The potential for Concept Cartoons to assist Natural Sciences teachers with developing scientific jargon for Primary School learners.

By

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Submitted in fulfilment of the requirements for the

Degree of Magister Educationis in the Faculty of Education at

Nelson Mandela University

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2019

ABSTRACT

The study was undertaken to investigate whether a teaching tool Concept Cartoons may assist Intermediate Phase (IP) Natural Sciences teachers with the development and understanding of scientific jargon, when implemented in Natural Sciences investigations. As a novice Natural Sciences teacher it was important to find a teaching tool which would assist second language learners with scientific concepts, particularly focusing on science investigations. The focal aim was to search for a fun, captivating, educational resource that would cater for these learners' barriers to science learning.

This research falls within a constructivist worldview, and the research method employed was a case study. Data were collected through qualitative approach, via semi-structured interviews. A total of nine participating Intermediate Phase Natural Sciences teachers from the Port Elizabeth Northern Areas schools contributed towards the findings of this study.

This study was an investigation undertaken to see whether a different teaching approach may encourage change. The findings of this study suggested that Concept Cartoons used in Natural Sciences investigations created an educational effect towards the learners understanding of science concepts. Intermediate Phase learners were introduced to Concept Cartoons to assist with their understanding of science terminology during practical investigations. The results of this investigation suggested that Concept Cartoons assisted English second-language learners with scientific jargon and served as an educative curriculum material for Intermediate Phase teachers. Furthermore Grade 4 findings suggested English home-language speakers struggled with scientific language, compared to their second-language peers who achieved greater results due to the amount of effort and determination they dedicated to translating these concepts. Further studies suggested this maybe because science terminology does not form part of their everyday vocabulary, therefore experiencing difficulty with science concepts during investigations. A total of six themes emerged from this study:

1. Concept Cartoons: teachers and scientific investigations
2. Concept Cartoons: design, characters and speech bubbles
3. Concept Cartoons: enabling scientific talk
4. Concept Cartoons: scientific jargon
5. Concept Cartoons: scientific jargon and ESL learners
6. Concept Cartoons: teacher learning.

This study, which aimed at introducing Concept Cartoons as an educative curriculum tool in Natural Sciences investigations, is expected to fill an important gap in literature surrounding teaching science jargon to English second-language learners.

ACKNOWLEDGEMENTS

I would like to thank the Department of Basic Education for granting me access to conduct my research in the Northern Area schools, the Principals for their kindness and welcoming me at every visit, the teachers for the time and effort invested in my research as well as their contribution and meaningful feedback that has impacted on my knowledge and understanding of this study.

My family and loyal friends for their support motivation and words of encouragement.

Last but not least Dr. Leslie Meiring.

Words cannot describe my gratitude and appreciation. You saw the potential I possess and for that I am forever grateful. Because of you, I am encouraged and motivated.

I owe this entire journey to you sir, thank you for you mentorship and support. You have positively contributed to my academic growth and always made everything seem possible.

DECLARATION

I, Warda Abrahams, student number: 208003013, hereby declare that the thesis, The potential for Concept Cartoons to assist Natural Sciences teachers with developing scientific jargon for Primary School learners. is my own work and that it has not previously been submitted for assessment or completion of any post-graduate qualification to another university or for any other qualification.

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April 2019

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CHAPTER ONE

1.1 Introduction

This introductory chapter is devoted to providing an understanding of what invoked this study. The background of this study gives clarity of why this research might be useful to primary school Natural Sciences teachers, and how it might benefit second-language learners in their task of coming to terms with the understanding of science jargon while carrying out hands-on scientific investigations. The primary focus of this case study are the perceptions of nine participating Intermediate Phase teachers and their use of a curriculum material, namely Concept Cartoons. The study attempts to investigate teachers' perceptions of the usefulness, or effectiveness of exposing English Second-Language (ESL) learners to scientific jargon by means Concept Cartoons.

The purpose of this research was to address ways of addressing the lack of understanding of scientific jargon used in Natural Sciences investigations in the Intermediate Phase (IP). This gap in understanding is a challenge for all involved, English Home-Language speakers, ESL speakers and even for the IP teacher. IP Natural Sciences teachers tend to be phase specialist and seldom view themselves as subject discipline specialists. This study interrogates how a teaching strategy, involving Concept Cartoons, might influence the teaching of science jargon by a small case-study of nine IP Natural Sciences teacher.

The underlying purpose of this research is to assist teachers with their teaching ESL learners to understand scientific terminology. The theoretical framework for this research resides with teacher learning. Teacher learning is "influenced by three key systems: the teacher's orientation to learning and to the profession, the professional development activity and the school context (Bertram, 2014, p. 91). Bertram (2014) states that teacher learning takes place when activities, workshops or programmes are scheduled, however, even though these development activities are design to encourage and enhance teacher learning, it may or may not result in the outcome (Bertram, 2014, p. 91). The conceptual framework is Educative Curriculum Materials. Educative Curriculum Materials (ECM) are designed to assist teachers in developing their skills with the curriculum they are teaching

i.e. teacher learning. It is when, teachers learn in a different ways, assisting them with acquiring knowledge. This can either be formal or informal learning; planned or incidental (Bertram, 2011, p. 12). In this study, Concept Cartoons are proposed as a suitable ECM for the teaching and learning of investigations in the Natural Sciences.

1.2 Background of the study.

This research originates from the teaching of Natural Sciences to Grade 7 learners within the Northern Area schools of Port Elizabeth. My classroom is filled with diverse learners from different sociocultural backgrounds. Many learners' home language is not English, with the majority of learners speaking IsiXhosa, while others speak Afrikaans and a few speak Somali as a home language. The school itself is situated in an Afrikaans community, with English as the language of instruction.

Overtime I became aware that teaching in a traditional way (e.g. chalk and talk) was not possible as my learners interpret information differently because of their home language which is different to my language of teaching. These learners struggle with scientific jargon (e.g. hypothesis; predict; dissolve and variables) which makes the science lesson ineffective.

