An investigation of a Systemic Functional Linguistic approach for teaching Energy to grade 7 Natural Science and Health Education Learners: A Namibian Case study

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By

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Declaration

I declare that the work contained in this thesis is my original work. It has not been previously submitted in any form for assessment or degree in any other higher education institution. All the ideas, quotations and other materials used in this study derived from the work of other people have been included in the list of references.

SSilvanus

Signature

Dedication

I dedicate this work to the Almighty God, my saviour, to my late mother Marth Ndapewoshali Hamunyel - I wish she was still alive to see my work, and to my children: Ndalinoshisho, Ngondjodi, Tulinawa, Mekeliwa and Pandulo - I neglected you many times to complete this project. Let my hard work be your source of inspiration.

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Abstract

Learners' general poor performance in science is a concern in science education. The literature mentions pedagogic strategies such as the use of practical activities and inclusion of indigenous knowledge, which are now acknowledged in various science curricula. In addition, many science educators and researchers are exploring innovative pedagogical approaches which may possibly help learners understand science better in order to improve their performance in the subject. Learners' poor performance in science and possible strategies for improving this, are also a concern in Namibia.

The Namibian national examination results (MoE, 2010-2014) revealed that the topic of Energy is one of those in which learners perform poorly. Energy is an important scientific concept that is widely used in various disciplines and it is thus problematic when science learners struggle to make sense of the scientific description of energy and related concepts. This triggered my interest to conduct a study focusing on the topic of energy. The study involved functional recasting from Systemic Functional Linguistic theory, as an intervention during my teaching the topic of energy to English second language grade 7 Natural Science and Health Education learners. The influence of the approach was investigated through the lens of social constructivism. The interpretive paradigm was adopted in order to make meaning of the learners' experiences, during and after the intervention. Data collection instruments such as pre and post test, stimulated recall interviews, observation and learners' journals were used. A qualitative approach was used to analyze the data.

The pretest and post test results showed that a noticeable shift had occurred in learners' understanding - the functional recasting teaching approach positively influenced learners' sense making of energy concepts. Sense-making of energy concepts was evident in learners' demonstrating the ability to construct and deconstruct technicality, making comprehensible output, meaningful use of gestures, scientific reasoning and asking relevant questions. The results also revealed dialogic discourse and positive attitudes as factors enabling learners' progress. The language of learning and teaching, and negative attitudes were found to be constraining factors for learners' progress. Functional recasting might be useful to science teachers and science teacher training programs as the finding for this study revealed that it enabled learners to make sense of energy concepts using scientific English. When using functional recasting, science teachers should consider the constraining factors and possibly avoid or minimize the impact.

Key words: sense making, prior knowledge, Everyday English, Scientific English, mode continuum, functional recasting, mediation, social constructivism, Systemic Functional Linguistics

Table of Contents

List of tables

List of Figures

Acronyms and abbreviations

ZPD – Zone of Proximal Development

SFL – Systemic Functional Linguistic

NSHE – Natural Science and Health Education

LTSM - Learning and Teaching Support Materials

MoE – Ministry of Education

MBEAC – Ministry of Education, Arts and Culture

NSSC – Namibian Senior Secondary Certificate

SATs – Standardised Assessment Tests

SRI1- Stimulated recall interview one

SRI2 –Stimulated recall interview two

LJ – Learners' journal

OBS – Observation Schedule

PRT – Pre test

POT – Post test

L1 – Learner one

L2 – Learner two

L3 – learner three

L4 – Learner four

L5 – Learners five

L6 – Learner six

List of Appendices

CHAPTER 1: SITUATING THE STUDY

1.1Introduction

The goal of this study was to investigate how English Second Language (ESL) grade 7 Natural Science and Health Education learners make sense of energy concepts when they are mediated through a Systemic Functional Linguistic approach. The energy concepts are of great importance in science curriculum. In Namibian curriculum, the concept of energy appears in the syllabi for Natural Sciences subjects such as Natural Science and Health Education grade 4 to 7 and Physical Science grade 8 to 12 (Namibia. Ministry of Education [MoE], 2010). It also appears in the syllabus for a technical subject - Design and Technology grade 5 to 7 (ibid). This study was motivated by Namibian learners' poor performance in the topic of energy in the national examinations for Natural Science and Health Education (NSHE) and from my own teaching experience of the challenges Energy poses at the primary and secondary school science levels.

The first section in this chapter describes the background of the study. This is followed by the rationale, problem statement, potential value of the study and the theoretical framework. The definitions of key concepts are then provided. The chapter ends with an outline of the thesis.

1.2 Background of the study

1.2.1The international context

An understanding of science and its processes is very important in our life endeavors (Fang, 2004). Despite the importance of science in our personal lives and to society, many learners fail to acquire scientific knowledge, understanding and abilities (Fang, 2004). Learners' difficulty in acquiring the knowledge of science is reflected in the results of international examinations which assess learners' performances in science. According to the Organisation for Economic Cooperation and Development (OECD) (2014) the Program for International Student Assessment (PISA)- an average learners' performance in science is very low and remained stable since 2006. The report indicates that among the 64 countries that took part in 2012, only 19 countries showed a slight improvement in science performance.

Some scholars conducted studies to investigate factors contributing to learners' poor performance in science (Bradshaw, 2012; Kola & Sunday, 2013; Mji & Mkago, 2006). These scholars identify

the language of learning and teaching (LoLT) as one of the contributing factors to learners' poor performance in science in countries where English is not the mother-tongue but used as the LoLT. They report that learners experience significant difficulties in comprehending science content in the language which is not their mother tongue.

In addition to the negative effect of LoLT in science teaching and learning, some scholars indicate that the biggest barrier to the learning of science is the language of science itself (Fang, 2004; Halliday and Martin 1993). This highlights that ESL learners experience a double challenge compared to their English First Language (EFL) counterparts – the challenge of English as LoLT as well as of scientific English.

In response to the need for improving learners' sense-making in science, some researchers advocate code switching (eg. Probyn, 2004), some advise the inclusion of practical activities (Gott & Duggan, 1996; Hodson, 1990; Muselwa & Ngcoza, 2003) while others recommend the inclusion of indigenous knowledge (Kibirige & Van Rooyen, 2006; Mkwambo, Ngcoza & Chikunda, 2012). These pedagogical strategies are acknowledged as being useful, and this is reflected in their inclusion in some of the science curricula internationally. For example, the Curriculum and Assessment policy statement (CAPS) for Natural Science intermediate phase, through its general aims, acknowledges the inclusion of indigenous knowledge (South Africa. Department of Basic Education (DoBE, 2011).

However, while the abovementioned pedagogical approaches to science teaching may improve learners' sense making, they do not necessarily apprentice learners into scientific English which is critical since learning in science is assessed in English when English is the LoLT. Fang (2004) critiques the emphasis on enquiry science that many studies recommend, and he advocates for approaches which can attend to both empirical activities/skills and the specialized language of science. He recommends pedagogical approaches which can prepare learners to understand the specialized language of science in for them to prosper in their learning of scientific principles, knowledge and values. This requires teachers to understand the role that language plays in shaping

experiences/ reality and learning so that they can adequately apprentice learners into the discourse community of science (Fang, 2004).

In discussing ways of supporting ESL learners to learn and understand scientific English, some scholars recognize systemic functional linguistic theory as providing tools appropriate for mediating science learning (Gibbons, 2003, Jawahar, 2011; Jawahar & Dempster 2013; Mohan & Slater, 2008).These studies highlight some functional language features that promote the development of scientific English, such as functional recasting (which is discussed in more detail in the literature review). In one empirical study, a model is presented, outlining how different functional recasting types identified, play a role in bridging everyday and scientific English (Jawahar, 2011). While the model indicates different types of functional recasting and their function in bridging everyday and scientific English, it did not go further to indicate whether functional recasting influences learners' sense making. I thus decided to adopt this model in designing a teaching intervention employing functional recasting, for investigating how such an SFL approach may influence learners' sense making of energy concepts.

1.2.2 National context

After independence in 1990, the Namibian education system underwent a number of reforms to move away from the apartheid education system and to address social and economic factors that would enable the country to fit into the global society (MoE, 2010).The current Namibian curriculum was reviewed in 2014 and the implementation is occurring in phases. The first implementation was done in 2015 with the junior primary phase (from pre- primary grade to grade 3) followed by senior primary (grade 4 to grade 7) with its implementation having started in 2016. The next implementation will be for the secondary phase (grade 8, 9, 10, 11 and 12) happening with one grade per year starting with grade 8 in 2017, followed by grade 9 in 2018, grade 10 in 2019, grade 11 in 2020 and grade 12 in 2021.

Within each new revised curriculum, changes occur in the subject content, methodology and the aim. These changes involve earlier versions of the syllabi, textbooks and workbooks being replaced by those aligned to the current curriculum frame. In the Namibian Natural Science and Health Education syllabus for 2016, the content details for each grade have changed in some ways

but the aims remain the same (Namibia. Ministry of Education, Arts and Culture [MOEAC], 2016). The aims for Natural Science and Health Education syllabus are:

- *'To provide basic scientific background for Namibian learners with the hope of producing the much-needed scientists for the country.*
- *For the Namibian society to be scientifically literate if it is to cope with challenges of appropriate global technology and economic advancement of the country' (MOEAC, 2016, p. 1)*

The implementation of the curriculum involves training programs (workshops) to orientate teachers to the changes made, specifically the changes related to the subject content. Although teachers receive training for each revised curriculum, challenges are experienced with accessing learning and teaching support materials (LTSM) such as textbooks. Misinterpretation of the curriculum requirements has also been observed for some curriculum components. For example, in a study conducted by Nyambe (2008) in Namibia, to investigate how teacher educators in Namibia interpret and practice learner-centered education pedagogy, the findings reveal that there is a misinterpretation of the notion 'learner-centered' by most teachers. He further indicates that teachers lack skills to develop and design activities that involve or apply pedagogical strategies that shift from teacher-centered education to learner- centered education. Such misinterpretation might affect the outcome of the curriculum objectives.

Furthermore, in Namibia, English is the only language of teaching and learning from grade 4 upwards (MOE, 2010). This is surprising considering that Namibia is a multilingual country with 13 indigenous languages being spoken by over 54 % of the Namibian population with only 0.8% speaking English as their first language (Brock-Utne & Holmarsdottir, 2001; Pütz, 1995). English being the sole LoLT in Namibia is reported to have negatively affected teaching and learning. Studies conducted in Namibia indicate that the language of teaching and learning impedes quality teaching and learning and contributed to poor academic performance (Benjamin, 2004; Frydman, 2011; Namupala, 2013).

The Namibian learners' poor performance in science is reflected in the examiners' reports for Standardized Achievement Tests (SAT's) for the Natural Science and Health Education subject

(Ministry of Education [MOE], 2010-2014). The National Senior Secondary Certificate (NSSC) examiners' reports for Physical Science, state that learners lack scientific terms to describe science concepts (Ministry of Education [MOE], 2009). Through their comments, the examiners request that teachers model the correct spoken and written science language in their classroom in order to avoid incorrect scientific language use by learners, which ultimately impacts negatively on their performance in examinations. The examiners' comments provide support for studies that identify teaching approaches that can help shift learners from everyday to scientific English, which is a necessary requirement for success in science assessment in English.

When I searched the literature, I did not find any studies in Namibia which investigated a systemic functional linguistic approach to teaching science or even to address the problem of language in science education, in general. However, I came across some studies conducted outside Namibia which recognize systemic functional linguistic theory providing pedagogical tools which can be used to mediate scientific English (Gibbons, 2003; Jawahar, 2011; Jawahar & Dempster, 2013; Mohan & Slater, 2008). These provided a basis for intervention during the teaching of energy concepts.

Gibbons (2003) used the SFL view to investigate how teacher-learner talk contributes to learners' language development. She described how functional recasts helps ESL learners to move across a mode continuum from everyday context-dependent talk towards more, specialist written scientific discourse. Mohan and Slater (2008) describe how a science teacher used functional recasts to connect theory and practice, revealing how SFL tools can be used strategically to enhance science learning. Jawahar (2011) used SFL to explore the nature of the utterance of the Physical Science educators in different language contexts. Through his study, Jawahar developed a model which illustrates different types of functional recasting and their outcomes.

Gibbons', and Mohan and Slaters' works provided me with insights into how to incorporate functional recasting in a way that develops learners' understanding and use of scientific English. My teaching intervention considered the range of functional recasting types described in Jawahar's model (Jawahar, 2011) and focused specifically on the functional recasting types related to technicality.

The following figure show a model of functional recasting outcomes adopted from Jawahar (2011).

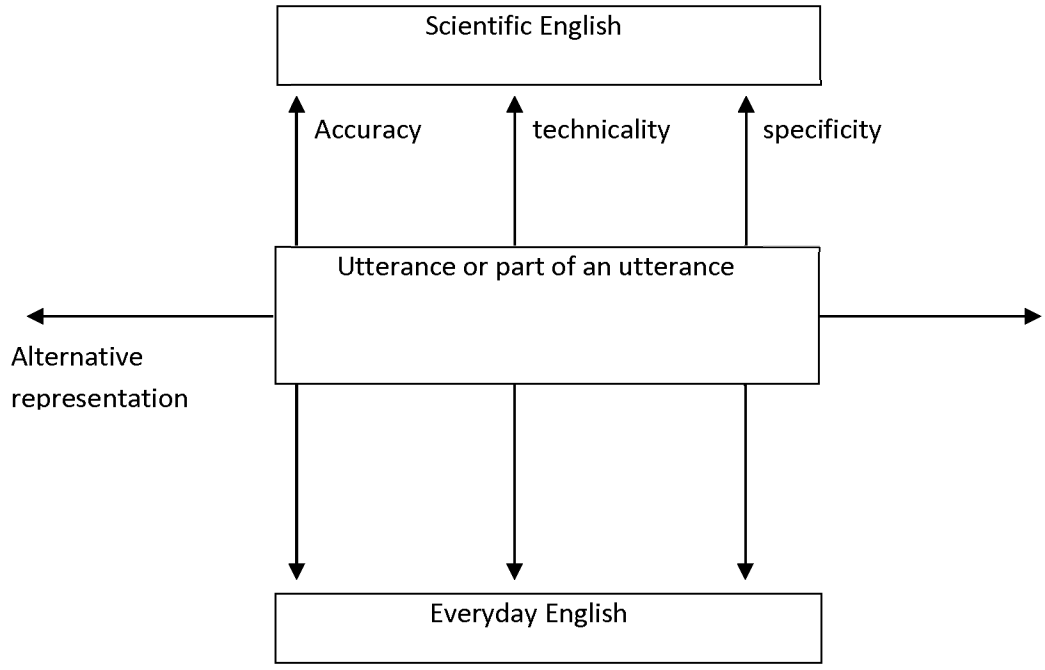

Figure1. Model of functional recasting outcomes (Jawahar, 2011)

The model illustrates that functional recasting types that increase accuracy, technicality and specificity lead towards scientific English and functional recasting types that decrease, accuracy, technicality and specificity lead to everyday English. The model illustrates also, that there are some functional recasting types which do not cause any shift between scientific English and everyday English – these are classified as alternative representations.

1.3 Rationale

Often, in my science teaching career, I noticed that learners have difficulties in understanding energy concepts. For example, learners confuse energy with related concepts such as power and force. I also noticed that in some languages these different terms are conflated into one word. For example in my first language (Oshiwambo), energy is referred to as '*eenghono*' which is the same word used for power and force. During Natural Science and Health Education teachers' workshops in the Ohangwena region in Namibia, where I serve as a facilitator, teachers share ideas and discuss pedagogical strategies for teaching Natural Science and Health Education. I noted during these workshops that teachers display negative attitudes toward teaching the topic of energy. Some teachers indicate that they find it difficult to help learners understand abstract concepts such as energy conversion. In these workshops the use of practical activities to help learners understand the concept of energy conversion was discussed as the possible solution to the problem.

