime water ▪ 2 * Coca cola cooldrinks ▪ 2 * balloons ▪ Lime water ▪ Empty test tube ▪ Egg shells ▪ 4 * empty bottles of tomato source ▪ 4 * balloons ▪ Hydrochloric acid (handled by the teacher)

Practical activities conducted	Easily accessible resources used
<p>Lesson 2 Preparation and testing for hydrogen and oxygen gasses</p> <ul style="list-style-type: none"> • Preparation of hydrogen gas • Preparation of oxygen 	<ul style="list-style-type: none"> ▪ Caustic soda (sodium hydroxide) ▪ Aluminium foil ▪ Balloons ▪ 2 * plastic bottles ▪ Water ▪ Burning splint (self-constructed) ▪ Wooden stick ▪ match ▪ Yeast ▪ Bottle of mayonnaise (750 ml) ▪ Burning splint ▪ Wooden stick ▪ match

Practical activities conducted	Easily accessible resources used
<p>Lesson 3, Demonstrations on pressure</p> <ul style="list-style-type: none"> • Having fun with cooldrink can • Blowing air between two suspended cool drink cans • Having fun with boiled eggs • Having fun with marshmallows (sweets) 	<ul style="list-style-type: none"> ▪ Cool drink can ▪ A bucket full of water ▪ Bunsen burner ▪ Tripod stand ▪ A kitchen cloth ▪ 2 suspended cool drink cans ▪ Learners to blow the air ▪ 4 * boiled eggs ▪ 4 * tomato source bottles ▪ Bicarbonate of soda ▪ Vinegar ▪ Pieces of papers ▪ Bunsen burner ▪ Marshmallow sweets ▪ A closed container ▪ Pressure pump
Practical activities conducted	Easily accessible resources used
<p>Lesson 3: Brain teasers</p> <ul style="list-style-type: none"> • Tea bags in hot and cold water • Human body as a conductor of electricity • Eggs in different liquids • Testing for acidity nature of carbon dioxide 	<ul style="list-style-type: none"> ▪ 2 * tea bags ▪ 2 * beakers (self-made) ▪ water ▪ An alarm bell ▪ Learners ▪ Hydrochloric acid ▪ Vinegar ▪ Lemon juice (concentrated) ▪ Water ▪ Raw eggs * 4 ▪ 4* beakers (self-made) ▪ Carbon dioxide gas collected from the reaction of egg shells and hydrochloric acid ▪ Litmus papers

Appendix D6: Story of lesson presentations

Lesson 1

Research Question: How does carrying out hands-on practical activities using easily accessible resources influence (or not) grade 10 Physical Science learners' conception, disposition and sense making?

Firstly, the teacher allowed the learners to enter the class and welcomed them. "Good afternoon learners". Learners responded to the teachers, "We are fine Mrs, good afternoon". The teacher introduced herself to the learners and the learners clapped hands and welcomed the teacher. The teacher also welcomed the learners laughing, "what smart learners" I thought you already forgot about me after a month so, that I was here".

The teacher asked learners to sit in groups, there were six groups, she then introduced the lesson to the learners by telling them a story about herself and the use of easily accessible resources to carry out hands-on practical activities. She wrote four activities on the chalkboard (those that will be done during this lesson).

1. Preparation of the oshiwambo non-alcoholic drink (oshikundu)
2. Reaction of egg shells and hydrochloric acid
3. Having fun with a coca cola cooldrink
4. Bubbling of the exhaled air through clear lime water

The teacher then handed out the worksheets to the learners and ask them to write their predictions and explanations in each of the activity. The learners wrote their predictions and explanations in their groups. The teacher gave instruction of the rest of the activities and what learners should do with the rest of the handouts.

The activity of oshikundu was already prepared before the lesson took place because it needed time for fermentation to take place and for the gases to be produced because the reaction is slow. The teacher asked learners to observe what happened to the oshikundu in different bottles and write their observation and explanation in the space provide in the worksheets.

One learner asked why the balloons that are on the mouths of the bottles not looking the same? One seems to be filled with air? The teacher asked learners to think about the answer to the questions that the learner asked.