During sciences lesson I have noticed learners struggle with scientific concepts which are used in teaching materials (e.g. textbooks). Learners may learn the terms but they lack a deeper understanding of scientific terms. For this reason they find scientific jargon difficult, resulting in learners not completing the investigative projects or assignments. What adds to this is the language of instruction is not the learner's home language, which already places the learner at a disadvantage when answering scientific questions. Consequently, I have been searching for different teaching methods and styles to make learning interesting and effective.

Teachers, including myself, think learners have grasped the content taught in previous Grades. We assume learners have basic scientific knowledge which is taught in previous science classrooms. However, while many learners are able to read, they might not understand the terminology used in Natural Sciences content, therefore they struggle with the subject. According to Probyn (2005), learners' difficulty with science concepts may be

due to these concepts being taught in a language which is not their mother tongue. Although Language-in-Education Policy (LiEP) allows schools to select their own language of instruction, research indicates that the trend within these schools is to retrain English as LoLT (Probyn, 2005 p. 3). “Bridging the gap and acquiring not only proficiency in English but also the kind of cognitive academic language proficiency required for academic learners and meaningful engagement with the curriculum is the difficulty for many such learners” (Probyn, 2005, p.3). What we are experiencing seems to be a national problem (Probyn, 2005).

As a Natural Sciences teacher, I found it difficult to explain certain science concepts to my learners. I explored the internet in search of different methods of teaching science concepts. I knew scientific jargon was the potential gap between understanding science concepts which hindered their (learners) understanding of the Natural Sciences (NS) curriculum content. I was intrigued by the characteristic features Concept Cartoons (CC) had, such as it invites learners to engage in group discussions and it creates scientific talk (Keogh & Naylor, 2000). I decided to further explore this topic by conducting formal research, to investigate whether this teaching tool may assist other NS teachers to benefit them and their learner’s understandings of science concepts.

The purpose of this research is to investigate whether Concept Cartoons may assist with the understanding of scientific jargon in the Natural Sciences for English Second-Language (ESL) learners. It is the duty of a teacher to find solutions which may assist in the learning process of science investigations. Teachers are the most important change agent in their classroom. Bourn (2015) states “many teachers see it as part of their role to be vision creators” (Bourn, 2015, p. 6). If teachers are motivated about a strategy or idea that they see ‘works’ they may implement it in the classroom. “They also need to be able to reflect on their own needs, to identify areas of personal and professional development that can help them be better teachers” (Bourn, 2015, p. 6). Concept Cartoons, as a teaching tool, may assist Natural Sciences teachers to better prepare their learners for understanding science jargon during science investigations. Teachers learn best when they are exposed to different teaching styles and are able to apply and reflect on this, whilst collaborating with other teachers in similar situations. They would

implement different educational tools that they deem beneficial for themselves and their learners. Educative Curriculum Materials, are learning materials designed to assist teachers in developing their skills with the curriculum they are teaching i.e. teacher learning (Bertram, 2011, p. 12). Not only do Educative Curriculum Materials enhance teachers learning, they are designed to assist learners with learning barriers (Davis & Krajcik, 2005, p. 3).

1.3 Literature review

This section (discussed in detail in Chapter 2) includes an understanding of different factors that affect English Second-Language (ESL) learners in the subject Natural Sciences. Defining what jargon and scientific jargon is, as well as the problems associated with scientific jargon. A brief description of Educative Curriculum Materials (ECM) will be explained, suggesting that well-structured curriculum materials might go some way to enhancing science teaching and learning. Furthermore, Concept Cartoons as a vehicle of learning will be explained, along with the teacher learning. The theoretical framework, teacher learning, will embed the construct of an ECM material which will highlight the importance of Concept Cartoons in this study.

1.3.1 Teachers English second-language (ESL) learners and science

South African learners might often be taught science in a language which may not be their mother tongue (England, Huber, Nesbit, Rogers, & Webb, 2007, p. 2). This has an influence on their understanding of science. There are a number of reasons that might contribute to learners' lack of science literacy in classrooms. While jargon words present their own challenge when occurring in science textbooks, there are words that do, however, occasionally pop up in some everyday conversation, and then they may have a different meaning in science to everyday conversation. For example, the word '*theory'* in everyday conversation means "a guess or unsubstantiated idea about how something works" (Swordstool, 2015, pp. 1-2), however, in science, the word '*theory*' refers to a "comprehensive explanation of an important feature of nature supported by facts gathered over time", (Swordstool, 2015, pp. 1-2). While this difference in meanings for the identical word is difficult enough for an English first-language learner, it becomes an almost, if not impossible challenge, for ESL learner. Teachers themselves especially, non-specialist

science teachers, might also not always understand the words themselves, or they may define words incorrectly when explaining a concept to learners.

Other factors which might contribute to the learner being confused, bored or intimidated when reading science textbooks, articles and reports etc. might be the style of writing, the specialist jargon used and the grammar and tone selected for science materials (Cobbing, 2011). Cobbing says, “This style of writing (jargon) may act as a barrier for entry speakers of English as a second language who must devote extra time to mastering the medium rather than the content of science writing” (Cobbing, 2011, p. 1). ESL speakers struggle with scientific jargon and must spend adequate time to try and understand what the writer has said. This places these learners at a disadvantage amongst their fluent Home Language English speaking peers, (Cobbing, 2011, p. 2).

In attempting to overcome this, learners need to find a working definition of the concepts before understanding the science content taught. A possible area in which these ‘working definitions’ originate is in the classroom itself, where, according to Probyn (2005), learners may speak their first language at school with their peers and during classroom discussions but, when reading, writing and being assessed, they complete these tasks in English.

South African Schools, apart from Afrikaans-medium schools, use English as the Language of Learning and Teaching (LoTL) in the IP and FET (Probyn, 2005). While English is the LoTL in these schools, not all teachers are first-language English speakers themselves. Sometimes this is advantageous, in that teachers who speak the same language as the learners, (which is not English), are able to switch from one language to that of the learner’s mother tongue (Probyn, 2005). These teachers may be able to use this to their advantage. This skill of multilingualism may enhance the learning of science language as they are able, “to explain new concepts, to clarify statements or questions; to emphasize points, and to make connections with learners’ own contexts and experience, to maintain the learners’ attention with question tags, for classroom management and discipline” (Probyn, 2005). However, Probyn (2005) found that at one school, where teachers and learners were IsiXhosa speakers, the teachers admitted to code switching when explaining the work to learners, they agreed there were limited

resources (terminology) available in the learner's home language to teach the lessons and explain to explain science concepts (Probyn, 2005). It is not unusual to find African parents enrolling their children into an English medium school from an early age, because they want their children to be taught in English (Stephen & Coetzee, 2013).