Energy is an important scientific concept that is widely used in various disciplines and it is also used as unifying theme within physical sciences (Leggets, 2003). Although energy concept being used in various disciplines is said to expose learners to the diverse form of energy, Leggets (2003) posits that such exposure can be at odds with science teaching and learning. Learners bring diverse prior knowledge about energy concepts to the science classroom, some of which is non-scientific. This is problematic and contributes to science learners struggling to make sense of energy concepts.

The directorate of National Examination and Assessment (DNEA) in Namibia conducts a Standardised Achievement Tests (SATs)- a diagnostic tool to test schools' performance in three subjects: English, Mathematics and Natural Science at grade 5 and grade 7 (MoE, 2010-2014). For the past 5 years in which the SAT's have been taking place in Namibia, the average score of Natural Sciences learners has been below 60%. The SAT's examiners' reports reveal that the topic of energy is one of the topics in which learners perform poorly (MoE, 2010-2014).

Although examiners' reports for the NSHE SATs in Namibia reveal that learners perform poorly in the topic of energy, the reports do not provide details about the nature of learners' misconceptions around energy. This highlights one specific knowledge gap. In addition to the SATs, NSSC examiners' report for Physical Science indicates that learners seem to have

misconceptions about energy concepts (Ministry of Education [MOE], 2011).This reveals that the challenges in understanding energy concepts haunts many science learners up into the senior secondary level.

Furthermore, the NSSC examiners' reports for Physical Science, state that learners lack scientific terms to describe science concepts (MOE, 2009). This suggests that Physical Science teachers need to focus more on the technicality aspect of science as a language. The examiners' comments allude to the need for studies that identify teaching approaches that can help learners make sense of science concepts and apprentice them into scientific English. This provides support for investigating an approach such as Systemic Functional Linguistics, which views sense-making as occurring through linguistic resources.

1.4 Problem statement

The concept of energy is important because it covers some everyday ideas that every person ought to know, such as energy resources (Millar, 2005). It is significant both in Physics and Chemistry (ibid). Although Energy is an important scientific concept across various disciplines, Namibian students perform poorly in it, at least in part due to the challenge of scientific English. Literature suggests functional language features such as functional recasting can be employed to mediate learners' movement through a mode continuum from everyday spoken English towards written scientific English (Gibbons, 2003). Thus, an intervention drawing from systemic functional linguistics for teaching the topic of energy has the potential to help learners sufficiently develop their scientific English in order to make sense of energy concepts. However, no studies could be found which focused specifically on this.

1.5 Potential value of the study

The study findings may provide insight into the usefulness of an SFL approach for developing learners' scientific English in order to make sense of energy. Such knowledge is needed to inform more effective teaching of energy in an effort to improve learners understanding of this important scientific concept. The findings may also inform science teacher training programs and contribute to the debate on whether language-based approaches are effective and should be pursued, especially in light of other options like practical work, being more resource-hungry.

1.6 Theories informing the study

This study employed the Systemic Functional Linguistic theory by Halliday (1993) and Social constructivism theory by Vygotsky (1978). Both Halliday (1993) and Vygotsky (1978) indicate that learning is a social activity mediated by language as a tool. Vgyotsky (1978) adds that language is not only a tool used for mediating learning but it also enables people to plan, coordinate and review their actions through external speech. Halliday (1993) offers that language can be used in the regulatory function to get people to do what they want to do.

Social constructivism theory (Vygotsky, 1978) asserts that people learn through social interactions in which more knowledgeable people help a learner to move from one level of knowledge to another with the space in between termed the Zone of proximal development (ZPD). The functional recasting intervention worked well with the notion of mode continuum for understanding the possibility of learners' shift from everyday spoken English to scientific spoken or written English. Hence the two theories offered the lenses that enabled me to characterize the influence of functional recasting on learners' scientific English development and sense making. The two theories are explored in more detail in Chapter 2.

1.7 Definition of key concepts

Various core concepts appear in this study and definitions aligned to the context of the study are briefly presented here. These concepts are: energy, everyday English, functional recasting, mediation, mode continuum, prior knowledge, scientific English, sense making, social interaction, and ZPD.

They are defined as follow:

- **Energy**- Ability to do work (MOEAC, 2016).
- **Everyday English**– the register of English which is used for day to day communication (Mortimer & Scott, 2003).
- **Functional recasting** – a process of reformulating, paraphrasing, recontextualising, signaling by the educator who presents or recontextualises learners' experiences in order to improve learners' ability to use the language as a resource for making meaning (Gibbons, 2003; Mohan & Beckett, 2003).

- **Mediation** - the process of assisting people to learn to do the task by themselves (Vygotsky, 1978).
- **Mode continuum**– the scale between an informal, spoken language and formal, written language that learners shift along (Gibbons, 2003).
- **Prior knowledge** – the knowledge that learners have acquired before hand, which can be from home experiences or from previous grades (Roschelle, 1995).
- **Scientific English** – One register of English characterized by technicality, abstraction, information density and authoritativeness (Halliday, 1993; Fang, 2004).
- **Sense-making** – a way in which people construct and interpret observable paths of knowledge change (Crawder, 1996).
- **Social constructivism** – a learning theory that views learning as a social interaction activity mediated by language (Vygotsky, 1978).
- **Systemic functional linguistics** – a language theory that recognize language as a social semiotic tool/ a resource that people use to accomplish their purposes (Halliday & Martin, 1993).
- **Zone of proximal development (ZPD)** – the difference between what a learner is able to do without and with, the assistance of a more knowledgeable person (Vygotsky, 1978).

1.8 Thesis outline

The thesis consists of five chapters. The following is an overview of each.

Chapter 1

This chapter discussed the background and the rationale of the study. The problem statement and potential value were highlighted. The theories used in the study were discussed. The chapter ends with definitions of core concepts and this outline of chapters.

Chapter 2

This chapter reviews some literature relevant to the study. Firstly, the Namibian Science curriculum expectations are presented. Secondly, the core concepts are discussed. The literature review also considers the role of language in science learning, the role of prior knowledge in science learning and the abstract nature of energy concepts. The chapter discusses the theories of systemic functional linguistic and social constructivism that underpin the research study, and how the two theories complement each another.

Chapter 3

This chapter discusses the research design and justifies why an interpretive paradigm was used. The research questions are presented. The research orientation, methodology, research site, the aim of piloting, the role of a critical friend and the techniques used for data collection, preparation and analysis are explained. Convenience and purposive sampling are discussed. Lastly, ethical issues and validity of the study are considered.

Chapter 4

This chapter presents the results of the analysis of data from the pre test, stimulated recall interviews, lesson observation, learners' journals and post test. It also presents the discussion of the finding based on predetermined themes from the literature (deductive analysis) the themes emerging from the data (inductive analysis).

Chapter 5

This conclusion chapter presents the summary of the study. It also considers the limitations of the study as well as recommendations for further research.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

The goal of my study is to investigate how ESL grade 7 Natural Science and Health Education learners make sense of the energy concepts when they are mediated through a systemic functional linguistic approach. Literature on various studies, discusses teaching and learning of science language. In order to enable my research to make a valuable contribution to the field, it was necessary to situate it in relation to the existing body of knowledge. This chapter discusses some literature related to how learners develop an understanding of science language. It considers several studies, arguments and comments from different authors in relation to science teaching and learning.

Firstly, the language issues arising from Namibian Curriculum for Basic Education are discussed. This includes the teaching and learning methods and the basic competencies (learning content that learners are expected to acquire) in the topic of energy as indicated in the Natural Science and Health Education syllabus (MoESC, 2016). Secondly, the chapter discusses sense making in science language, the role of science language, the role of prior knowledge in science learning and teaching, and the complexity of energy. The literature around these main concepts provided a context for the later discussion of the study findings. Lastly, the theories of social constructivism and systemic functional linguistic are discussed. These theories provided appropriate tools for the designing of the intervention used in the study. They also provided lenses that enable the researcher to investigate the influence of the intervention.

2.2 Literature review

2.2.1 Language issues in the Namibian curriculum

In the Namibian Education system, both English First Language (EFL) and English Second Language (ESL) learners, from grade 4 upwards are learning science with the LoLT being English. This is mandatory from the Namibian language policy for schools which states English to be the only LoLT from grade 4 upwards. (Namibia. Ministry of Basic Education and Culture [MBEC], 1992).

The National curriculum for basic Education is a document which describes the goal, aim and rationale of the curriculum, the principles of teaching, learning and assessment, language policy

and curriculum management at school level (Namibia. Ministry of Education [MOE], 2010). The document provides guidelines for planning, organizing and complementing teaching and learning. It indicates the role of English in teaching and learning and requires English language to be taught across the curriculum. The document states:

> *'English has a special role in the Namibian situation as the official language and the medium of instruction from grade 4 upwards. All teachers have the responsibility to improve the learners' aural/oral skills in discussion, reflection and reporting; their perceptual skills in using different types of reading techniques and materials; and their written skills especially in summaries, note taking, writing papers and reports' (Ministry of Education, 2010, p. 27).*

Although the curriculum requires teachers to teach English language skills within their subject, policies for integrated language and content teaching strategies are essentially absent. Science subject policies do not outline or discuss how to teach language and science content in an integrated way. This places Namibian teachers in a dilemma of how to teach English language skills and subject content in an integrated way.

Since the introduction of this curriculum many questions have been raised as to how teachers should teach English language in their subjects. Some teachers feel that teaching English language skills should be left in the hands of the English language teachers. This suggests that teachers are not willing to and/or face challenges in implementing the curriculum requirements of teaching English language across the curriculum.

The curriculum further explains that teachers must teach in such a way that they help learners to learn to understand and use the terminologies of the subjects in writing and also in classroom discourse (MOE, 2010). This highlights an earlier mentioned fact, that apart from the challenge posed by the English as the LoLT, ESL learners face an additional challenge of needing to learn the register of scientific English. It can thus be argued that Namibian science educators face the responsibility of employing appropriate teaching methods that can shift learners from everyday English towards scientific English. Mediating the shift from everyday English towards scientific

English is an integral skill in the context where unfamiliar ways of using new language are being used to construct new content knowledge (Jawahar, 2011).

The National curriculum for basic education (MOE, 2010) structures the basic education into four phases: Junior primary (pre grade to grade 3); senior primary (grade 4 - 7); junior secondary (8-9) and senior secondary (grade 10 -12). The curriculum has also indicates the subjects available for each phase. In the senior primary (grade 4 – 7) where grade 7 is situated, learners are expected to build on the literacy skills (language skills) and numeracy skills (Mathematics) which they have acquired from junior primary. They are also expected to develop learning skills and basic knowledge in Natural Sciences, Social studies, Technology, Arts and Physical Education (ibid).

The Natural Sciences learning area comprises different subjects in each phase. In junior primary phase Natural Sciences comprises Environmental learning and Environmental studies; in senior primary it comprises of Elementary Agriculture, and Natural Science and Health Education (NSHE); in junior secondary phase it comprises Physical Science, Life science and Agriculture and in senior secondary phase it comprises Physical Science, Biology and Agriculture. The focus for this study is in Natural Sciences through the subject of NSHE.

The NSHE subject contains some topics which are also covered in other subjects in the Namibian Curriculum for Basic Education (MOEAC, 2016). It embraces content of the cross-curriculum issues which serve as a direct link to other subjects for the Namibian school curriculum (ibid). The subject aims to provide essential scientific background necessary for learners to join the country's scientific industry (MOEAC, 2016). It also provides opportunity for the Namibian society to be scientifically literate in order to cope with scientific and technological challenges they may face (ibid). To enhance learners' interest in joining the science industry, science teachers need to mediate science learning in a way that can help learners to develop such interest.

Bloor (2007) reiterates that teaching the content of a subject is related to teaching the language of the subject. However, in the Namibian context, the teaching approach for NSHE as indicated in the syllabus does not explicitly outline how science teachers should teach to enhance scientific English. This is deeply problematic considering Wellington and Osborne (2001) reminder that all science teachers are language teachers. Despite the gap in terms of how, it is clear that in addition to teaching science as content or process, science teachers must also teach science as a language.

Teachers thus need to employ teaching strategies which recognise language based approaches. From the sociocultural perspective, language learning is mediated by language use in the collaborative interactions between the teacher and learners (Wells, 1994).Therefore, is thus strong support for my study adopting the sociocultural view of science as a language.

In this study the usefulness of the language tool of functional recasting drawn from systemic functional linguistics, was explored for helping learners develop an understanding of energy concepts. The learning content of Natural Science and Health Education is defined by the learning objectives and the basic competencies in the syllabus (MOEAC, 2016). The learning objective is a statement outlining long term outcomes for the topic while the basic competencies is a statement outlining short term outcomes that can be achieved within one lesson. The basic competencies under the topic of energy as outlined in the Natural Science and Health Education are as follows:

- *'Investigate and name the energy sources available in their local environment*
- *Investigate how energy sources are used*
- *List the most important energy sources for Namibia*
- *Identify four fuels commonly used*
- *Distinguish how the fuels identified are used*
- *State that fuels are limited and that energy sources can be exhausted*
- *Distinguish between renewable and non-renewable energy sources in their environment*
- *Explain how energy sources are used*
- *Describe energy as an ability to do work*
- *Outline that people use energy for their everyday living requirements*
- *Distinguish between forms of energy*
- *State the law of energy conservation*
- *Identify energy conservations and identify different forms of energy conversions in practical examples*
- *Describe the movement of energy through the local environment (by naming the different types of energy)'* (MOEAC, p. 36)

The significance of language as a tool for mediating learning (Vygotsky, 1978) supports the study investigating the influence of an SFL teaching approach on ESL learners' sense-making of the abovementioned energy concepts.

2.2.2 Core concepts in this study

2.2.2.1 Sense making

Crawder (1996) describes sense making as a way in which people construct and interpret observable paths of knowledge change. Crawder (1996) further indicates that learners can be identified as being involved in meaning making when they present ideas with multiple stops, starts and reasons through verbal or gestural cues in classroom talk. Multiple starts and stops are some of the verbal language features which can happen in classroom talk involving learners presenting their ideas in an unpolished way such as repeating words, pausing and starting over.

More recently, Fellows and Liu (2015) describe sense-making as "a process of social construction that occurs when discrepant cues interrupt individuals' ongoing activity and involves the retrospective development of plausible meanings that rationalize what people are doing" (p. 247). They further indicate that people construct meaning through the process that enables them to make sense of their world by interpreting the signals they perceive. This highlights that construction of meaning is synonymous with sense-making.

Lemke (1990); Lyle (2008); Mortimer and Scott (2003) characterize classroom talk as a crucial mode of the sense making process. Lemke (1990) posits that through classroom talk learners externalize their thinking. This supports the Vygotskian view of learning. Vygotsky (1978) describes learning as a social activity which is mediated by language as a tool. Cummins (1996) affirms that meanings are sometimes constructed between individuals rather than by just one, and are shaped by the social activity in which the individuals participate and the collaborative nature of the interaction. Social interactions can thus be viewed as fertile ground for meaning making. In order to create opportunities for the learners in my study to interact, the teaching intervention design included activities such as group discussions and presentations in order to stimulate learner talk.