Teacher poured the clear lime water into three test tubes and ask three learners to move around the class to show others the lime water in the test tubes and teacher asked learners what it is used for. The learners answered that lime water is used to test for carbon dioxide. The teacher than asked for three volunteers to come and bubble the exhaled air into the clear lime water using the plastic straws while other learners are observing and write down their observation in the worksheets.

Learners were commenting like: Wauh, Eish. So, the air that we exhale is carbon dioxide or perhaps contain carbon dioxide. The teacher also took the cool drink and shake it and place a balloon on the mouth of bottles and asked learners to observe again. The teacher asked two learners to react the egg shells with vinegar and hydrochloric acid while other learners are observing the reaction.

After all activities were done, the teacher and learners engaged into the discussion about what has been observed from the activities. The discussion was very rich, and learners were actively involved in the discussion by asking questions.

The lesson was concluded by the teacher as she highlighted the use of easily accessible resources to carry out hands-on practical activities. She also highlighted the production and testing of carbon dioxide gas.

The teacher asked if learners have any comment or a question that they want to make. One learner commented that I was really a fruitful presentation and we have learned a lot from it and I now understand the preparation and testing of carbon dioxide. "I can see that this has improved their understanding of how to test for carbon dioxide because they have seen it with their eyes.

Appendix E1 Summary of qualitative approach

CHARACTERISTICS OF A QUALITATIVE APPROACH	APPLICATION IN MY STUDY
<p>Exploration</p> <ul style="list-style-type: none"> Through exploration, a central phenomenon can be understood (Maree, 2017, p. 257). 	<ul style="list-style-type: none"> This research is to investigate the possibilities and challenges of the use of easily accessible resources to carry out hands-on practical activities in a grade 10 Physical Science.
<p>Understanding a phenomenon</p> <ul style="list-style-type: none"> The purpose is to understand a phenomenon (Creswell, 2008, p. 54) Broad and open-ended questions assist in understanding the phenomenon (Maree, 2007, p. 257) 	<ul style="list-style-type: none"> Investigation of a phenomenon leads to the understanding of the phenomenon of possibilities and challenges on the use of easily accessible resources to carry out hands on practical activities in a physical science classroom. One of the data collection methods used in this study were focus group interview (FGI) as well as the Stimulated Recall Interview (SRI)
<p>Purposive sampling</p> <ul style="list-style-type: none"> The sample size is generally small, and participants are selected for a purpose (Maree, 2007; Brantlinger, Jimenez, Klingner, Pugach & Richardson, 2005) 	<ul style="list-style-type: none"> I selected a grade 10 class deliberately for this study because I knew they may provide me with rich data about the phenomenon under investigation.
<p>Collecting words</p> <ul style="list-style-type: none"> The research is a key tool to collect data (Ary et al., 2010, p. 25). Data were collected directly through subjective methods such as: observations, interviews, questionnaires and reflections (Maree, 2007; Brantlinger et al., 2005) 	<ul style="list-style-type: none"> I was an observer inside the classroom where the lesson presentations were taking place. Since I positioned myself as a core-learner, I was also assisting learners with the skills they struggled with and stimulate the environment.
<p>Relying on participants for data</p> <ul style="list-style-type: none"> In qualitative research, the participants are the major informants of data and not necessarily literature (Creswell, 2008, p. 53). Literature does not always contain all the information regarding the phenomenon that is being studied, therefore the researcher wishes to understand the phenomenon through 	<ul style="list-style-type: none"> I read many readings about practical activities in Science as well as easily accessible resources, but I did not find any that addresses the possibilities and challenges that the use of easily accessible resources to carry out hands-on practical activities have in a grade 10 physical science classroom. Even though the readings made me understand the concepts of practical

<p>observations, interviews and questionnaires with the participants. (Creswell, 2008, p. 51).</p>	<p>activities and the easily accessible resources better, I gained more information and understanding of this phenomenon in the context of my study through questionnaires, observation and interviews</p>
<p>Data Analysis</p> <ul style="list-style-type: none"> • Data from interviews are transcribed and along with other data collected, codes and categories that arise are labeled (Ary et al., 2010; Maree, 2007). • The data analysis correlates categories which are then analysed into patterns (Creswell, 2008) 	<ul style="list-style-type: none"> • After I carried interviews with the four learners, the audio materials were transcribed. • With other data from observations, questionnaires and journal reflections, I started looking for themes and categories that correlate with one another. and label them accordingly