Learning science requires learners to read the content; discuss or argue what was read and then conclude by writing what they have learnt using scientific terminology understanding (England et al., 2007, pp. 4- 9). Often learners struggle to understand what they have read, therefore they are unable to argue or write about what was taught. Cobbing says science is used in such a way that it confuses the learners and the message becomes unclear (Cobbing, 2011). Learners eventually give up and avoid the content further because they lack scientific understanding. Furthermore scientific jargon used in textbooks is difficult to understand, this adds to the confusion, especially if the scientific key words were not defined at the start of the lesson.

1.3.2 What is scientific jargon?

Jargon is defined as specific vocabulary used by people with common interests. As new words are created within a discipline, they are defined as jargon (Rosenberg, 2012). Furthermore, scientific jargon is defined as specific words used by scientists to "establish themselves as professionals of their discipline by using specialist terminology" (Rosenberg, 2012). Sometimes jargon confuses the reader, by making the reading material difficult to understand or it deliberately addresses the reading material to a sophisticated audience (Clarke, 2010). In science, jargon complicates the reading materials because of words used, such as predicting; independent variables; hypothesis; photosynthesis etc. are words that learners might not use in their everyday vocabulary.

Scientific terminology is difficult to comprehend for learners. Learners arrive in a Grade with little or no scientific vocabulary, because they have not been exposed to this type of language in the previous Grades. Sibold, says "Often vocabulary instruction receives inadequate attention" (2011, p. 24). The fault does not lie with the learner's lack of knowledge, but rather the lack of knowledge gained from the basic lessons taught because the vocabulary (jargon) is simply downplayed during the lesson.

According to Henderson and Wellington (1998) “technical terms present obvious barriers to effective communication for science teachers” (Henderson & Wellington, 1998, p. 4). Other factors are the lack of understanding of scientific jargon for learners. This makes the lesson difficult to understand, which may result in scientific jargon identified as a learning barrier. Findings gathered in the article of Henderson and Wellington (1998) identified “certain commonly spoken and written words such as accurate and observation” are difficult concepts for learners to understand (Henderson & Wellington, 1998, p. 4). Scientific words such as ‘rate’, ‘factor’ and ‘valid’ are major problems, yet science teachers introduce them in science content not realizing the consequence this has towards the learning of science content. Science teachers need to be aware of how they “implement non-technical and technical terms of science as this will encourage interpretation” (Henderson & Wellington, 1998, p. 4).

1.3.3 Educative Curriculum Materials

A curriculum is a document “that includes strategies for achieving desired goals or ends” (Jack, p. 1). Stenhouse (1975) states “the curriculum is a book of instructions to teachers”, (Stenhouse, 1975, p. 2). Stenhouse defines the curriculum as an act of what happens to learners in schools as a result of what teachers do. He further adds “the problem of specifying the curriculum is one of perceiving, understanding and describing what is actually going on in school and classroom” (Stenhouse, 1975, p. 2). The curriculum can be viewed as the intended plan of what teachers would like to happen in schools, and “it is seen as existing state of affairs in schools of what does in fact happen” (Stenhouse, 1975, p. 2). The statement of Stenhouse (1975) refers to the relationship of the intended curriculum compared to the reality of what really happens in classrooms (the enacted one).

Curriculum materials, “are textbooks; teacher guides and technology-based materials designed with student learning as the goal”, (Schneider & Krajcik, 2002, p. 222) which, should be well structured and easy for the reader to understand (Davis & Krajcik, 2005, p. 3). A well-structured curriculum material is complete with “good representations of the content, a clear purpose for learning it, and multiple opportunities for students to explain their ideas” (Davis & Krajcik, 2005, p. 3).

There are, however, a category of curriculum materials designed to support teachers (textbooks and teacher guides). Schneider and Krajcik (2002), however, claim that the purpose of any good curriculum material is to support the learning of both teachers and learners (2002, p. 222). Such materials have been dubbed as Educative Curriculum Materials (ECM) (Bertram, 2011). According to Davis and Krajcik (2005, p. 3) “Educative Curriculum Materials should help to increase teachers’ knowledge in specific instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations (Davis & Krajcik, 2005, p. 3).” Educative Curriculum Materials (ECM), are learning materials designed to assist teachers in developing their skills with the curriculum they are teaching and with their pedagogy and learning. ECM enhances the learning of learners as well, by identifying the key areas that can help with learning barriers; dealing with learners from diverse backgrounds and achieving the learning outcomes set in the curriculum (Davis & Krajcik, 2005, p. 3). ECM are not tailored in any specific way, as long as the teaching resource has key characteristics of teacher learning it can be called an Educative Curriculum Material.

Concept Cartoons are educative teaching tools which relates to a specific topic in science. These teacher resources are designed to enhance scientific thinking and reasoning. They may be considered an ECM if the key features of Concept Cartoons are congruent with an educative curriculum material i.e. teachers’ and learners’ learning.

1.3.4 Concept Cartoons

Concept Cartoons are a creative method, using animated characters, to explore scientific discussions. It is a way of teaching that intends to develop learners’ thinking skills and potentially enhance scientific vocabulary (Naylor & Keogh, 2012). The cartoon style characters intrigue learners into discussions with peers, the speech bubbles use scientific terminology which enables learners to think scientifically and also by relating the cartoon to a familiar context or scenario promotes the understanding of words (jargon). The scenarios are everyday situations which learners can relate to. These Concept Cartoons have been found to be suitable for all age groups (Naylor & Keogh, 2000). By being suitable for the development of conceptual understanding of science for all age groups, Concept Cartoons have the potential to enhance teachers as well as learners’ conceptual

understanding of a particular concept. They are an effective means of getting learners involved in open-ended discussions (Constantinou, 2016). Learners enjoy visuals and materials that are different, creative and challenges their thinking skills, as such, this vehicle of learning which might productively be deployed to promote scientific vocabulary. STEM Learning organization states, (2015) “children benefit from undertaking regular investigations which allows them to practice using their communication skills effectively through group discussion and reasoning” (STEM LEARNING, 2015). Scientific discussions helps secure children’s understanding of a topic as they process why and how something has happened. Furthermore Concept Cartoons aim to harvest the use of scientific vocabulary correctly and “using adventurous vocabulary” (STEM LEARNING, 2015).