Mortimer and Scott (2003) assert that meaning making is a dialogic process which entails the notion of bringing together and working together. Lyle (2008) characterizes dialogic talk in

classroom as a teacher to pupil discussion. He posits that dialogic talk helps learners to share and build meaning in a collaborative way. Lyle (2008) further indicates that dialogic talk allows learners to play an active role in developing a personally constructed understanding of the curriculum through a process of dialogic interchange. Through exchanging views with the teacher, learners may develop an understanding of science beyond that which they could achieve on their own. In this study, dialogic talk was used as the mode through which functional recasting was applied towards the possibility of shifting learners' language from everyday English to scientific English.

Classroom talk happens in our everyday science teaching but Lemke, (1990), Mortimer and Scott (2003) express their concern that in many science classrooms learners are not afforded the opportunities to talk. Where it does happen, most of the discussion may end up being unfocused and unproductive (ibid). Mortimer and Scott (2003) further indicate that most of the science classrooms are still reflecting the teacher-centered approach with teachers dominating classroom talk. Such type of classroom interaction is referred to as monologic talk (Lyle, 2008) and it involves a teacher transmitting knowledge to the pupils.

Furthermore, Zhang (2008) indicates that classroom talk plays a major role in everyday lessons and contributes much to the learning processes. It is one of the pedagogical practices through which teachers can model for learners, the use of scientific English (ibid). Lemke (1990) describes that learners construct meaning when classroom talks reflect the Initiate Response Feedback (IRF), an exercise involving a teacher initiating the response from the learners and giving them feedback. Through such dialogic talk, teachers shape learners' knowledge to reflect the knowledge required.

Rahm (2004) describes the indicators of sense making observed in a science center. He explains that learners' action and talk shows what they learnt and how they accomplished learning. He highlights that learners can be characterised as making sense of what they are learning through the features of conversations such as the type of questions they ask, vocalized sounds they make, restarts and repairs with their responses; through gesturing; through gazes and through the way they interpret ideas. He concludes that knowledge is collaboratively constructed among students and teachers as they engage in activities they are committed to.

Fang (2004) describes the indicators of sense making in science writing, more specifically. He indicates that sense making in science writing can be realized through the display of information density in a text. Information density is a language feature in science which is determined by lexical density - a measure of content words per clause (Fang, 2004). He points out that if learners do not understand the meaning of the lexical terms they will not use them effectively in their own writing. This links to the earlier point about learners making sense in science when they are able to use technical terms effectively.

Fang (2004) further indicates that sense making in science writing can also be realized through the display of technicality. He stresses that students who do not know the meaning of the technical vocabulary struggle with comprehension of science text and will lack the grammatical resources needed to accurately and effectively communicate scientific ideas. This suggests learners making sense of science when they are able to explain technical terms and when they are able to explain science activities using technical terms.

Audet, Hickman and Dobrynina, (1996) describe learning logs and journals as vehicles that provide evidence of learners' sense making. They indicate that through journals, learners make their knowledge public. They also indicate that learning logs can be used to mediate the dialogue between the instructor and the student, a feature that redefines traditional classroom roles and responsibilities. Audet et al. (1996) further state that conditions that promote students' understanding arise when teachers conduct scientific conversations with learners asking questions that integrate theory with evidence. In this study learners' reflections in their journals enable the researcher to get deeper insights into learners' sense-making on the topic of energy over the course of the SFL teaching intervention and also to get insights into what enables or constrain ESL learners' sense making as they traverse the mode continuum when mediated by functional recasting in English.

2.2.2.2 The role of language in science

Language plays a major role in cognitive development (Vygotsky, 1978). Vygotsky (1978) asserts that language serves as a psychological tool that causes a fundamental change in mental functions. This describes language as a stimulus for constructing ideas and enabling communication. The importance of language in science is that science is rich in words and terms and students need to

be advanced into abstract thought using scientific English if they are to learn science (Wellington & Osborne, 2001). From the systemic functional linguistic perspective, science is a language with its own words which are accessible and understandable to people in the field.

Learning science is learning the language of science and science teachers are language teachers (Wellingtone & Osborne, 2001). Science teachers thus have the responsibility of apprenticing learners into scientific English. Aikenhead and Jegede, (2008) indicate that some learners find it difficult to cross the cultural and language border to obtain the language and culture which is exercised in school science. In fact, Bloor (2007) believes that the language of science acts as a barrier to learning in the field, discouraging some children from achieving success in science. For these reasons teachers need to apply pedagogical approaches which can help learners to navigate the shift from everyday English into scientific English.

Fang (2004) indicates that the structure of science language challenges learners when they are learning school science. He indicates that when learners come to school they are more familiar with the social language of social interactions that need to be transformed into the language required in schools. Wellington and Osborne (2001) state that learners need to learn the language of science so that they can be able to critically read and analyse scientific research.

Kim (2007) in his study about language development strategies for teaching science in English, suggests language development strategies appropriate for various concepts in teaching science. He suggest that science teachers should be in a position to identify the language demand and address vocabulary and technical terms by integrating language functions such a summarizing, rephrasing, evaluating, and making explicit the different structure and features of the language of science.

Discourse, including talk and conversation, writing and acting, is manifested in language. The culture of power of school science is taught through understanding the language, rules and discourse of the science content (Lyle, 2008). Wellington and Osborne (2001) assert, together with others already cited, that the key to understanding a subject is to understand its language. Thus science educators should to pay more attention to science language in order to improve the quality of science education.

2.2.2.3 The role of learners' prior knowledge in science education

In a science study that involves an intervention, it is prudent to consider learners' prior knowledge. Studies indicate that learners come to school with much knowledge that they have acquired from home interactions or from previous grades (Roschelle, 1995). Roschelle (1995) suggests that learners' prior knowledge needs to be elicited in science teaching and learning since it potentially informs teachers about what learners already know in a particular topic.

A variety of studies support the recognition of prior knowledge in science teaching and learning (Gott & Duggan, 1996; Johnstone, 2010; Muselwa & Ngcoza, 2003; Oloruntegbe & Ikpe 2011; Roschelle, 1995).Some scholars (Johnstone, 2010; Muselwa & Ngcoza, 2003; Roschelle, 1995) highlight that the inclusion of prior knowledge in science has multiple benefits such as raising awareness of the value of science; providing students with multiple experiences of science; enabling students to acquire new knowledge; contributing to an increasingly knowledgeable society.

Roschelle (1995) further emphasizes that success begins with the cultivation of the ability to look at the learners' viewpoint and to discover the seeds from which knowledge and identity can grow. Through sourcing learners' prior knowledge the teacher will be able to identify what the learners already know and thus what they do not know. Johnstone (2010) points out that neglecting learners' prior knowledge in science teaching results in learners not getting the educational message. He thus urges science teachers to adopt the rational approach of starting with what learners already know and what interests them in order to effectively lead them to discovering new ideas. Stears, Malcohon and Knowelas (2003) indicate that learners participate actively when their cultural experiences are involved in the lesson. Inclusion of learners' prior knowledge in teaching thus increases the level of participation, and so is especially important in a study drawing strongly on social constructivism, such as the current one.

Even though prior knowledge is believed to be a foundation for new knowledge, Roschelle (1995) points out that prior knowledge can also be flawed. She indicates that prior knowledge may contain misconceptions and misunderstandings. It is thus important for the teachers to take into account that while prior knowledge can be a building block for new knowledge, it could also be a stumbling block. This alerts science teachers that when acknowledging learners' prior knowledge in their

classroom teaching it is important for them identify and diagnose such misunderstandings and correct them, since they may otherwise interfere with the structure of scientific knowledge the teacher envisages being built.

The Namibian curriculum via the NSHE syllabus acknowledges the importance of the inclusion of prior knowledge in science teaching and learning. It requests the focal point for teaching and learning to be based on the wealth of knowledge and social experiences that learners bring to school (MoE, 2010). It also states that learning at school must build on, extend and challenge learners' prior knowledge and experiences. As indicated earlier, in the Namibian curriculum, the topic of energy appears in the intended curriculum for Natural Sciences subjects from grade 4 up to grade 12. That suggests that in addition to their everyday experience of energy concepts (described earlier), grade 7 Namibian learners do have some prior knowledge about energy concepts from their previous grades completed at school.

Vygotsky (1978) indicates that prior knowledge has a significant influence in the way individuals construct meaning. In this study, identifying learners' prior knowledge in the topic of energy provided the baseline for their envisaged sense making through the intervention. Identifying learners' prior knowledge allowed me to characterize the language challenges relating to energy concepts which could then be focused on in the intervention. It also allowed me to characterise what learners already know and what they do not know about energy concepts, including misconceptions around energy concepts.

2.2.2.4 The complexity of the concept energy

The concept Energy carries significant value in science but it also seems to pose challenges in science education. Leggett (2003) indicates that energy is an abstract concept which poses challenges to teaching and learning. She highlights that the term energy is used as a unifying theme across many disciplines. Legget (2003) further indicates that when students encounter the energy concepts in the range of various disciplinary contexts they may become confused and may well carry the uncertainty with them into higher grades. As indicated earlier, in the Namibian curriculum for basic education, energy concepts appears in the syllabi for several subjects. Energy concepts being taught in various subjects provides supports for Legget's point, making it significant in the Namibian context.

However, there is also support for the idea that confusion about energy concepts begins even before formal education. Millar (2010) posits that learners come across the term energy before they come to school because this term is so commonly used in everyday language. Moreover, Millar (2010) points out that the way energy concepts are described in everyday language differs substantially from descriptions in scientific discourse and this may give rise to misunderstandings by the learners. Supporting Millar's ideas, Legget (2003) posits that the way energy concepts are described in everyday language do not fit comfortably with the scientific discourse. Legget (2003) further points out that some everyday talking such as 'wasting energy' and 'losing energy' do not describe energy in a scientific way, considering the law of conservation of energy in science. This highlights how everyday language poses challenges to learners when they learn scientific English.

Mathew (2014) indicates that some sources of confusion about energy concepts among the learners are caused by the information provided by science textbooks. He points out that some textbooks give scientifically incorrect information about energy concepts. Santa and Alvermann (1991) confirm the point by stating that some textbook authors write in a way that is often inconsistent with the educational goal of science. This alerts us that textbooks may carry non-scientific information and if this goes undetected then both science teachers and learners might be misled.

Moreover, some studies conducted in science education indicate that learners have common misconceptions about the concept energy. Trumper (1990) indicates that learners associate the concept energy with living things, Stead (1980) indicates that some learners describe energy as a fuel, Driver (1981) indicates that learners describe energy as a force and Clement (1987) through the study about overcoming students' misconceptions in physics identifies that students associate energy with movement. He also identifies that students classify energy as being recycled. The awareness of these misconceptions held by the learners informed my design of the pre test used in this study. I found it appropriate to test for specific misconceptions that learners have about energy concepts in order to attempt addressing them through the intervention.

2.3 Theoretical framework

2.3.1 Systemic Functional Linguistics

SFL is a theory that views language as a social semiotic, a resource that people use to accomplish their purpose by expressing meanings in context (Halliday & Martin, 1993). Fang (2004) expresses

that language has traditionally been viewed as set of rules, a vehicle that transmits thought and reality. From the systemic functional linguistic perspective, language is a semiotic tool, a set of resources the people can use for their actions and interactions. Halliday (1993) asserts that language allows its user to make certain lexicogramatical choices that are appropriate for them to accomplish their purposes in life. By choosing lexicogramatical items available in the language, speakers and writers are able to communicate within a type of register containing linguistic features different from other registers (Fang, 2004). Scientific English is also a register, a form of English which has its own words and grammar that differentiate it from other registers of English. It contains unique lexicon, syntax, semantics and structures (Fang, 2004).

According to O'Donnell (2012), SFL describes language as systemic and functional. SFL includes both syntagmatic relations, which is the ordering of linguistic elements into a large unit and paradigmatic relations that reflect language elements can be substituted for each other a particular context. These two relations are often glossed as "chain" and "choice". A systemic approach views language as having choice potential, with choices operating in a particular context. O'Donnell further indicates that SFL's approach to language recognizes that people use language as a tool for meaning-making by using "choice" as well as "chain". O'Donnell highlights that the language choices depend on the context and the lexicogrammar of choices and carries information about the socio-cultural background of the speaker.

With the view that language is systemic and functional, scholars identify that SFL offers language resources such as functional recasting and mode shifting, nominalization, lexical cohesion and lexical density (Jawahar, 2011; Gibbons, 2003), which have the potential for mediating science learning. Mohan and Beckett (2003) describe functional recasting as a language feature mediating between words and grammar improving learners' ability to use language as a resource for meaning making. Gibbons (2003) explains functional recasting as an ongoing process of recapping by the educator who presents or recontextualises learners' experiences and the events that they talk about in ways that fits the broader pedagogic objectives of the curriculum. Jawahar (2011) empirically identifies different types of functional recasting in science teacher talk, some of which contribute to developing scientific English. He explains that functional recasting types which lead to increasing technicality; accuracy and specificity mediate the shift towards scientific English while

functional recasting which leads to decreased technicality, accuracy and specificity mediates the shift towards everyday English, as illustrated in Figure 1 shown earlier.

From the SFL perspective, language resources are characterized by three features which are: field, tenor and mode (Halliday, 1993). Field refers to what is being talked or written about; tenor refers to the relationship between the reader and speaker or writer while mode refers to whether the language is written or spoken (Halliday, 1993). This study examines how the SFL approach of functional recasting mediates learning. The functional recasting approach used in this study was applied through talking activity and so it can be characterized under mode, but due to it being aimed at science learning it is also significant to field. I used functional recasting as an approach to possibly provide linguistic assistance to learners for moving from everyday English to scientific English through recasting of their responses.

SFL theory informed this study as it provided a language tool of functional recasting which was used to mediate science learning. Functional recasting occurs through interactions between a teachers and learners and interactions were observed around the classroom talk when the teacher was assisting learners to move from everyday English to Scientific English. Learning through interactions is a view of learning which is described by social constructivism theory and is discussed in the next section.

2.3.2 Social Constructivism

Social constructivism is a learning theory that views learning as a social product constructed through a process of negotiations mediated by language (Vygotsky, 1978). Kim (2007) describes social constructivism as a learning theory that recognizes learning as a social process which occurs when people are engaged in social activities. During linguistic interaction, people create and negotiate meaning using language as a tool. Those with more knowledge and skills can help others to advance their level of knowledge and skills. By doing so, more knowledgeable others help learners to move from one level of knowledge to another through a region which Vygotsky termed the Zone of Proximal Development (ZPD) (Vygotsky, 1978). Vygotsky (1978) describes ZPD as the difference between what a child can do without assistance and what a child needs assistance with.

Vygotsky (1978) indicates that human activities and cognitive functions are mediated and facilitated by tools, with language being the most common meditational tool. Mediation is a Vygotskian term describing the process of assisting a person to learn to do things on his or her own (Vygotsky, 1978). Gibbons (2003) comments that mediation is used in situations that involve people of different knowledge ability, and school classrooms are the major sites for this. In school classrooms teachers offer assistance to help learners appropriate what is to be learned. In this study the specific language mediation tool being explored was functional recasting.

SFL theory and social constructivism are complementary frameworks (Wells, 1994). Both theories view language as a tool that mediates learning. Social constructivism views language as a tool that people use to express their thought - a tool that facilitates thinking and SFL view language as a set of resources which people can use to make meaning. The SFL functional recasting notion is an appropriate linguistic approach in contexts which engage learners in social activities of discussions and dialogues, as well as in classrooms where science education happens mostly through talk. In the context of this study the social constructivist idea of the ZPD is viewed specifically in terms of the SFL mode continuum and the social constructivist idea of more knowledgeable others helping learners' movement through the ZPD via mediation tools is aligned to the teacher mediating learners' movement through the mode continuum via functional recasting.

CHAPTER 3: RESEARCH DESIGN

3.1 Introduction

The goal of my study is to investigate how ESL grade 7 Natural Science learners make sense of energy concepts when mediated through a systemic functional linguistic approach. In this chapter the research question, paradigm and the methods used to answer the questions are described. The research site and participants are also discussed. The data gathering techniques, aim of piloting the data gathering instruments, preparation of data and analysis of the findings are also discussed. Validity issues and ethical considerations are presented. The chapter ends with the limitations of the study.

3.2 Research goal and questions

3.2.1 Research goal

The goal of this study is to investigate the influence of systemic functional linguistic approach on learning the topic of energy to ESL grade 7 Natural Science learners. The main research question presented below was framed in order to achieve the goal of the study. It has been further divided into sub-questions.

3.2.2 Main research question

What is the influence of a systemic functional linguistic teaching approach,on Namibian Natural Sciences learners' sense making of energy concepts?

Sub-questions

1. What prior knowledge about energy concepts do Namibian grade 7 Natural Science learners have?
2. How do grade 7 Natural Science learners make sense of the concepts of energy when mediated through the use of functional recasting?
3. What factors enable or constrain grade 7 ESL Natural Science learners' progression through a mode continuum when mediated by functional recasting in English?

3.3 Research Paradigm

This study is underpinned by the interpretive paradigm, an approach aiming at understanding the nature of human experiences and which is concerned with individual's behaviours, attitudes, beliefs and perceptions during a certain process (Cohen, Manion & Morrison, 2011). Bertram and Christiansen (2015) comment that the interpretive paradigm is appropriate when a researcher intends to describe and understand how people make meaning of the world by interpreting events and situations. They also indicate that the purpose of the interpretive paradigm is "to develop a great understanding of how people make sense of the context in which they live or work (p. 6)".

In this study, the researcher aimed to develop an understanding of how ESL grade 7 Natural Science learners make sense of energy concepts when mediated through a systemic functional linguistic approach. In order to understand the phenomena investigated, the researcher had to interact with the people involved, talking to them, listening to them and sharing their experiences as described by Cohen, et al.(2011). This provides the researcher with an opportunity to generate rich explanation of what happened on the ground. The phenomenon was investigated in a specific context as will be described in the next section.

3.4 Methodology

This study is a qualitative case study. Gay, Mills and Airasian (2009) describes qualitative case study as a research approach which focuses on a phenomena in a bounded system. Kothari (2004) asserts that case study enables the researcher to develop broader understanding of a particular phenomenon through interacting with people in that situation. Furthermore, Cohen, et al., (2011) describes a case study as a specific instance of a bounded system providing unique examples of real people in real situations. Bertram and Christiansen (2015) also indicate that a case study aims to describe what it is like to be in particular situation.

This study is an experimental case study investigating the influence of a teaching intervention on learners' sense making. Bertram and Christiansen (2015) describe experimental research style as the research design used when the researcher wants to investigate the relationship between two phenomena or when the researcher wants to test claims about particular phenomena. There are three types of experimental style of research such as: single-group pre test and post test design, true experimental design and quasi-experimental design (Bertram & Christiansen, 2015) and this

study used the single-group pre test and post test to investigate how a functional recasting approach influence learners' make sense of energy concepts. Bertram and Christiansen describe single-group pretest and posttest as a design in which a researcher can test the influence of a particular factor with a single group. In this study, the influence of functional recasting was tested with a single group.

Gay et al., (2009) highlight that case study research can be characterized by the disciplinary orientation the researcher brings to the case study such as data collection techniques, approach to data analysis and data presentation. This case study employed qualitative data gathering techniques of pre test; stimulated recall interviews; observation; learners; journals and post test. The study employed qualitative analysis to gain an understanding of learners' experiences before, during and after the intervention.

Cohen et al., (2007) further stress that in a case study events and situations should speak for themselves other than being interpreted, evaluated or judged by the researcher. In this study a rich explanation in Chapter 4 includes excerpts as evidence and for deeper understanding of the case.

3.5 Research site and participants

3.5.1 Research Site

The case study was conducted at Omeva (pseudonym) combined school in Ohangwena region, in northern Namibia. The school is a state school situated in a rural area. It offers basic education from pre-grade up to grade 10. The school has an enrollment of 397 learners and most of them are from the surrounding villages. There is no community library in the area or internet facilities, hence learners at this school have little exposure to English outside of school.

The school facilities include 21 classrooms, a school hall, administration block and toilet facilities both for teachers and learners. The school has internet connection but there are only five computers and learners do not have access to them. There is no science laboratory, but there is a storeroom where science materials and equipment are stored. This indicates that learners at this school might have some experiences of science laboratory experiments. The school has no library but there is a storeroom where library books are kept and a teacher assists learners with borrowing books.

The school where the study was conducted falls in the region which was recorded to have performed poorly in the SAT when the test was first conducted. A local newspaper reports that Ohangwena region is one of the weakest performing region in the SAT when it was first conducted in 2010 (Susman, 2011). The school is also in the environmental context where language of learning and teaching (English) for many learners it is their second language.

The LOLT from pre grade up to grade 3 at the school is Oshiwambo and from grade 4 upward is English in accordance with the Namibia language policy document (Namibia, Ministry of Education and Culture [MoEC], 2001). Oshiwambo is the home language for most of the learners. There are 25 teachers at this school and only 3 teachers are non-Oshiwambo speakers. The majority of teachers at this school are qualified. They possess teaching qualifications as per the Namibian Qualification Authority (NQA) requirement.

3.5.2 Sampling

According to Bertram and Christiansen (2015) sampling is an exercise involving making decisions about participants, settings, events or behavior to include in the study. It is an exercise in which the researcher has to select the appropriate site and participants for the study that meet the requirement for the study.

Two forms of sampling were used in this study- purposive and convenience sampling. Bertram and Christiansen (2015) describe purposive sampling as a means of making specific choice about groups of people or objects to include in the study. Furthermore, Bertram and Christiansen (2015) describe convenience sampling as the means of choosing a sample which is easily accessible by the researcher. In this study, convenience sampling was used to choose the research site, which is within the reach of the researcher, so that the study would be viable.

Purposive sampling was used to decide on the participants. Grade 7 was chosen for the reasons that will now be presented. In the Namibia curriculum, grade 7 is the exit point were learners move from senior primary phase to junior secondary phase. Grade 7 is where learners cover the foundations of energy concepts for the next phase. It is also the phase where Namibian learners start to learn content subjects in English. In addition, Grade 7 takes part in the SATs.

I decided to conduct the study within my own teaching practice because I could not find a teacher with existing knowledge about functional recasting approach. I also hoped that involving my learners in this study would motivate them in their engagement in science and towards possibly improving their performance in science. Gay at el., (2009) point out that by selecting the research site a researcher needs to consider the need to access the site and the research sample as well as the expectation that the study must yield credible data. The fact that my learners don't see me as an outsider in their science classroom, allowed for them to possibly participate more freely. This contributed to generating more valid data.

The grade 7 class selected had 25 learners- 11 boys and 15 girls. Out of 25 learners, 24 learners' parents consented for them to participate/ take part in this study. One learner was not granted the permission from her parent to take part in the project. The benefit of the project to the learners, and the parents' rights to permit or not to permit their children to take part in the project were explained in the informed consent letter sent to the parents and so their decision was respected. The project activities took place in the afternoon at the time when learners are studying on their own and this learner decided to stay in the classroom although she was not taking part in the activities. I considered that this option would not single her out by her peers. Of the 24 participant learners, only 23 completed both the pre test and post test. One had been absent for a few days during the intervention and he also missed the post test. The data from pre and post test which was analysed in this study was obtained only from the learners that completed both pre test and post test.

From the 23 learners, four learners were purposively selected for stimulated recall interviews based on their responses in the pre test. One had shown few language difficulties and had answered all the questions. One showed some language difficulties and had answered most of the questions. The other two selected had shown many language difficulties and had left some questions unanswered. Stimulated recall interviews after the pre test, were used to get deeper insights into learners' scientific English weaknesses and strengths, and their prior knowledge about energy concepts. Stimulated recall interviews conducted after the post test were used to explore learners' sense making of the energy due to the intervention.

The researcher researched her own practice. To avoid bias due to being both teacher and researcher, the researcher used peer debriefing (Gay, et al., 2009). Gay et al., (2009) describe peer debriefing as a strategy employed when the researcher tests his or her growing insights through interactions with other professionals. They suggest that researchers can identify a critical friend or a colleague who is willing and able to help reflect on the research by listening, prompting and recording insights throughout the process.

In this study one science teacher at the school agreed to play the role of a critical friend. The critical friend has 15 years of teaching experience, holds a Basic Education Teachers Diploma (BETD), Higher Education diploma in Mathematics Education, Honours degree in Education, and is currently a registered Master of Education student. Although he currently teaches only Mathematics in grades 9 and 10, he is qualified to teach Mathematics and Science from grade 4 to 12.

3.6 Piloting

Maxwell (1992) indicates that a pilot study serves some of the same functions as prior research. He further indicates that one particular use of piloting in qualitative research is to generate an understanding of the concepts and theories. Christiansen and Bertram (2015) suggest more specifically, that pilot testing must be done before an instrument is used in a study.

According to Cohen et al. (2011), a researcher can pilot the pre test by giving it to a group of experts to review in order to determine the suitability and relevance of the items in the test. They further indicate that pilot of a pre test can also be done with test takers to get feedback on the clarity, ambiguities, readability level, omissions, duration and the complexity of the test. In this study, the pre test was first reviewed by the research supervisor and the critical friend using the curriculum requirement skills (basic competencies) and the literature to ensure content alignment.

The pre test was also piloted with different learners before it was administered to the actual target group. The sample of the students selected to participate in the pilot test was grade 7 ESL Natural Science and Health Education learners, from the state school in the same region and also located in a rural area. Most of the learners at this school come from the villages surrounding the school. Learners at this school had the same language context as the target group.

After the pilot test administration, individual students' responses were transcribed so that the analysis could be performed to refine the test questions For example, the piloting of the pretest questions revealed that learners had difficulties interpreting some of the components in pictures due to the image quality. The pictures in the pilot test were in black and white, and so some learners could not identify certain components in the pictures (see appendix A). Learners subsequently answered the related questions without referring to the pictures. Insight into this problem was sourced from an informal interview with the pilot participants. There was also a word misspelled in one of the questions -the word principle was spelled principal, and most of the learners answered with the name of their school principal. Results from the pilot helped the researcher identify and edit the typing errors as well as identify the need for printing images in colour, before administering during the main data collection with the target group. The researcher subsequently also decided to use pictures with colour in the worksheets used during the intervention. After revisions were made based on the reviews and learners' feedback, the pre test was administered to the targeted group.

3.7 Data gathering techniques

Gathering data is an approach used in educational research to collect data which holds answers to the research question (Cohen et al., 2011). The study employed a range of data gathering techniques to collect data: pre test, lesson observation, learners' journals, post test and stimulated recall interviews.

Table 1 summarises the data gathering techniques used and the purpose of each.

Table 1 Summary of the data gathering stages, methods and purpose

Stages	Method used	Purpose
Stage 1	Piloting the pre test	To assess the quality and suitability of the pre test questions
Stage 2	Pre test with target group	-To gain insights into prior knowledge learners had on the topic of energy including possible misconceptions -To identify difficulties with scientific English based on learners' responses
Stage 3	Stimulated recall interview 1	-To probe learners' prior knowledge about energy concepts, and diagnose related misconceptions -To probe scientific English difficulties in learners' responses, and diagnose related misconceptions
Stage 4	Lesson presentation, and observation	-To gain insight into learners' sense making when the teacher use functional recasting during the lesson presentation -To gain insight into what enables or constrains learners' development of scientific English for the SFL intervention
Stage 5	Learners' journals	-To identify learners' sense making in the learning of energy concepts -To identify what enable or constrain learners' development of scientific English
Stage 3	Post-test	-To identify learners' overall sense making -To determine what enables or constrain learners' development of scientific English
Stage 6	Stimulated recall Interview 2	-To gain insight into learners' sense making of energy concepts -To probe into enabling and constraining factors for learners making sense of the energy concepts

I will now discuss the data gathering techniques in more detail.

Bertram and Christiansen (2015) describe a pre test as a "baseline measure which gives research a measure of the depended variable before the subject of the experiment receives the special treatment" (p. 51). While acknowledging that humans involved in a study are not subjects, and that this study is not a (post)positivist study, it employed a pre test to gauge learners' prior knowledge about energy concepts. The pre test was developed (see Appendix B) with consideration of the Namibian context (curriculum requirements as stated in the NSHE syllabus 2015 (see Section 2.1) and the common misconceptions some learners have about the concept energy as highlighted in the literature (see section 2.2) and also the specific language challenges.

After the pre test, a stimulated recall interview1 was conducted to probe learners' prior knowledge, misconceptions and language challenges of the energy concepts identified from the pretest. The data collected with these tools was aimed to provide answers to research question 1 and also to inform the intervention. The data would reveal specific scientific English challenges facing

learners, to be focused on during the intervention. It would also reveal misconceptions facing learners and any lack of knowledge about some energy concepts which would be addressed during the teaching intervention. For stimulated recall interview1 guiding questions (see Appendix C).

The study employs lesson observation as one of the data gathering techniques. According to Bertram and Christiansen (2015) observation allows the researcher to collect firsthand information. They emphasise that observation helps the researcher to generate information from a real situation or context. This technique was used to investigate the influence of functional recasting on learners' sense making of energy concepts, during the lessons. In this study I presented the lessons while the critical friend videotaped the lessons. Five parallel lessons were presented. For each lesson, a lesson plan was prepared to guide the presenter. All five lessons recorded were transcribed by me. Transcripts of the video recorded lessons helped me to apply discourse analysis in order to characterize the presence or absence of learners' sense making through talk.

After presenting each lesson, I watched the video recording of the lesson and completed the observation schedule (see Appendix D). The observation schedules were discussed with the critical friend to validate the analysis since I was both the researcher and teacher. The data from the observation provided insight into learners' sense making about energy concepts which answered the research question 2. The data from observation also provided insight into what enables or constrain learners' sense making of energy concepts when mediated through functional recasting which answered research question 3.

The study also employs the post test as one of the data gathering techniques. The post test questions were the same as in the pre test (see appendix B and Appendix E). According to Bertram and Christiansen (2015) "the best way to test whether the one factor has a particular effect is to use a single group pretest and posttest design (p. 51)". The post test technique was used to identify shifts in learners' sense making of the energy concepts from the initial understanding evident from the pre test. Bertram and Christiansen (2015) indicate that while an intervention can cause an improvement in the post test result, there might be critique that factors such as learners' exposure to the pre test might also cause some improvement. In this study a comparison between pre test and post results was not made to see the improvement in terms of marks in general but to bring to

the fore possible scientific language shifts in learners' responses after the intervention, as an indication of sense making.

After the post test, the stimulated recall interview 2 was conducted to probe learners' responses to the post test. The data from the post test and from the stimulated recall interview 2 triangulate with the data from the observation to provide insight into learners' sense making of the energy concepts which answered the research question 2. It also revealed what enables or constrains learners' sense making of energy concepts when mediated through functional recasting, which answered research question 3. In this study stimulated recall interviews were done by me as the interviewer, viewing the learner's answer script with them and asking questions based on the responses by the purposively selected learners. For stimulated recall interview2 guiding questions (see Appendix F).