As a teaching strategy or teaching tool, Concept Cartoons, have been researched by various researchers. This method of teaching has delivered positive results from researchers within various countries. They have been implemented to investigate the development of scientific argumentation amongst learners (Williams, Webb & Meiring, 2005). Concept Cartoons form a constructivist approach to science learning, which occurs when learners are actively involved in the lesson. Learners are constructing their own knowledge when they interact and engage with the teaching tool Concept Cartoons.

1.3.5 Concept Cartoons as Educative Curriculum Materials

Naylor and Keogh designed Concept Cartoons to challenge the thinking of both learners and teachers (Naylor & Keogh, 2000, p. 1). For teachers it may improve subject knowledge and their understanding of science and for learners it may enhance learning. Schneider and Krajcik (2002, p. 222) state, “Educative Curriculum Materials are designed to support teacher learning, as teachers use the materials to support student learning”. Concept Cartoons are potential Educative Curriculum Materials as they explain how teachers can implement this in their lessons, clarify uncertainty concerning misconceptions teachers and learners might have about science by providing broad explanations of the complex scientific concepts, that are easy to understand (Naylor & Keogh, 2000, p. 5).

Concept Cartoons have not featured, or at least not prominently, in the South African curriculum to date. However, the purpose of a curriculum is to assist teachers to apply new knowledge that may enhance the teaching of learners. Even though the current curriculum does not cater for Concept Cartoons, it is possible for teachers to adjust their learning and teaching styles by implementing this tool in a lesson and thus potentially promote learning in their science classrooms.

1.4 Research question

Natural Sciences teachers are faced with a dual challenge, first, having to teach science through a language (English) that is not necessarily the home language of their learners, or their own home language and second, being confronted by scientific jargon inherent in the teaching and learning of science. This study attempted to interrogate the efficacy of a single strategy, Concept Cartoons, to address this two pronged challenge. The study is situated within the title:

The potential for Concept Cartoons, to assist Natural Sciences teachers with developing scientific jargon for Primary School learners.

In the previous sections of this dissertation a case was made that Concept Cartoons can be considered as an educative curriculum material and, as such, can be used to promote both teaching and learning. This study did not intend to, or assume that it could, measure the efficacy of using Concept Cartoons directly on learner understanding. Consequently, learners were not directly involved at any stage. The study's purpose was to identify the potential of Concept Cartoons, in the eyes of teachers, to teach scientific jargon. In this study teachers were exposed to Concept Cartoons and invited to use them in their classrooms and the report back on their perceptions of the potential for Concept Cartoons to make the scientific jargon of investigations more understandable for learners.

As such the following main question and three sub-questions were used to investigate the potential of Concept Cartoons to enhance understanding of the scientific jargon used in IP investigations.

Main Question:

Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?

In order to respond to the main question three sub-questions, each addressing and aspect of the main question were asked:

Sub-question 1: What are a group of Port Elizabeth educator's perceptions of their learners' understanding of selected science terminology?

Sub-question 2: What are teacher's perceptions of the effects of using Concept Cartoons for their learners understanding, after trying them out in a classroom?

Sub-question 3: What evidence is there to suggest that Concept Cartoons have enhanced teacher's capabilities to teach terminology with respect to scientific investigations?

1.4.1 Research design and methodology

The research design is established by certain "decisions regarding what, where and when and it also "constitutes the blueprint for the collection, measurement and analysis of data" (Kothari, 1990, p. 31). This means the design provides an outline of what I will do from the prediction of the problem statement, to the operational implications of the study until the "final analysis of data" (Kothari, 1990, p. 31).

A research process needed to be explored adopting a qualitative approach focusing on a single learning problem, that of the difficulty for Natural Sciences teachers to teach scientific jargon to ESL learners within their own specific classrooms. By implementing this data collection, by means of interviews, a comprehensive description of the case emerged. This qualitative study is associated with opinions, worldviews and involve the study of research problems aimed at understanding how participants refer to, and interact with social or human challenges (Creswell, 2003). As such, this study involves a qualitative research methodology using a case-study approach.

Semi-structured interviews were employed to gather information from participating teachers, along with instrumental tools such as a biographical sheet. The biographical sheet provided information of participant's teaching history; the subjects they taught; their teaching experience and skills they have obtained throughout their teaching careers.

I investigated the learning process which was implemented by educators, not planning to engage with the learners myself. The research was conducted in such a way that the teachers received adequate information and training by me on using Concept Cartoons in their classrooms with their learners. Teachers interacted with their learners and collected learners' work and shared their observations of using Concept Cartoons with me. A qualitative research approach was implemented to conclude the data provided by the teachers during structured interviews.

1.4.2 Ethics

Nelson Mandela University (NMU)[1] ethics board granted the researcher ethical clearance to conduct this study. The institution provided the researcher with the relevant ethical clearance reference number is **H1-EDU-ERE-005** (Appendix 1).

Interested teachers within the Schauderville/Northern Area schools cluster four were invited to volunteer and participate in the study for this investigation. It was important for the school to willingly participate in this research as this had potential to be a time consuming process, involving structured lessons done during classroom contact time. This may have taken time away from the teacher's curriculum content teaching. The selected school principals and teachers signed consent forms from Nelson Mandela University acknowledging this investigative procedure as well as the relevant stakeholders involved.

A qualitative research approach was applied to this study where data were gathered mainly through interviews. Verbal one-on-one interviews tended to reduce the chances of uncertainty that might arise with written questionnaires. The researcher is able to frame

[1] Previously Nelson Mandela Metropolitan University (NMMU).

questions and reframe questions during an interview and thus hopefully receive meaningful answers from the participant (Sofaer, 1999, p. 1103).