During the intervention, learners were requested to keep reflective journals for recording their reflections after every lesson (see appendix G). Gay et al., (2009) describe learners' journals as tools that can provide teachers with a window into learners' daily classroom experiences, which need to be considered for teaching practices. In this study learners' journals were used get insight into what enabled or constrained learners' sense making of energy concepts when mediated through functional recasting. The data from learners' journals triangulate with the data from observation, post test and stimulated recall interview2 to provide answers to research question 3.

3.8 Data preparation

All five lessons presented during the intervention were video recorded and were transcribed by me. Transcription enabled subsequent analysis of the classroom utterances produced during the intervention. All stimulated recall interviews were also audio-taped and transcribed by me. After transcribing, the data was reduced to remove the utterances which were not relevant. Bertram and Christiansen (2015) describe data reduction as a process of selecting, focusing, simplifying, abstracting and transforming the data that appears in written field notes or transcription. In this study some teacher's and learners' utterances such those around greeting or non-teaching conversation were removed from the interview transcripts prior to analysis. The teacher's utterances for classroom discipline management from the observation transcripts also did not form

part of the analysis. This was done for the researcher to select and focus on the data which talks to the research question.

3.9 Data analysis

According to Cohen et al. (2011) data analysis is a process of organizing, shifting, sorting, reviewing and reducing data to make sense of it. Gay et al., (2009) describe qualitative data analysis as a process of summarizing data in a more accurate and dependable state that leads to the presentation of understandable findings. All the data sets for this study were analysed qualitatively as necessitated by the nature of the research questions and the interpretive paradigm.

The data collected in this study consisted of lesson observation transcripts, stimulated recall interview transcripts, pre and post test answer scripts, observation schedules and learners' journals. Bertram and Christiansen (2015) describes inductive analysis as involving the researcher eliciting categories, patterns and themes from the data while deductive analysis involves analyzing the data using codes and themes drawn from the theory or literature. The data sets in this study were analysed both deductively- in consideration of existing literature and theory, and inductively - to allow for extension of existing literature findings and theory.

The data from the pre test and from the stimulated recall interview1 was analysed inductively using themes from the curriculum about the topic energy, to identify learners' prior knowledge. It was also analysed deductively using the themes from the literature to identify learners' misconceptions and language specific challenges.

The data from observation was analysed both deductively and inductively. The discourse analysis involved coding the teacher's and learners' utterances which were related to learners' being able to construct and deconstruct technicality. Although the intervention was focused on the possibility of shifting learners along the mode continuum, the analysis did not only look at sense making in terms of language use because I did not want to conflate learners simply mimicking my scientific English, with sense making. Sense making has a broad range of indicators, including those specifically related to language. My analysis therefore included a broader range of sense making indicators. The codes helped me to sort data into categories and themes.

In learners' written work such as responses to the pre test and the post test, I analysed learners' responses using the themes from the literature. Stimulated recall interview 2 transcripts were analysed to identify what enables or constrains sense making of energy concepts when mediated through functional recasting. Observation schedules and learners' journal were analysed to validate the findings from the lesson observation transcripts.

3.10 Validity of the study

According to Gay et al. (2009), validity is the measure of accuracy of what the study intends to measure. Based on that definition, a research method can be regarded as invalid if the data does not reflect what they were intended to measure. Therefore, researchers need to justify their study validity by defending accuracy and credibility (Gay et al., 2006). Bertram and Christiansen, (2015) assert that validity and trustworthy of the study can be enhanced when the researcher uses various tools to collect data. It can also be reached when there are two people observing the same situation at the same time, and also when the instruments are tested before use (ibid). In this study, the pre test and post test, lesson plans and worksheets used during the intervention were all compiled by the researcher and checked by the critical friend. Observation schedules were also completed by the researcher and validated by the critical friend.

Cohen et al., (2011) describe the use of various data gathering techniques in a research study as triangulation. Gay, et al., (2009) defined triangulation as a process of using various methods of collecting data to obtain a broader picture of the study. Using various methods of collecting data allows the researcher to see if the data collected from the tools correlates or contradicts each other (ibid). All these authors assert that triangulation is a powerful method to contribute to validity in a particular qualitative research.

In this study, the pre test instrument was piloted before being administered to the targeted group. The pilot report for the pre test was compiled by the researchers in collaboration with the critical friend. The report from analysis of the data from piloting the test informed the researcher on how to improve the test questions before collecting the data. Lesson plans and worksheets used during the intervention were also designed in collaboration with the critical friend. The critical friend verified the observation schedules compiled from the video records of the lesson taught.

Stimulated recall interviews were audio recorded and lesson presentations were video recorded to enhance accuracy of the transcripts as advised by Bertram & Christiansen (2015).

3.11 Ethical considerations

Informed consent was requested from relevant authorities and from the participants before the study commenced. I sought written informed consent from the Director of Education (Ohangwena region) to conduct my study in the region (see appendix H). I also received informed consent from the school principals (for the two schools), the grade 7 Natural Science and Health Education teacher who was my critical friend and the parents of the grade 7 learners who participated in this study (see appendix I, J and K). The content of the consent letters to the parents was first explained to the learners who were in turn requested to explain it to their parents. The consent letters to the parents were written in English and translated in Oshiwambo (a local language) because some parents have difficulties understanding English (see appendix K).

Furthermore, all the participants were informed about their rights to participate in the research study and were informed that they were free to withdraw from the study at any time if they felt uncomfortable. To maintain anonymity, the identities of the participants were protected. The real names of the participants and their schools were replaced with pseudonyms.

3.12 Limitations of the study

In conducting a study, a researcher might experience challenges that may hinder the effectiveness of the study process. Some challenges may be beyond the researchers' control. Such challenges are referred to as limitations of the study (Gay et al., 2009). Gay et al. (2009) further describe limitations of a study as aspects of the study that may negatively affect the results of the study. Generalizability is a commonly mentioned limitation to case studies (Bertram and Christiansen, 2015). This study was conducted with learners in the junior primary phase so the findings shed light on whether the systemic functional linguistic approach of functional recasting helps learners to make sense of the energy concepts in that phase and in a particular geographical and linguistic context. Generalizability of the results for this study is limited due to the very specific context in which it was conducted. However, the intention of the study was not to generalize but to understand what is happening on the ground. Despite the limitation of limited generalizability, it was still

worthwhile to carry out this study because the rationale and potential value of the study warranted it being undertaken.

CHAPTER 4: PRESENTATION OF FINDINGS, AND DISCUSSION

4.1 Introduction

This chapter presents the findings and the discussion. As indicated earlier, findings from the pre test and the stimulated recall interview1 were obtained to answer research question 1 and provided the baseline contextual data to inform the intervention. The data from observation, post test and stimulated recall interview2, and learners' journal were analysed towards answering research question 2 and 3.

4.2 Baseline contextual findings

4.2.1 Curriculum topic-specific findings in relation to prior knowledge

The finding about grade 7 learners' prior knowledge is presented in two separate tables. This is because some questions in the pre test were language-specific. The tables are not separated as a way of separating science and language but to indicate how each set of data informed the intervention (see appendix F).

Table 2 Curriculum topic-specific findings in relation to prior knowledge.

Topic	Questions	Codes	Prior knowledge Theme
Defining energy	1,13, 14, 17	-Learners defined energy as power or ability to do work -Learners indicated that energy is the same as force or power -Learners associated energy with living thing -Learners describe energy as recycled	Misconception about the concept energy
	12, 13 16	-Learners indicated limited knowledge about the principle of energy -Learners indicated limited knowledge about fuels as energy sources -Learners indicated limited knowledge about the energy conversion	Lack of knowledge about energy concepts
Energy sources and how they are used	7, 11	Learners were able to identify sun and food as energy sources	Knowledge about energy concepts that learners have
Forms of energy	2, 3, 4, 5, 6, 8(c), 8 (d)	-Learners stated that kinetic energy is energy of motion or movement -Learners stated potential energy is the stored energy	
Renewable and non renewable energy sources	2, 3, 4, 5, 6, 8 (a), (b),	-Some learners were able to classify renewable and non renewable energy resources	
Energy Conversions	9	Learners described how energy is transferred from the sun to the plant and from plant to the person	

The data revealed that the participant learners did have misconceptions about the concept energy as reflected in their responses to question 1, 13, 14 and 17 of the pre test. In their responses to the pre test questions, most of the learners defined energy as power to do work. Also, most of the learners described energy, power and force as being the same thing. For example one learner described energy, power and force as follows: "*energy, power and force are same thing because they all talk about abilitiness* [SRI1,L1]". The misconception about energy concepts seems to be rooted in other subjects. All learners interviewed indicated that they have learnt some energy concepts in the Design and Technology subject. One learner said *"I was taught in Design and Technology that energy is power or ability to do work"[SRI1,L2].*

The data also revealed that learners associated energy with moving living things. During the interview one learner stated "*energy is only found in living things because livings are the only organisms that move"[SRI1,L1].*The data revealed that learners describe energy as being recycled. Learners interviewed indicated that energy can be recycled because energy resources can be saved for later use. One learner gave an example that energy resources such as petrol and diesel are being saved when the car is parked and used.

The evidence of learners having limited knowledge about fuels as sources of energy was reflected in the learners' responses to question 14 of the pre test. One learner interviewed, specified that he could not describe whether energy is a fuel or not because he has no idea what a fuel is.

Learners appeared to have little knowledge about other forms of energy such as heat and light. The evidence of learners' limited knowledge about heat energy and light energy was reflected in the learners' responses to question 5 and 6 of the pre test. From the 4 learners interviewed, all indicated that they guessed the answer to question 5 and 6.

The data revealed that learners have some knowledge about energy sources. The evidence of energy sources being familiar was reflected in the learners' responses to question 7 and10 of the pre test. The majority of learners identified the energy sources from the picture shown in the test. Learners interviewed, indicated that they were taught about energy sources from the previous grades. In an interview one learner said "*we are taught that solar make electricity from the sun*" [SRI1,L5]

The data revealed that learners have knowledge about some forms of energy as reflected in learners' responses to the questions 2, 3 and 4, of the pre test. Most learners identified potential energy as the stored energy and identified kinetic energy as the energy of movement. Learners interviewed indicated that they have acquired the knowledge about potential energy and kinetic energy from the Design and Technology subject.

Learners appeared to have knowledge about renewable and non-renewable energy resources. The evidence of renewable and non renewable energy resources being known by the learners were reflected in the learners' responses to question 8(a), 8(b) and 11 of the pre test. Most learners classified the renewable and non renewable resources accordingly but did not provide the reason, although it was required. Some learners indicated that they were taught about these concepts in the same subject from previous grades.

The data also revealed that learners have some knowledge about energy conversion. The evidence of energy conversion being known was reflected in the learners' responses to question 9 of the pre test. Most learners have described how the energy is transferred in the picture using their own words. During the interview, when I asked one learner how she described the energy conversion, she said "*I have just answered according to the arrows. Like that energy from sun go to the plant and from the plant it go to the person and from food to the person and cause the person to run"[SRI1,L4].*

4.2.2 Language-specific challenges in relation to prior knowledge

Some questions in the pre test were language specific and the following table presents the summary of those findings.

Table 3: Language-specific challenges in relation to prior knowledge

Register of English	Questions	Findings
Everyday	7	Learners were not able to explain the terms "energy source"
	8	Learners were not able to rewrite the sentences using their own words
Scientific	9	Learners were not able to describe the energy conversion using technical terms
	10	Learners were not able to explain the energy uses, using technical terms

The data from the pre test and the stimulated recall interview 2 revealed that most of the learners could not explain the technical terms using their own words as reflected in the learners' responses to question 7 and 8 of the pre test. For question 7, some learners gave an explanation using the same words for the term and some learners explained using examples. For example, one learner explained the term energy source as follow: "*Energy source is the way to get energy from source*" [PRT,L6]. Another explained the term energy source by saying: "*I mean things that you get to get energy, like the sun or wind"* [SRI1,L2]

Further evidence that learners could not explain the technical terms was reflected in their responses to question 8 of the pre test. Most of the learners could not use their own words to rewrite the sentences. For example, one of the pre test question asked learners to rewrite the following sentence using their own words: **"most of the energy we capture on earth originates from the sun"**. One learner rewrote the sentence as: "*many of the power we capture on earth originates from the sun"* [PRT,L1] the other learner rewrote it as, "*because we get energy from the sun*" [PRT,L7]

The data also revealed that learners could not explain science activities using technical terms as reflected in the learners' responses to question 9 and 10 of the pre test. For question 9, most of the learners were able to explain the energy conversion from the picture but they lacked technical terms. None of the learners could explain the energy conversion using the technical terms. For example one learner described the energy conversion as show in the illustration: *A) the sun gives the plant energy to grow, B) the plant is eaten by the people and animals to get energy, C) the people and animals get energy to do exercise e.g running* [PRT,L6].

4.3 Discussion of baseline data findings

The baseline data were obtained from the pre test and stimulated recall interview1 and are discussed in order to provide answers to research question 1 and also to inform the intervention.

4.3.1 Prior knowledge about energy concepts that ESL grade 7 NSHE learners have

The findings from the pre test and the stimulated recall interview1revealed that learners come to school with some prior knowledge about energy concepts. The findings revealed that earners have acquired some knowledge about energy concepts from previous grades in the same subjects and also from other subjects. The finding reflected what is stated by Roschelle (1995) - that learners

come to school with much knowledge that they have acquired from home interactions or from previous grades. According to Millar (2010) the term energy is commonly used in everyday talking and learners may come across the term energy before they come to school. This highlights why learners come to school with the diverse prior knowledge about energy concepts.

Among the prior knowledge about energy concepts, some are misconceptions. As indicated earlier most of the learners defined energy as power to do work and they indicated that energy, power and force are the same thing. They also associated energy only with living things. The misconceptions revealed in the finding are consistent with some mentioned in other studies. Trumper (1990) indicates that learners associate energy with living things, while Driver (1981) indicates that learners describe energy as a force and Clement (1987) through the study about overcoming students' misconceptions in physics identifies that students describe energy as a fuel and associate energy with movement.

The finding from the curriculum-specific topics informed me about the concepts which learners have better scientific knowledge about and the concepts that learners have limited scientific knowledge of, in addition to specific misconceptions. These findings informed my teaching intervention so that it was contextually relevant.

4.3.2 Language specific challenges about energy concepts

The findings from both the pre test and the stimulated recall interview 2 revealed that learners were not able to explain some technical terms. The finding also revealed that learners were not able to explain using technical terms. According to Fang (2004) learners who do not understand the meaning of technical vocabulary will have difficulties to construct scientific knowledge and will not be able to communicate scientific information in their own writing.

Wellington and Osborne (2001) pointed out that science teachers are language teachers. This reminds science teachers of their responsibility to apprentice learners into specialised language of science. For the learners to be able to explain technical terms or to be able to explain using technical terms, teaching methods which recognise science as a language (with technicality as its most noticeable feature) need to be applied. The language specific findings influenced my intervention focus being on the technicality aspect of scientific English. In my intervention I employed an

approach of functional recasting to specifically help learners to be able to construct and deconstruct technicality. The findings from the intervention are discussed next.

4.4Findings after the intervention

The intervention included the teaching and learning activities aimed at the development of learners' scientific understanding and use of scientific English. In each lesson an activity was designed for the learners to discuss in groups with each group doing a different task. After the group discussions, a learner from each group presented and functional recasting was applied by the teacher signaling for the learners to explain, giving learners access to technical terms, asking for other learners to contribute and shaping learners' responses as informed by Gibbons (2003).

After the intervention, the transcripts of the video records for the lessons, observations schedules, post test answer scripts, stimulated recall interview and learners' journals were analysed to determine the influence of functional recasting on learners' sense making and the factors enabling or constraining learners' progression through the mode continuum when mediated by functional recasting in English. The finding from the post test was compared with the pre test findings to identify shifts in how learners constructed and deconstructed technicality.