The method I incorporated was semi-structured interviewing of educators only. I have structured pre-questionnaires and trained educators on how to implement Concept Cartoons in their classrooms. The objective of this study was to conduct interviews to identify the potential of whether Concept Cartoons might assist Natural Sciences teachers with the development of scientific jargon.

1.4 Chapter summary

This chapter starts with an exposé of the challenge of teaching science to learners who are learning science in their second or even third language. The focus is placed on scientific jargon as used in Intermediate Phase Natural Sciences investigations. Sibold (2011, p. 24) says, “When students are able to understand the vocabulary for the content they are reading and hearing, they will have a better understanding of the material”. With this in mind, the chapter introduces the concept of Educative Curriculum Materials (ECM), i.e. materials that have the potential, and explicit intention, of enhancing teaching and learning via teacher learning. Explicit in this is that ECM promote learning in both learners and teachers. This section concludes with an explanation of the ECM that drives this study, namely, the Concept Cartoons. The main research question of the study is: *Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?* Three sub-questions, intended to provide data and information that will support the answering of the main question are presented. After the unveiling of the research question a section briefly introduces the research design and methods. This qualitative study using a case-study uses a number of different data-generating instruments: namely biographical data sheet which provides details of each participant; a questionnaire to guide the researcher and semi- structured interviews conducted after participants have implemented Concept Cartoons in their classrooms. All studies that involve humans must consider the participants. In order to protect them from any form of harm, a study such as this one requires careful scrutiny of the methods and intentions. This ethical control is explained in the final section of the chapter. The following chapter provides both the theoretical and

conceptual frameworks within which this study is conducted. This is done via a literature review of relevant academic works from the literature.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Chapter 2 provides the conceptual framework and review of the literature within which this study resides. The study involves practicing teachers as participants. The participants are introduced to Concepts Cartoons as a tool to support both their own understanding of using these Concept Cartoons to teach scientific jargon and to assist learners in their learning of the jargon that occurs in scientific investigations. Concept Cartoons in Natural Sciences classrooms may be used to assist English Second-Language (ESL) learners to more fully understand the terminology used in investigations. The first sections of this chapter introduce the Intermediate Phase Natural Sciences curriculum. This is followed by a sections on teacher learning and scientific investigations. Scientific investigations, as found in the NS Curriculum Assessment Policy Statement (CAPS) document (Department of Basic Education, 2011a), form the main content and skills that are used in this study. This investigations section of NS CAPS is chosen as it is one section that contains a great deal of scientific jargon. It is this jargon that is poorly understood by both teachers and learners, especially ESL learners. A section of this chapter then introduces and discusses the construct of an Educative Curriculum Material (ECM). Concept Cartoons are presented as a tool to support the teaching and learning of scientific jargon within the content of CAPS. The chapter concludes with a justification for considering Concept Cartoons as a suitable ECM to address the challenge that initiated this study, namely, that ESL learners struggle to come to grips with scientific jargon.

2.2 The Intermediate Phase Natural Sciences curriculum

The subject Natural Sciences (NS) in the Intermediate Phase (IP) is combined with Technology in the Curriculum and Assessment Policy (CAPS) (Department of Basic Education, 2011a). This study will, however, only focus on NS as, while jargon might also be problematic in Technology, it is the jargon specifically related to scientific investigations that is of interest. Natural Sciences aims to understand the world we live in

through observation, testing and through evidence leads to explanatory theories (Department of Basic Education, 2011a).

A scientific investigation is conducted by formulating a hypothesis, designing and carrying out experiments or activities to test the hypothesis. “Repeated investigations are undertaken, and the resulting methods and results are carefully examined and debated before they are accepted as valid” (Department of Basic Education, 2011a, p. 8). The Curriculum Assessment Policy Statement (CAPS), has developmental methods which Intermediate Phase Natural Sciences teachers must incorporate during their teachings of science investigations.

The CAPS document which is a guided resource curriculum for IP teachers applies a methodological approach of “discovery through carrying out investigations” (Department of Basic Education, 2011a, p. 9). The aim of Natural Sciences investigations are: “Learners should be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions” (Department of Basic Education, 2011a, p. 10). In each academic term learners will apply scientific skills by completing a practical investigation where they will “solve problems that need some practical ability” (Department of Basic Education, 2011a, p. 10). The CAPS documents states “learners should have access to sufficient workspace and equipment to carry out investigations” (Department of Basic Education, 2011a, p. 13). These investigative procedures need to be guided by the teacher, for the prevention of injury and/or breakage of equipment. It is important for learners to explore and carry out a variety of investigations, this, however, will depend on the availability of equipment. The CAPS documents further states “teachers should be encouraged to improvise” in instances where equipment in unavailable, (Department of Basic Education, 2011a, p. 13). Learners must be “supported when doing investigations, they need to expand on the concepts or knowledge to which they have been introduced and to deepen their understanding of the subject matter” (Department of Basic Education, 2011a, p. 13).

For each academic term the learners will be taught a Natural Sciences and Technology strand, these strands are organised to promote clear progression of concepts across the Grades and in the Phase. For each strand a practical tasks, or investigative task is

completed. These practical tasks are designed specifically for “learners to demonstrate their skills or proficiencies” (Department of Basic Education, 2011a, p. 68). Learners are required to produce, investigate, or create something using tools and equipment provided. These investigative tasks are “useful for assessing how learners draw on knowledge and values to carry out practical skills” (Department of Basic Education, 2011a, p. 68). The Natural Sciences investigative tasks enhances several different skills such as predicting; doing investigations; comparing; measuring; identifying problems and issues; analysing; hypothesising and communicating. These tasks include a “range of activities where learners communicate what they know and what they can do” (Department of Basic Education, 2011a, p. 68).

In order for teachers to successfully conduct investigations with their learners, they need to thoroughly explain each step to the learners using the appropriate vocabulary. However, to make these lessons meaningful this vocabulary or jargon must be clearly understood by the learners. This is a tedious task, which requires a thorough explanation, and understanding of the terms by the teacher herself, particularly the jargon words and terms used during the investigation. If learners are required to conduct investigations they will need to understand the procedure and the definitions and the jargon.