The data from the post test, stimulated recall interview, observation and learners journals were analysed and descriptive label were used as codes. The codes that are similar were grouped and themes assigned. The following table presents the findings on learners' sense making of energy concepts and some related excerpts.

Table 4: Themes, codes and excerpts showing learners' sense making of energy concepts

Theme	Code	Excerpt	Source
Technicality • Deconstructing technicality • Constructing technicality	Able to explain technical terms	Energy source is the energy that transferred the temperature Energy source refers to where energy comes from	PRT,L7 POT,L7
	Able to explain using technical terms	water – use to drink Plant – get energy from the sunlight Food – we get energy from the food wood – wood is used to give heat energy to cook or light Candle is used to lighting and heating Sun – sun give heat to dry clothes and light energy to make the plant to make their own food Water – water is used to generate electricity example Ruacana	PRT,L2 POT,L2
Comprehensible output	Making contribution to others responses Using others feedback to repair their responses	When one group was presenting, learners from the groups that did not present were whispering to one another. They were informing the secretary for the group to change some of their answers.	OBS
Gestures	Demonstrating the energy possessed by objects in space	A Learner from one group pulled her hands apart demonstrating to others in a group that rubber bands of a catapult stretch. She also explained that rubber bands have the elastic potential energy because they stretch.	OBS
Clarification of ideas	Asking questions	The teacher says that renewable energy resources are resources that replace, did the sun replace?"	LJ
	Giving scientific reasons	Teacher: Ok. You indicated that energy is not found only in living things. What is your reason? Learner: yes because energy is also in fuels but fuels are non living things Energy is not a fuel because fuels are sources of energy	STR,I2 POT,L4

4.4.1 Indicators of learners making sense of energy concepts

The data from lesson observation, post test, stimulated recall interview 2 and learners' journals revealed learners making sense of energy concepts through constructing and deconstructing technicality, comprehensible output, making gestures and through clarification of ideas.

4.4.1.1Technicality

After the intervention, all the learners interviewed were able to explain the term 'energy source' using their own words. This is reflected in their response to the same question when it was asked during the interview. Analysis of post test responses revealed that most of the learners were able to explain using technical terms. The data revealed that most of the learners were able to describe energy conversion using technical terms. The evidence of learners being able to explain science activities using technical terms was also reflected in the collaborative interaction that occurred during the teacher-guided reporting.

4.4.1.2 Comprehensible output

Comprehensible output is a theme drawn from Scott (2008) as an indicator of learners' making sense through talking. The data revealed that learners were observed making contributions in which meanings were made visible. The evidence of learners making contribution to other learners' responses is reflected in the video record transcripts of the lesson and also in the observation schedules. This indicator was observed during the teacher-guided reporting. The following excerpt shows the evidence of learners making contributions.

Excerpt

Teacher: OK. Look at the picture, what does it shows? What exactly do you see in the picture?
Learner: (No responses)
Teacher: Let all of us look at the picture B. What is shown in the picture? What does the picture shows?
Learner: (no response)
Teacher: Is it the gas or a cylinder? Is it a gas or a cylinder? Who can help?
*Learner: The cylinder(**a different learner responded**)*
Teacher: The cylinder, the container in which the natural gas is kept. And these are the cylinders which are connected to the what? Where do we connect these cylinders?
*Learner: Freezer (**a different learner responded**)*
Teacher: To the freezer or to the stove. That means the natural gas is used for what?
Learner: Natural gas is used to cook
Teacher: Good. That means natural gas is a source of energy used to do what? Can you say it again?
Learner: Natural gas is source of energy used to cook
Teacher: Natural gas is used to produce heat energy for cooking.

The excerpt illustrates that the learner was presenting what they have discussed in their group. The teacher functionally recasted the learners' responses, providing access to technical terms. The teacher involved the whole class when she realized that the learner could not respond. It was at this point that other learners contributed to the conversation.

Through the observation schedules the data revealed learners were using feedback received by others to correct and shape their own responses. The data revealed that during group presentations learners from the groups that were yet to present were whispering to each other and changed their answers to reflect the recasting provided to the groups that had presented. So functional recasting which was meant to shape the responses for individuals during the teacher guided reporting was also used constructively by other learners.

4.4.1.3 Gestures

The data from observation schedules revealed that during group discussion some learners were using gestures to explain to others. For example, some learners used gestures to demonstrate the form of energy possessed by the ball on a hill and the form of energy possessed by the rubber bands of a catapult. The evidence of learners using gestures to explain energy concepts was only revealed through observation.

4.4.1.4 Clarification of ideas

(i) Reasoning

The data revealed that learners were able to reason scientifically. The evidence of learners able to give scientific reasons was reflected in the learners' responses to the post test question 11 in which most of the learners were able to give scientific reasons in contrast to the results from the pre test. The data revealed that in the pre test learners were able to classify the energy resources as renewable or non renewable but they could not provide scientific reasons. The following table presents the answers of one learner to the same question in the pre test compared with the post test.

Table 5. The comparison of the learner's responses to question 11 of the pre and post test.

Pre test responses	Post test responses
• *wind energy – is the energy that have all* • *Petrol- is the petrol of the car* • *Coal – is the plastic that have oil seal* • *Solar panel- is the panel of cooking and see* • *Natural gas- is the natural gas that you use to put in pot [PRT,L6]*	• *wind energy- non renewable because cannot be replaced* • *Petrol- non renewable because the petrol go in car cannot be replaced* • *Coal – non renewable because cannot be replaced* • *Solar panel- non renewable because cannot be replaced* • *Natural gas- non renewable because cannot be replaced[POT,L6]*

The table shows that the learner's responses in the post test align more to scientific English than their response to the same questions in pre test. The further evidence of learners being able to give scientific reasons was reflected in the learners' response to question 13, 14, 15 and 16 of the post test. Compared to pre test results, most of the learners provided scientific reasons. Data from the stimulated recall interview revealed that learners were also able to give reasons to support their claims.

(ii)Asking questions

The data from learners' journals revealed that learners had questions to ask the teacher. Most of the learners included questions about the concepts which they find challenging and they wanted the teacher to clarify. The excerpts present a number of questions which were common in the learners' journal books.

- *The teacher says that renewable energy resources are resources that replace, did the sun replace?*
- *How electricity is generated from coal? What I want is the teacher to explain how electricity is from coal*
- *Explain more about how the wind produces electricity and how dead organisms form coal and found underground.*
- *Coal, what is a coal? Can teacher explain?*

- *How can energy be recycled? I do not understand this.*

The excerpts indicate that learners had lot of questions about the energy concepts that they seem not to understand well. These questions appeared only in the learners' journals but none of the learners asked during the lesson, although opportunities were provided for them to ask.

4.4.2 Enabling factors

As indicated earlier, the data from lesson observation, post test, stimulated recall interview 2 and learners journal were analysed to identify factors that enable or constrain learners' sense making, to provide answers to research question 3. The following table presents the factors identified to have enabled or constrained learners when they make sense of energy concepts. Each theme will then be discussed.

Table 6: Themes and codes for the enabling and constrain factors

Theme	Factors	
	Enabling	**Constrain**
Dialogic discourse	Dialogic Talk	
Disposition	Positive attitudes • Interest • Confidence	Negative attitudes • Learners do not want to speak out aloud • Lack of confidence
LOLT different from mother tongue		• Lack of proficiency

4.4.2.1 Dialogic Discourse

The data revealed that the dialogic talk between the learner and the teacher enabled learners to shape their responses using scientific English. The evidence of the dialogic talk enabling learners to shift towards scientific English is reflected in the video transcripts of the lessons during the collaborative interactions between the learners and the teacher through the discourse analysis. The data revealed that dialogic talk created a platform which enabled learners to learn. The following excerpt presents a dialogic conversation and the evidence of a learner being able to use technical terms to explain.

Excerpt

Teacher: Ehh, A person talking he or she produces the sound. How energy conversion takes place in a person talking? From what to what form?
Learner:Sound energy
Teacher: Sound energy. Ok there is energy transferred in the form of sound. Sound energy is transferred from what form of energy which is stored in the body?
Learner: Chemical potential energy
Teacher: Ok. Please speak up.
Learner: Chemical potential energy
Teacher: Very good. Ok. Now, describe the energy conversion in a person talking?
Learner: is chemical potential energy to sound energy
Teacher: Very good. Thank you very much. Can you clap hands for him?

4.4.2.2 Disposition

(i) Interest

The data revealed that learners showed some positive attitudes which enabled them to learn from the teachers' functional recasting. The data from learners' journal indicates that learners were interested to learn the topic of energy. The evidences of learners interested in the topic were reflected in the comments which appeared common in most of the journals. The following excerpts present the comments which appeared common in the learners' journal books.

- *I like this topic*
- *The lesson was very interesting*
- *The lesson was very nice*

(ii) Confidence

The data revealed that learners had confidence in their learning progress. Learners' confidence was reflected in the comments made by most of the learners in their journal books. The following excerpts present some of the comments made by the learners in their journals.

- *I will pass this topic.*
- *I understand everything*
- *I understand what is energy, energy sources*

4.4.3Constraining factors

4.4.3.1 Different LOLT from learners' mother tongue

The data from observation revealed that learners lack proficiency to explain and communicate in the LoLT. Learners' lack of proficiency was observed during teacher-learner interaction. Learners were presenting their responses in multiple starts and stops, as described by Crawder (2004) due to lack of vocabulary in the language of learning and teaching. The following excerpt presents the evidence of a learner being challenged by the LOLT as he was presenting his response.

Teacher: OK. What is petrol used for?

Learner: petrol is used for....petrol used in....used for cars [VRT]

The data revealed that learners were challenged by LOLT and they wanted the teacher to code switch. In their journals, most learners indicated that they want the teacher to speak in both English and Oshiwambo for them to understand. For example, one learner wrote "*the teacher could help me to understand English.*" The other one wrote "*If teacher explain in English and in Oshiwambo I will understand".* Also during the interview one learner indicated that lack of proficiency in English limits his ability to explain his point.

4.4.3.2 Disposition

The lesson observation schedule data also revealed that learners are not comfortable responding when the teacher indicated the need for them to reformulate or rephrase their responses. The data revealed that learners stopped the conversation when the teacher signaled for them to reformulate or to rephrase their responses. The data revealed that some learners do not want to speak out aloud as evident from observation and learners' journals. The observation data revealed that some learners spoke very softly even after the teacher encouraged them to speak louder. The attitude of some learners not speaking aloud frustrated other learners. One learner wrote in his journal: "*I want learners to speak loud, because I want to learn what they say".* The data revealed negative attitudes which could constrain their learning as reflected in the data from the observation schedules indicating that some learners had a tendency to laugh when others made mistakes. The act of laughing persisted even after the learners were told to stop and to appreciate everyone's contribution.

4.5Discussion of findings from the intervention

4.5.1 ESL grade 7 NSHE learners' sense making of energy concepts

The finding revealed that there was a shift in the learners' response in the post test compared to pre test. The findings revealed that learners were making sense of energy concepts through deconstructing and constructing technicality. The findings also revealed that learners were making sense of energy concepts through making comprehensible output. Some learners were observed taking over the responsibility of clarification and they were also observed using others feedback to correct their responses. This finding reflects what is highlighted by Scott (2008) that when dialogic talk is employed in the class learners treat the utterances of others as thinking devices. Scott (2008) further highlighted that when dialogic talk is between the teacher and the learners, other learners react to show that they are making meaning out of the talk.

Other findings revealed that learners were making meaning of energy concepts through gestures. The indicator of learners making sense of energy concepts using gestures occurred only in special cases. It only occurred when learners were demonstrating the energy concepts which have to do with positions and movements. The use of gestures as a sign of sense making is explained by Crowder (2004) and Rahm (2004). Rahm (2004) explains that learners' actions and talk show what they have learnt and how they have accomplished learning.

Asking questions was also revealed as indicators of learners making sense of energy concepts in this study. In their journals, learners wrote some of their reflections in the form of questions. The findings showed that learners were making sense of energy concepts and they wanted the teacher to clarify some concepts which were still not clear to them. The finding is aligned to the comment by Audet, et al. (1996) that journals are vehicles that provide evidence of learners' making sense - the platform where learners make their knowledge public. The data from this study revealed that from learners' journal provided useful insight into what was happening in the mind of the learners during the intervention.

4.5.2 Factors enabling ESL grade 7 NSHE learners' sense making

Discourse analyses in this study indicated dialogic talk as the enabling factor of learning. The findings revealed that dialogic talk enabled learners to learn. The teacher's recasting enabled learners to make meaning of what was being talked about. Dialogic talk helped learners to shift

from everyday English to scientific English. Dialogic talk is an example of social interaction involving a teacher recasting learners' responses, shaping them into scientific English. Dialogic talk being an enabling factor of learning in this study reflects the view of social constructivism theory which describes learning as a social activity which occurs through collaborative interactions (Vygotsky, 1978). It also reflects the role of language being the common mediational tool of learning.

The finding revealed that learners have shown interest in the topic of energy. The finding revealed that learners have shown confidence in what they were learning. According to Hodkison, Beista and James (2008) showing interest and being confidence are indicators of some types dispositions which can enable and facilitate learning. e have then The positive attitudes of learners being confident and being interested might enable them to learn.

4.5.2 Factors constraining ESL grade 7 NSHE learners' progress

The finding revealed that learners might be constrained to learn by certain negative attitudes to mistakes. The finding revealed that some learners laugh when others make mistakes. An act of laughing at others when they make mistakes might have prevented some learners from learning.

The finding also revealed that learners were constrained by the LOLT. In some studies conducted in Namibia, LOLT has been reported as a constraining factor for both teaching and learning (Benjamin, 2004; Frydman, 2011; Namupala, 2013). The finding for this study contributes to the findings from other studies which indicate that LOLT which is not their mother tongue, constrains ESL learners' learning of science.

Furthermore, the finding revealed that some functional recasting types prompting them to correct their responses make learners feel uncomfortable, possibly due to lack of proficiency in the LOLT. This highlights that ESL learners are faced with a challenge of learning scientific English in the language which is not their mother tongue. It is thus important for the science teachers to note that ESL learners experience challenges with both everyday English and Scientific English.

CHAPTER 5: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 Summary of findings

The aim of the study was to investigate how ESL grade NSHE learners make sense of energy concepts when mediated through functional recasting. The study was motivated by learners' poor performance in the SATs examination and by my own teaching experience in the classroom. The findings of the study have helped me to get more insights into what prior knowledge ESL grade 7 Natural Science and Health Education learners have about energy concepts, how learners make sense of energy concepts when mediated through functional recasting and the factors which enable or constrain learners' progression through a mode continuum when mediated by functional recasting.

The study was conducted at Omeva combined school and focused on ESL grade 7 Natural Science learners. The study used a qualitative method to generate data from pre and post test, stimulated recall interviews, lesson observations and learners' journals. Convenience sampling was used to select the school and purposive sampling was used to select the learners interviewed. Ethical issues were considered through getting informed consents from relevant authorities and also from the participants. Ethical consideration was also taken into account through assuring anonymity.

I found out that learners in the Natural Science class had some knowledge about energy concepts which they have acquired from previous grades and also from other subjects. Among the prior knowledge that learners come with, some are misconceptions. The findings revealed that learners were taught in Design and Technology to think of energy as power or ability to do work. This definition does not fit with the scientific definition of the concept which is provided in the NSHE syllabus. Learners' misconceptions about energy concepts that were identified in the pretest and stimulated interview 1 were addressed during the intervention.