2.3 Teacher Learning

Teacher learning may be described as either teacher development, professional development, or teacher change. Each of these concepts are interchangeable with the other, (Bertram, 2014, p. 93). Bertram (2014) states that teacher learning is influenced by three aspects: the teacher herself; the professional development activity, which refers to specific task to enhance teacher learning or development, and last, the school context which influences the environment in which the teacher works (Bertram, 2014, p. 93).

In order to understand how teachers acquire knowledge, we must consider “how a teacher’s individual learning orientation system interacts with the school’s learning orientation” (Bertram, 2014, p. 93). This is important information as teachers who are teaching Natural Sciences in the IP may or may not be science specialist, therefore they lack the depth of science discipline knowledge to teach science. The schools orientation towards learning influences the activities in which teachers participate and then are

reciprocally affected by the change which occurs during participation of these activities (Bertram, 2014, p. 93). These activities must be developmental and may range from activities such as teacher developmental workshops, social learning, and peer evaluation. Teachers who lack confidence as a result of their limited science knowledge, may benefit from these activities such as learning from colleagues, developmental workshops and being moderated by the head of department. Teachers who attend workshops may realise they need support in their teaching and in understanding the curriculum materials. According to Bertram (2014) “teachers will acquire knowledge in a particular context” (Bertram, 2014, p. 94), for example formal workshops or programmes, and here after apply this knowledge in to a classroom context. This process may be complex from a social-cultural perspective, as the environment in which learning is done should be identical or similar to which it will be implemented, (Bertram, 2014, p. 94). Bertram (2014) further add that teachers working collaboratively in communities of practice enhance teacher learning (Bertram, 2014, p. 94).

2.4 Scientific investigations in primary school

The Curriculum Assessment Policy Statement (CAPS) is known to be the ‘teachers’ bible’. This document explains how teachers should implement tasks, and more specifically, what content should be taught. The CAPS document states which methods of inquiry and investigation should be applied, (Department of Basic Education, 2011a, p. 7):

> These methods lend themselves to replication and a systematic approach to scientific inquiry that attempts at objectivity. The methods include formulating hypothesis, and designing and carrying out experiments to test the hypothesis (Department of Basic Education , 2011a, p. 7).

The purpose of these investigate procedures are to enhance learners’ skills and proficiencies. Learners use certain materials and equipment to conduct these investigative experiments under the supervision of their teacher in the classroom. The teacher observes the learners demonstrating specific practical skills, where these skills may vary according to the type of investigative task and expectation. The CAPS document outlines skills which may be identified during practical investigation such as: raising and writing a question to investigate; making a prediction; hypothesis; planning

the investigation; collecting data; recording data and evaluating and communicating results (Department of Basic Education , 2011a, p. 69).

For each school term the curriculum prescribes an investigative task in the IP NS. Included are certain cognitive questions which are required to be answered by learners when completing the experiment or activity. In IP Grade 5, Term 3, learners are required investigate how long a candle will burn when covered with different sized glass containers (Department of Basic Education, 2011a, p. 39). Learners will need to identify the input energy which is needed to make the candle burn. They will predict the outcome (hypothesis) of the experiment by formulating a research question before conducting the investigation. Experiments are “step-by-step procedures used to validate the hypotheses” (Friedl , 2003). The experiment provides evidence which may or may not support the hypothesis. Hereafter learners will observe the investigation, record, and measure the findings that occurred.

At the start of the practical investigation learners identify the possible variables. “A variable is any parameter in the experiment that can change” (Friedl , 2003). There are three types of variables in an investigation that the IP learner must understand in order to carry out the investigation. The independent variable is the one that can be manipulated during the experiment and the dependent variable is the one which we measure as a result of changes in the independent variable. The control variable is that which we keep the same throughout an investigation. It is these control variables that are kept constant throughout the experiment and would result in the test/ investigation being fair.

It is after the investigation process that learners will look at their results and compare this with the research questions and make reasonable statements relating to the investigation that has been done (Ramnarain, 2011).

During NS investigations learners need to investigate the problem (research question), design a solution to the problem, finalise the outcome and communicate their solution by answering scientific questions (Maila, 2013, p. 3). Learners are expected in both Primary and High Schools to complete scientific investigations as part of assessment tasks. Zangori, Frobes, Biggers (2013, p. 2) state:

> A crucial scientific practice is that of explanation construction which requires students to give priority to evidence in formulating evidence-based explanations that answer an investigative question and build upon their knowledge.

Therefore it is important for science teachers to conduct practical investigations with their learners. Zangori et al. (2013, p. 2) says “there is consensus that the link between evidence and explanation is central to scientific sense making”. This may enhance scientific understanding if learners visually see the investigation taking place, and hereafter they may be able to answer investigative questions and build scientific vocabulary. It is this scientific vocabulary that might be considered as scientific jargon.

According to Hirst (2003) jargon is linked “specifically to the specialized language of science and technology” (Hirst, 2003, p. 206). Jargon are words with specific meaning which are linked with science vocabulary, if used incorrectly, can “destroy understanding” of content, and when used correctly may will “remove barriers to understanding” (Hirst, 2003, p. 225). It is here where learners struggle to interpret and answer questions as they cannot comprehend the scientific investigative questions because they do not understand scientific terminology.

Teachers believe that “learners learn through experience” (Goldston & Downey, 2013), therefore teachers are encouraged to plan investigations where learners are able to visualise, and “experience science and acquire knowledge as a process”, (Goldston & Downey, 2013). These experiences and hands-on activities might be ineffective if the scientific words are not fully understood by learners, thus hindering their learning during science instigations.

2.5 Learners’ and teachers’ challenges with investigations

A crucial part of the school science curriculum is that in every term the learners are expected to complete a scientific investigation as part of continuous assessment (Department of Basic Education, 2011a). The intention of this is to improve learners’ scientific understanding and expose learners to scientific investigations in their classrooms. Depending on the resources of the school, teachers set up investigations according to the curriculum topic for the term, hereafter learners observe and engage, by

having classroom discussions and answering scientific questions. “Research shows that teachers support learners by asking probing questions at all stages of the investigation. The teachers used a questioning strategy enabling learners to understand more clearly the question or hypothesis they intend investigating” (Ramnarain, 2011, p. 53). However, what happens if the teachers are not fully understanding of the scientific terminology and if they have a class consisting of ESL learners who struggle with the language of instruction let alone the scientific jargon?

It is suggested that many teachers, especially non-science specialists in the primary school have similar understandings about science and naïve views, or misconceptions as, held by science learners, (Hind, Leach , & Ryder, 2001, p. 6). In addition Hind et al. (2001) claim that non-specialist teachers may or may not understand the scientific jargon from teacher guides or the definition given in learner textbooks. This limits teachers’ abilities to design and use higher order thinking skills to probe students’ understanding in science topics (Tshiredo, 2013). Where teachers do not further equip themselves or seek knowledge of how best to explain the scientific terms’ meanings or interpretation, learners, especially ESL ones, will struggle to understand the whole purpose of investigations. This might be how scientific knowledge becomes misunderstood and consequently regarded as difficult (Hind, et al. 2001). Teachers understanding of scientific concepts is important as their method of teaching influences how learners understand scientific concepts during their teachings, (Hind, et al. 2001).

There are certain learning demands which hinder the learning of science investigations, such as “particular aspects of the science curriculum, that arise due to differences between the social language of school science and the social language which the learner brings to the classroom (Hind et al., 2001, p. 7). This mismatch between a scientific use of a term, for example ‘theory’ and its everyday use presents challenges for both teachers and learners, especially ESL ones. This has an effect on how teachers teach and how learners learn science investigations. In order to get the correct understanding of science investigations teachers will have to teach in a manner which is understandable for the type of learners they have in their classrooms. Another factor which contributes to the teaching of Natural Sciences are the teachers’ need to have a working definition of

science concepts. This may develop from teachers' prior knowledge and assist with the explanation of science concepts. Verloop, Van Driel and Meijer (2001) state that teacher knowledge is "professional craft knowledge" (Verloop, Van Driel, & Meijer, 2001, p. 446). It is specific knowledge which is derived from the teachers' practical experience, or their formal schooling in the past, which is initial teacher education or continued professional development, (Verloop et al., 2001, p. 445). Before learners can interpret and understand science investigations their teachers need to possess sound knowledge of science concepts in order to assist learners' understanding of science concepts.

2.5.1 Potential challenges teachers experience in Natural Sciences

The role of the science teacher is to organise learners' intuitive ideas about science concepts and to build on these as an anchor for new science knowledge. Teachers are required to replace learners' initial knowledge with scientific understandings that would benefit the learners during science teachings (Pine, Messer, & St. John, 2010). However, whether learners' incorrect understanding of scientific knowledge has been abandoned and replaced with the teachers' correct conceptualisation of science, or merely held alongside the original learner concept, is unknown (Pine, Messer, & St. John, 2010, p. 80). This challenge requires teachers to identify means of assessing whether learners have rearranged their original thoughts and ideas or not. According to Joyce (2006) Concept Cartoons can be used at the start of the lesson; during the lesson or at the end to review learning (Joyce, 2006). This might indicate learners' ideas and stimulate a starting point for investigations (Joyce, 2006).

Factors which contributed to teachers' challenges when teaching science are that learners find science concepts extremely difficult to understand. Oyoo (2016) identified that, when confronted with this challenge of learners not grasping the scientific concept, teachers explained they would find synonyms for science concepts, to replace the words learners did not understand. This was done to help learners complete scientific questions, however, this did not always help as certain words that are used in everyday conversation, had different meanings in Natural Sciences. By way of example, the word '*diversity*' in everyday speaking language, means a range of different things, however, in NS '*diversity*' means "within species, between species and of ecosystems, which is linked to

Biodiversity and in Natural Sciences this is variables of all living sources (Department of Basic Education, 2011a).

Other factors which may contribute to misconceptions learners had in Natural Sciences teaching was whether the correct content knowledge was retrieved from previous teachings. Prior knowledge influences current learning and understanding. When learners lack prior knowledge this affects how new information is interpreted and understood, (Rodrigo, Ong, Bringula, & Basa, 2013, p. 3). This may be influenced by how learners interpret information according to how they were taught in previous Grades. This influences how learners interpret science lessons moving forward.

2.5.2 Challenges experienced by English second-language learners'

English Second-Language (ESL) learners face multiple challenges in the classroom, the first being the communication barrier. Learners need to translate certain words or sentences into their home language, process the information, then translated back into the original language, before attempting to respond to a question or participate in classroom discussions. Sibold (2011) states "academic vocabulary is notably more difficult to learn than conversational language because it is more specific and sometimes abstract, making it difficult to grasp" (Sibold, 2011 p. 24). In the USA "Teachers expressed frustration over the wide range of English language and academic levels and the fact that they received little professional development or in-service training on how to teach" or translate key concepts (Van Roekel, 2008, p. 2). Similarly in South Africa, the lack of teacher's knowledge to assist learners with language barriers is a major problem. Also "educational material for science teachers in South Africa does not always recognise the need for clear simple language" (Sibold, 2011, p. 3). Sometimes teachers misinterpreted language barriers as rudeness or they assume the learner has no way of addressing to an adult (Van Roekel, 2008, p. 3).

Cummins (1989), cited in Mayaba (2008, p. 15) "stated that there is a cognitive process where what is known in the first language can be transferred to the second language". This suggested that learners are able to learn successfully in an additional language, if they are fluent in their mother tongue. However, there is a tendency for black parents, to prefer their children attending English medium schools. Their motivation is a perception

that the standard of education is higher in these schools. Additionally there is an assumption that English is the language of power, giving an advantage that would grant their children affluent careers (Prinsloo, 2007). This stems from the influence of politics and commerce. Parents feel that being fluent in English places their children at an advantage which will enable them to communicate, and interact in society (Krügel & Fourie, 2014, p. 40). What happens is a potential neglect of fluency in the first language, thus hindering understanding when learning is happening in a second language. What these parents, who send their children to schools where they are taught in a second language, are unaware of is the "conversational skills their children pick up are no indication that they have acquired cognitive academic language proficiency" (Prinsloo, 2007, p. 94). Gibbons (2002) claims that many second-language learners seem able to cope with English at school, yet have academic or literacy related difficulties in class. These ESL learners "…require more linguistic skills to use language for academic purposes than it does to use it in everyday conversation", (Gibbons, 2002, p. 4). Learners may feel confident when speaking English with their friends and people whom they are comfortable with because, it is often "easier to talk to people we know well and with whom we are at ease than to converse more formally with a stranger" (Gibbons, 2002, p. 4). There are a variety of teaching resources which may assist ESL learners with conversing and improving science vocabulary. According to Keogh and Naylor (2000) cartoons tend not to intimidate learners with difficult words which they may struggle to pronounce and understand. It is the non-intimidating characteristic of Concept Cartoons that encouraged scientific talk and academic confidence (Keogh & Naylor, 2000).