Through investigating learners' prior knowledge, I also learnt that learners were faced with language-specific challenges. The findings revealed that learners could not explain technical terms or explain using technical terms. The findings about learners' prior knowledge and language specific challenges informed me in designing the intervention which focused on helping learners develop scientific English in order to make sense of energy concepts. The intervention involved

functional recasting as described by SFL. Gibbon (2003) and Mohan and Slater (2008) provided me with the strategies on how to apply functional recasting.

Gibbons (2003) and Mohan and Slater (2008) investigated the functional recasting in lessons which involved practical activities. I used functional recasting in the lesson which only involved talking. The findings revealed that learners were observed making sense of energy concepts through showing ability to deconstruct and construct technicality, through comprehensible output, through asking questions and through giving scientific reasons.

The findings also revealed that learners' sense making through a mode continuum was enabled by dialogic talk. It was through dialogic talk that learners were able to make sense of what was discussed. Learners have shown some positive attitudes such as interest and confidence which might enable them to learn.

In addition, the findings revealed that learners were constrained by LOLT. The challenges posed by LOLT were revealed through learners' lack of proficiency. Learners were observed presenting their response in multiple starts and stops due to lack of proficiency. Through their journals learners indicated that they want the teacher to use both English and Oshiwambo.

5.2 Recommendations

- Functional recasting in an ESL classroom context requires additional time. The teacher has to recast several times and ask several questions because ESL learners are challenged by both everyday English and Scientific English
- During the analysis, I found out that multiple choice questions were not very useful. If I may be given the chance to do it again, I would ask learners to give reasons for their choices.
- Assessing and weighing the language specific challenges from the learners' responses to the pre test and the post test questions was limited to the questions which were language specific. If I had to repeat the study, I would set all the questions in the pre test and the post test questions to involve some focus on language.
- During the functional recasting process I consciously avoided the functional recasting type which decreases accuracy due to its negative pedagogic effect.

- Multiple starts and stops were considered in the analysis as an indicator of sense making but the data revealed multiple starts and stops as an indicator of learners' sense making being constrained due to lack of English proficiency.
- Learners' journals provided insight into what was happening in their mind. If I could focus on individual learners, then I could easily trace their learning progress.
- The finding for this study revealed that a functional recasting approach enabled learners to make sense of energy concepts using scientific English. So science teacher and science teacher training programs may consider functional recasting as useful.
- When considering functional recasting, science teachers should consider the constraining factors and possibly avoid or minimise their impact.
- Functional recasting in science needs to be explored at other grades and with other science topics.

5.3 Limitations of the study

Conducting a study with my own learners was possibly both a strength and limitation. It was of strength in the sense that learners were excited and felt positive about being involved in this project. Learners were actively participating during the lesson. Learners interviewed felt free to talk to me. However, due to the fact that learners felt comfortable, some learners were trying to make some funny expressions such as waving hands when the camera was faced to their group. Such acts affected others' concentration and interfered with some useful expressions which are indicators of learners making sense of what they were learning. However, the teacher (me) tried to calm them and encouraged them to concentrate on their work. Her voice (my voice) when she was calming these learners was noticed in the video recording of the lessons.

5.4 Areas for future research

The following are suggested possible areas for further research

- As was indicated - the topic of energy is also found in the syllabi for other subjects such as Design and Technology. It would be interesting to carry out further research on the curriculum attainment in the topic of energy in different subjects.
- It would also be interesting for further research to look at the influence of functional recasting on the development of abstraction. The model by Jawahar (2011) would provide

the functional recasting types which lead to the construction and deconstruction of abstraction.

5.5 Conclusion

The study focused on how ESL grade 7 NSHE learners make sense of energy concepts when mediated through an SFL approach. The approach was successful overall, based on findings indicating that learners were observed making sense of energy concepts in various ways. The findings revealed that through functional recasting, learners were able to construct and deconstruct technicality, make comprehensible output, ask questions and give scientific reasons. Dialogic talk was observed as the factor that enabled learners to make sense of what they were learning. The findings revealed the positive attitudes of learners being interested and being confident in the topic of energy which might enable them to learn. The findings further revealed that the LOLT constrained learners when they were trying to make sense of energy concepts. Moreover, the findings revealed that the negative attitudes of learners laughing at others mistakes and of not speaking aloud, were factors constraining to the learning process.

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Appendices

Appendix A: Pre test piloted

Pre test

Topic: Energy Date: .....

1. Energy is needed to do things such as walking to school or picking up a pencil. We also use energy to do various types of work in our homes, schools and communities.
   (a) From the above explanation construct a scientific definition for the term 'energy'.
   .....
   .....

Energy appears in different forms. Circle the letter of the answer you consider correct.

2. The form of energy which is also known as "stored energy" is:
   A. gravity
   B. Potential energy
   C. Sound energy
   D. Kinetic energy

3. This type of energy is transferred by a difference in temperature:
   A. Light energy
   B. Heat energy
   C. Geothermal energy
   D. Solar energy

4. The energy available due to an object's position above a certain point is:
   A. Kinetic energy
   B. Light energy
   C. Elastic energy
   D. Gravitational Potential energy

5. The form of energy stored in the body and in all fuels is:

   A. Chemical potential energy
   B. kinetic energy
   C. gravitational potential energy
   D. elastic potential

6. This is the only visible form of energy:
   A. Solar
   B. Light
   C. Heat
   D. Chemical

7. Explain in your own words, what "energy source" refers?

.....

.....

.....

8. Rewrite the following sentences using your own words

(a) Some energy resources are renewable

.....

.....

(b) Some energy resources are non-renewable

.....

.....

(c) Kinetic energy is the energy possessed by objects in motion

.....

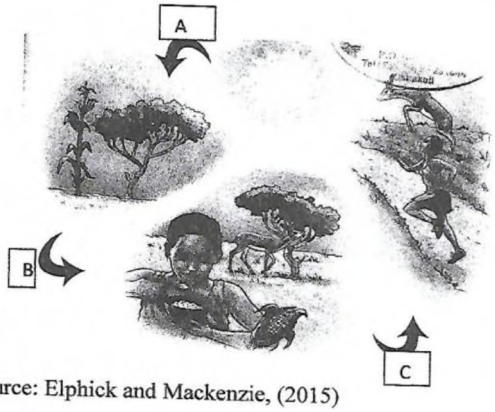
.....

(d) Most of the energy we capture on earth originates from the sun.

.....

.....

9. The pictures show the transfer of energy in our everyday lives. Write a sentence to scientifically describe the energy conversion represented by each arrow



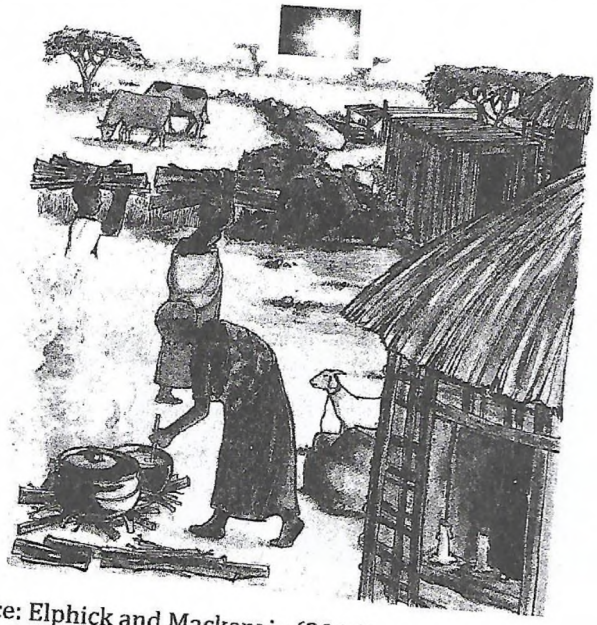
Source: Elphick and Mackenzie, (2015)

A: .....

B: .....

C:.....

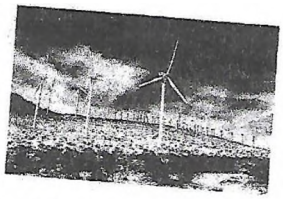
10. The following picture shows different sources and uses of energy. State all the sources of energy that you can see in the picture AND describe scientifically how the energy is used. Write you answers in the table provided.



Source: Elphick and Mackenzie (2015)

Energy source	How energy is used

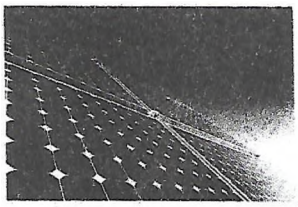
11. Classify the energy resources in each picture below, as renewable or non-renewable AND write a scientific reason for your choice.



A. Wind energy

B. Petrol

C. Coal



D. Solar panel

E. Natural Gas

Source: Elphick and Mackenzie, (2015)

Source	Renewable or non-renewable and the reason (s)
Wind Energy	
Petrol	
Coal	
Solar panel	
Natural gas	

12. What is the principal of energy conservation?

.....

.....

.....

13. State with a reason, whether the following is true. Energy can be recycled.

.....

.....

.....

.....

14. State, with a reason, whether the following is true or false: Energy is found only in living things.

.....

.....

.....

15. State with a reason, whether the following is true or false. Energy is a fuel.

.....

.....

.....

16. State with a reason, whether the following is true or false. Photosynthesis converts light energy into usable chemical energy.

.....

.....

.....

17. Explain the difference between energy, power, and force (or indicate whether any of them are the same thing).

.....

.....

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.....

.....

Appendix B: Pre test- Final

Pre test

Topic: Energy Learners' code:.....

1. Energy is needed to do things such as walking to school or picking up a pencil. We also use energy to do various types of work in our homes, schools and communities.
   (a) From the above explanation construct a scientific definition for the term 'energy'.
   .....
   .....

Energy appears in different forms. Circle the letter of the answer you consider correct.

2. The form of energy which is also known as "stored energy" is:
   A. gravity
   B. Potential energy
   C. Sound energy
   D. Kinetic energy
3. This type of energy is transferred by a difference in temperature:
   A. Light energy
   B. Heat energy
   C. Geothermal energy
   D. Solar energy
4. The energy available due to an object's position above a certain point is:
   A. Kinetic energy
   B. Light energy
   C. Elastic energy
   D. Gravitational Potential energy
5. The form of energy stored in the body and in all fuels is:

   A. Chemical potential energy
   B. kinetic energy
   C. gravitational potential energy
   D. elastic potential

6. This is the only visible form of energy:
   A. Solar
   B. Light
   C. Heat
   D. Chemical

7. Explain in your own words, what "energy source" refers?

.....

.....

.....

8. Rewrite the following sentences using your own words

(a) Some energy resources are renewable

.....

.....

(b) Some energy resources are non-renewable

.....

.....

(c) Kinetic energy is the energy possessed by objects in motion

.....

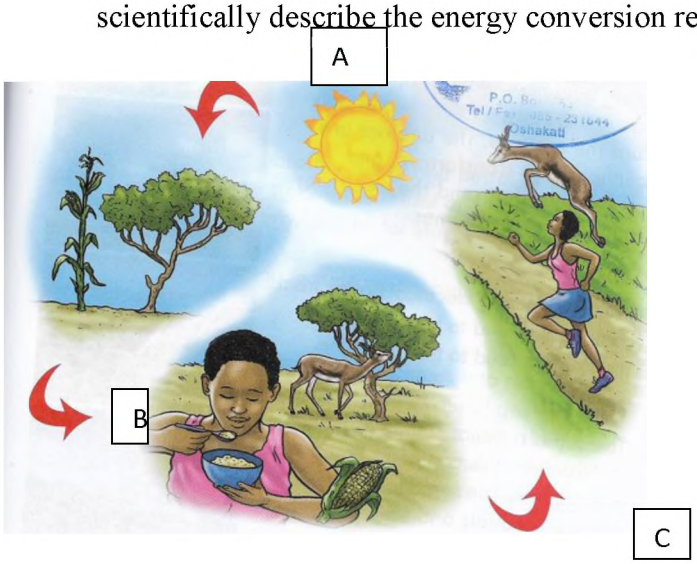
.....

(d) Most of the energy we capture on earth originates from the sun.

.....

.....

9. The pictures show the transfer of energy in our everyday lives. Write a sentence to scientifically describe the energy conversion represented by each arrow

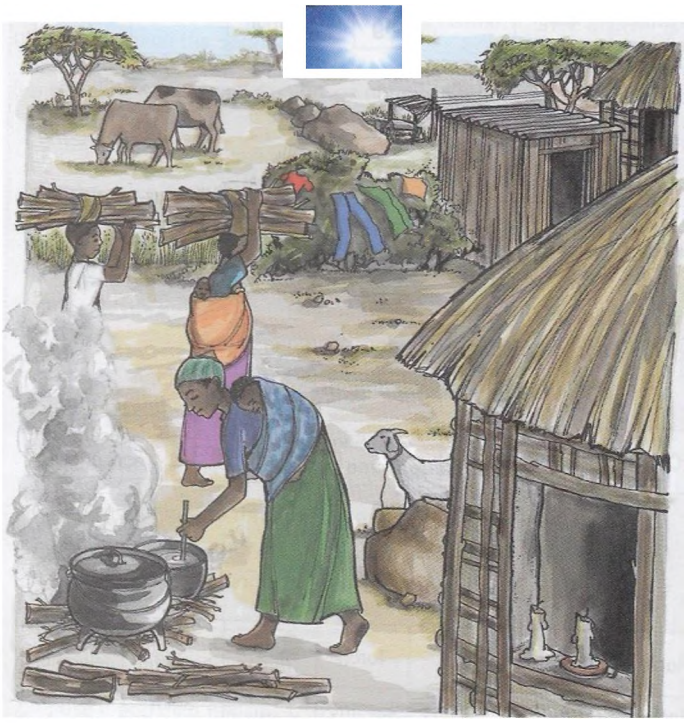


A: .....

B: .....

C: .....

10. The following picture shows different sources and uses of energy. State all the sources of energy that you can see in the picture AND describe scientifically how the energy is used. Write you answers in the table provided.

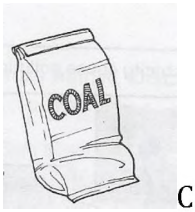


Energy source	How energy is used

11. Classify the energy resources in each picture below, as renewable or non-renewable AND write a scientific reason for your choice.

A. Wind energy

B. Petrol



C. Coal

D. Solar panel

E. Natural Gas

Source	Renewable or non-renewable and the reason (s)
Wind Energy	
Petrol	
Coal	
Solar panel	
Natural gas	

12. What is the principle of energy conservation?

……
……
……

13. State with a reason, whether the following is true or false. Energy can be recycled.

……
……
……
……

14. State, with a reason, whether the following is true or false: Energy is found only in living things.

……
……
……

15. State with a reason, whether the following is true or false. Energy is a fuel.

……
……
……

16. State with a reason, whether the following is true or false. Photosynthesis converts light energy into usable chemical energy.

……
……
……

17. Explain the difference between energy, power, and force (or indicate whether any of them are the same thing).

……
……
……
……
……

Appendix C: Stimulated recall interview one

Pre prepared interview questions for the stimulated recall interview 1

1. How do you define energy? .....
2. What is your reason for selecting?.....
3. What is your reason for selecting? .....
4. What is your reason for selecting? .....
5. What is your reason for selecting? .....
6. What is your reason for selecting? .....
7. Describe the concept energy using your "own words"
8. How do you understand these sentences?
   A) Some energy resources are renewable
   B) Some energy resources are non renewable
   C) Kinetic energy is the energy possessed by objects in motion
   D) Most of the energy we capture on earth originates from the sun
9. Scientifically describe the energy conversion for each arrow?
10. Describe scientifically how the energy sources show in the picture are used?
11. Explain you classified these energy sources.
12. What is the principle of energy?
13. State with a reason whether energy can be recycled
14. State with a reason whether energy is found only in living things
15. State with a reason whether energy is a fuel
16. State with a reason whether photosynthesis convert light energy into useable chemical energy
17. State with a reason whether energy, power and force are the same thing

Appendix D: Observation schedule

Observation schedule

Throughout the lesson, please note down the learners' behaviours with respect to their engagement whether during the group discussions or during their interaction with the teacher Please write full description.

Behaviour	Description
What is the behaviour?	
Signs which show learners making sense during the interaction between learners themselves	
Signs which show learners making sense during the interaction between learners and teacher	
Behaviour which seem to affect them as they discuss or as they talk with the teacher	
General comments	

Appendix E: Final post test

Post test

Topic: Energy Learners' code:

.....

1. Energy is needed to do things such as walking to school or picking up a pencil. We also use energy to do various types of work in our homes, schools and communities.
   (b) From the above explanation construct a scientific definition for the term 'energy'.
   .....
   .....

Energy appears in different forms. Circle the letter of the answer you consider correct.

2. The form of energy which is also known as "stored energy" is:
   E. gravity
   F. Potential energy
   G. Sound energy
   H. Kinetic energy
3. This type of energy is transferred by a difference in temperature:
   E. Light energy
   F. Heat energy
   G. Geothermal energy
   H. Solar energy
4. The energy available due to an object's position above a certain point is:
   E. Kinetic energy
   F. Light energy
   G. Elastic energy
   H. Gravitational Potential energy
5. The form of energy stored in the body and in all fuels is:
   E. Chemical potential energy
   F. kinetic energy
   G. gravitational potential energy
   H. elastic potential

6. This is the only visible form of energy:
   E. Solar
   F. Light
   G. Heat
   H. Chemical

7. Explain in your own words, what "energy source" refers?

.....

.....

.....

8. Rewrite the following sentences using your own words

(e) Some energy resources are renewable

.....

.....

(f) Some energy resources are non-renewable

.....

.....

(g) Kinetic energy is the energy possessed by objects in motion

.....

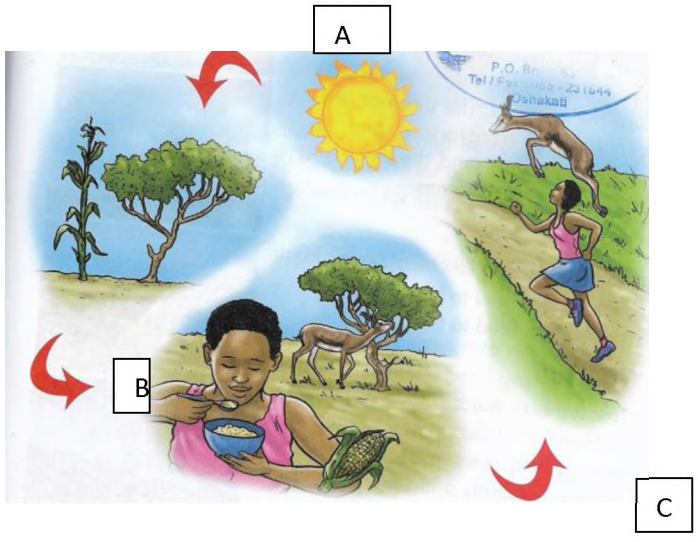
.....

(h) Most of the energy we capture on earth originates from the sun.

.....

.....

9. The pictures show the transfer of energy in our everyday lives. Write a sentence to scientifically describe the energy conversion represented by each arrow

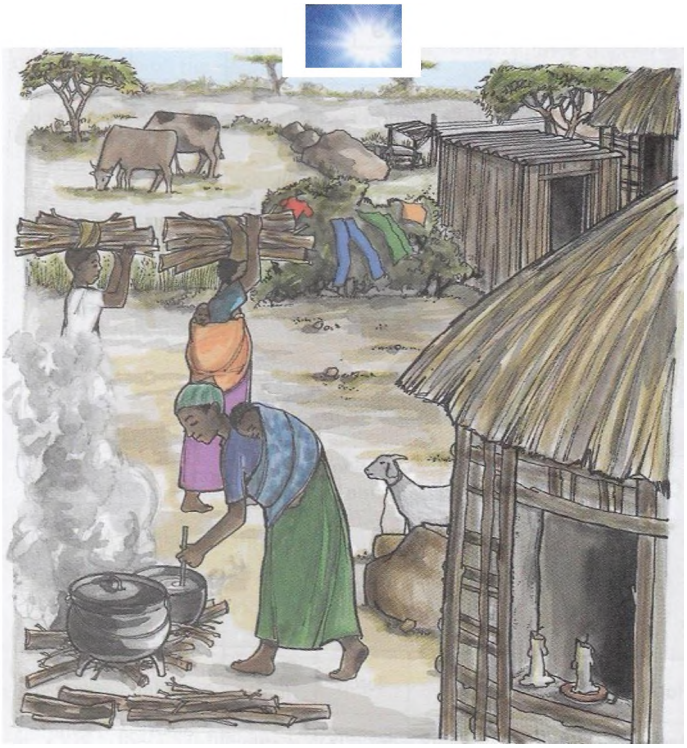


A: .....

B: .....

C:.....

10. The following picture shows different sources and uses of energy. State all the sources of energy that you can see in the picture AND describe scientifically how the energy is used. Write you answers in the table provided.

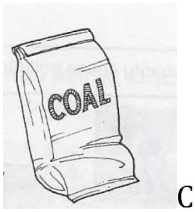


Energy source	How energy is used

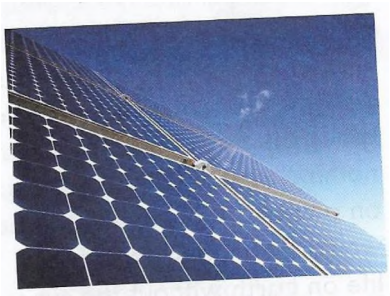
11. Classify the energy resources in each picture below, as renewable or non-renewable AND write a scientific reason for your choice.

B. Wind energy

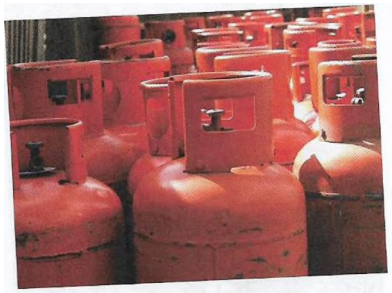
B. Petrol



C. Coal



D. Solar panel



E. Natural Gas

Source	**Renewable or non-renewable and the reason (s)**
Wind Energy	
Petrol	
Coal	
Solar panel	
Natural gas	

12. What is the principle of energy conservation?

……
……
……..

13. State with a reason, whether the following is true or false. Energy can be recycled.

……
……
……
……

14. State, with a reason, whether the following is true or false: Energy is found only in living things.

……
……
……..

15. State with a reason, whether the following is true or false. Energy is a fuel.

……
……
……

16. State with a reason, whether the following is true or false. Photosynthesis converts light energy into usable chemical energy.

……
……
……

17. Explain the difference between energy, power, and force (or indicate whether any of them are the same thing).

……
……
……
……
……

Appendix F: Stimulated recall interview 2

Pre prepared interview questions for the stimulated recall interview 2

1. How do you define energy? ……
2. What is your reason for selecting? ……..
3. What is your reason for selecting? ……..
4. What is your reason for selecting? ……..
5. What is your reason for selecting? ……..
6. What is your reason for selecting? ……
7. Describe the concept energy using your "own words"
8. How do you understand these sentences?
   E) Some energy resources are renewable
   F) Some energy resources are non renewable
   G) Kinetic energy is the energy possessed by objects in motion
   H) Most of the energy we capture on earth originates from the sun
9. Scientifically describe the energy conversion for each arrow?
10. Describe scientifically how the energy sources show in the picture are used?
11. Explain how you classified these energy sources.
12. What is the principle of energy?
13. State with a reason whether energy can be recycled
14. State with a reason whether energy is found only in living things
15. State with a reason whether energy is a fuel
16. State with a reason whether photosynthesis convert light energy into useable chemical energy
17. State with a reason whether energy, power and force are the same thing

Appendix G: Learners' journal book

Journal Book (Reflective Learning Log)

Name:..... Topic: ..... Date: .....

Things that I understood well in this topic
Things that are still not clear to me in this topic
What I think teacher could have done to help me understand the topic
Use the space below to write anything you want to say about the lesson

Appendix H: Permission letter to the Ohangwena regional director of Education

OHANGWENA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE
DIRECTOR'S OFFICE

1st Floor Greenwell Complex Private Bag 88005 Eenhana Tel: 065 – 290 201 Fax: 065 -290 224

Enquiries: Magano Gaoses
Email: mcnotto@yahoo.com

8 June 2016

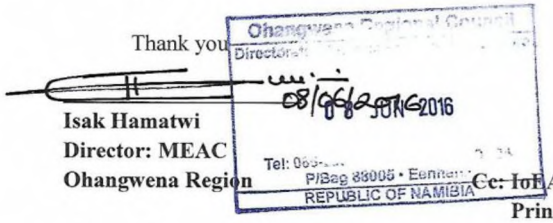
Ref: 12/3/10/1

To: Ms. Secilia Sylvanus
Rhodes University
Email: mrsmulek@gmail.com

Subject: Permission to conduct educational research in two schools in Ohangwena Region.

1. Receipt of your letter dated 13 April 2016 bears reference.
2. The Ohangwena Directorate of Education, Arts and Culture indeed supports your initiative as your focus is mainly to better the performance of the learners who are not doing well in Natural science.
3. This office however would like to inform you that the normal teaching and learning process must not be disturbed and that prior arrangements must be made with the Principals of the schools concerned.
4. The office of the Regional Director hope you will find this in order and wishes you all the best with the endeavor you are taking on.

Thank you



Isak Hamatwi
Director: MEAC
Ohangwena Region

Cc: IoEAC- Endola & Ohangwena Circuits
Principals – Nghiteke and Onepandaulo CS

Appendix I: Permission Letter to the school principal to conduct a study in the school

Enq:Secilia Silvanus
Cell: 0812964404

09 April 2016

TO: The Principal Onepandaulo combined school
Endola Circuit, Ohangwena Region

Dear Sir

RE:REQUEST FOR PERMISSION TO CONDUCT EDUCATIONAL RESEARCH IN THE SCHOOL

My name is **Secilia Silvanus** and I am an M.Ed student registered at **Rhodes University in South Africa.** My student number is **13S7075**.I am conducting a research study entitled: Investigating the influence of Systemic Functional Linguistic approach for teaching Energy to Namibian grade 7 Natural Science learners. I am requesting an access to your school in order to carry out a study regarding the above-mentioned topic. The study will involve one class for grade 7 learners and the grade 7 Natural Science teacher will serve as a critical friend. I plan to administer a pre-test to all learners in one grade 7 class, stimulated-recall interview with 4 learners to be selected after the pre test and the teaching of the topic of energy to the whole class with video recording the lessons. Learners will be expected to write journals after the lessons which will form part of the data. A post test will be conducted to evaluate the learners' progress after the teaching of the topic energy. Informed consent will also be requested from the circuit inspector, critical friend, students and their parents

You are assured that the study will not in any way interrupt the normal running of the school. The involvement of the participants in this research study is completely voluntary and they can withdraw at any time without prejudice. The data to be collected from this research study will be published as the Rhodes University half thesis. In addition, the study may benefit the participating teacher and learners as far as the learning and teaching of science is concerned. The identity of each participant and their views or contributions will be treated with a high degree of anonymity.

If you agree for your school to participate in my research, please complete the attached consent form (declaration). If possible, conduct me on the number indicated earlier for inquiries. I thank you for taking the time to read this letter. Your permission to conduct this study will be highly appreciated.

Yours sincerely
Secilia Silvanus

(Please complete the declaration below).

I …… (full name of principal), the principal of …….. (full name of school) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to my school participating in the research project. I understand that my school is at liberty to withdraw from the project at any time.

Name of Principal	**Signature of Principal**	**Date**
……	……	…….

Appendix J: Permission letter to the critical friend

Enq: Secilia Silvanus
Email: 0812964404

09 June 2016

Dear Research Participant

RE: REQUEST FOR PERMISSION TO BE A CRITICAL FRIEND IN THE EDUCATIONAL RESEARCH AT YOUR SCHOOL

Thank you for agreeing to be a critical friend in my study. As per our discussion, my research area is an investigation on the influence of Systemic Functional Linguistic approach for teaching the topic energy to Namibian grade 7 Natural Science learners.

The study involves an intervention of teaching the topic of Energy using functional recasting approach drawn from Systemic Functional Linguistic theory. Before the intervention, learners will be given a pre test to evaluate their prior knowledge on the topic of Energy. After the pre test a stimulated –recall interview will be conducted with 4 learners to be selected based on their responses in the test, to get more insights of the learners' responses. An intervention will be done which is the teaching of the topic of Energy using functional recasting approach and you will assist me with video recording the lessons and we will also analyse the video together. Learners will be required to write reflections after every lesson which will form part of the data. A post test will be conducted to evaluate the learners' progress after the intervention.

The study will be conducted in the afternoon in order not interfere with normal running school activities. Your participation in this research study is completely voluntary and you have the right to withdraw at any time without prejudice. The data to be collected in this study will be published as a Rhodes University half thesis. Your identity, views or contributions will be treated with a high degree of anonymity.

If you agree to participate in my research, please complete the attached consent form (declaration). If possible, conduct me on the number indicated earlier for inquiries. I thank you for taking the time to read this letter.

Yours sincerely
Secilia Silvanus

(Please complete the declaration below).

I …… (full name of the teacher), the Natural Science teacher at
…….. (name of the school) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that my liberty to withdraw from the project at any time.

Name of teacher	**Signature of the teacher**	**Date**
…….	…….	……..

Appendix K: Permission letter to the parent

Enq: Secilia Silvanus
Cell: 0812964404

P. O Box 2036
Oshakati
09 June 2016

Dear parent/ guardian for .....

RE: PREMISSION FOR YOURCHILD TO BE MY RESEARCH PARTICIPANT

I am Secilia Silvanus, a Natural Science teacher at Onepandaulo combined school in Endola Circuit, Ohangwena Region and I am a registered student at Rhodes University in South Africa doing a Masters of Education in Science Education. I am conducting a research study entitled: Investigation the influence of Systemic Functional Linguistic approach for teaching Energy to Namibian grade 7 Natural Science learners. I am hereby requesting you as a parent / guardian to permit your child to be a participant of the piloting program of my research study that I am conducting at their school. This activity involves a pre test, stimulated-recall interview, a mini teaching with video recording the lesson.

Being a participant in this activity I believe it will benefit him/her to have a better understanding of the concepts of energy. This activity will not interfere with normal running of the school as it will be done in the afternoon. I therefore would like to inform you that the participants might not arrive home on time.

The identity of each participant and their views or contributions will be treated with a high degree of anonymity. Also be informed that you have the full right to refuse for your child not to take part in this activity. If you agree for your child to participate in my research, please complete the attached consent form (declaration). If possible, conduct me on the number indicated earlier for inquiries. I thank you for taking the time to read this letter.

Yours sincerely
Secilia Silvanus

(Please complete the declaration below).

I ..... (full name of the parent), the parent/guardian of..... (name of the child) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to my child participating in the research project. I understand that my child is at liberty to withdraw from the project at any time.

Signature of the parent Date **Date**

....

Signature of the child **Date**

....