There is a difference between social language which learners acquire in a communicative context and academic language as used in formal school teaching and learning situations. Learners are able to "acquire conversational English – Basic Interpersonal Communicative Skills (BICS), in a short time frame, however, it takes learners approximately five to seven years before they are able to function academically on the same level as English first language learners (De Wit, 2018). BICS are the language skills learners acquire to interact socially with other people (De Wit, 2018). Teachers may think learners are proficient in English when they demonstrate good social language, however, these learners require assistance and continued support to fully acquire Cognitive

Academic Language Proficiency (CALP). CALP is where learners are able to function optimally within an English medium education system" (De Wit, 2018). It is CALP that is essential for learning, thinking, understanding and communicating in all subjects" (De Wit, 2018).

2.5.3 Teachers' views of ESL learners' challenges in the Natural Sciences

South African ESL learners cannot always communicate their scientific conclusions in the language used for a test. English and Afrikaans are the only two languages of teaching and teaching (LoLT) currently used for matriculation examinations. In particular, learners who study mathematics and science in their second language tend to have difficulty comprehending the questions asked and then also struggle to articulate their answers to open-ended questions (Howie, 2001; Probyn, 2005). Villanueva (2010) showed that learners' level of language competence is so poor that they are unable to read the learning materials provided for them, and that the tasks and exercises they are given are often conceptually too difficult and beyond their competency. This results in ESL learners resorting to rote learning science content and concepts, leaving little room for deep conceptual understanding. This lack of understanding, resulting from a depleted command of the second-language, leaves learners dependent on their teachers to assist with Natural Sciences tasks and investigations (Villanueva, 2010).

There are, however, other potential factors which may contribute to learners struggling with Natural Sciences. The NS teachers themselves might be teaching science in their second language, experiencing all the concomitant challenges experienced by learners who are learning in a second-language. An aspect noted by Villanueva (2010), which may be as a consequence of teaching in a second language, is that "South African teachers appear unable to communicate attitudes of curiosity, respect for evidence and critical reflection necessary for the development of higher cognitive skills" (Villanueva, 2010), aspects that are necessary to teach the Natural Sciences. The only way of improving science education and addressing the challenges learners face in science classrooms, are to improve "the quality of science teachers being produced as well as the development of in-service teachers" (Villanueva, 2010). This might involve pre- and in-service training

in new skills and strategies that focus on the challenges of teaching and learning in a second language.

2.6 Disciplinary subject jargon and the ESL learner

Jargon is defined as specific vocabulary used by people with common interests. As new words are created within a discipline, these words are defined as jargon (Rosenberg, 2012). Jargon is used in to convey something that only a select group of readers would appreciate, i.e. readers who are already aware of the terms and their unique meanings within the context in which used (Literary Devices Editors, 2013).

Learners arrive at school with informal ways of talking and teachers have to change their communication from informal spoken and written language, to a more formal way of speaking and reading (Mayaba, 2008). As learners progress from one Grade to next, the vocabulary of the different subject discipline increases and the words become more complex. When this is coupled with the introduction of a discipline's unique jargon, the challenges for ESL learners increase exponentially with each Grade. Learners who do not understand the basics of the discipline, including its jargon, will not comprehend the content later. Kennedy, Rodgers, Romig, Lloyd, and Brownell (2017) claim that the demand on adequate reading and comprehensions skills increases substantially with increasing complex and technical (jargon) vocabulary.

ESL learners need to code switch into and out of their mother tongue in an attempt to cope with English, when English is the language of learning and teaching (LoLT). Wababa (2009) laments that textbooks in all subjects, including the Natural Sciences, tend to be written only in English[2]. It is not uncommon for teachers to use the mother tongue of the learner to explain concepts and terms, where the teacher is fluent in this language. This, however, may result in poor academic performance and might place the learner at a disadvantage because assessment tasks on which academic performance is based are required to be completed in English (Wababa, 2009). Krügel (2005, p. 3) states "English proficiency and cognitive language skills are essential for the achievement of learners

[2] This study refers to the LoLT as being English. While it is acknowledged that Afrikaans is also a LoLT in South Africa, the dominant LoLT in the IP, SP and FET is English, however, the LoLT in the FP is mother tongue where possible.

who are required to complete assessment tasks in English, and who use English to perform assessment tasks in other learning areas". ESL learners' low performance standard in science may be "attributed by limited proficiency in English and weak mastery of academic language", (Estrella, Au, Jaeggi, & Collins, 2018).

South African schools, apart from the Afrikaans-medium schools, have 'chosen' English as the language of communication, despite the South African constitution encouraging multi-lingualism. The majority of our schools do not cater for diverse language teaching (Krügel, 2005). Research provides evidence of ESL learners struggling with reading and understanding content. They lack reading vocabulary and that limits their understanding of the grammar of the English language (Krügel & Fourie, 2014).

Krügel argues that learners are successful in learning a second language if they have mastered the ability to interpret meaning in their home language (Krügel, 2005). It is difficult for learners to translate the meaning of words and then comprehend what they are reading. Research suggests that it takes learners seven years to acquire the skill of understanding the second language (Krügel, 2005 p.25). ESL learners experience subtractive bilingualism, where they are denied access to learning in their mother tongue. Subtractive bilingualism is when an additional language is added at the expense of the home language and culture (Cummins, as cited in Mayaba, 2008). According to Cummins (cited in Mayaba, 2008) learners who are taught in an additional lauguage (bilingual environment) "succeed to a greater extent than those whose first language and culture are devalued by their schools and by the wider society" (Cummins, cited in Mayaba, 2008, p. 16).

Learners need to adjust their language skills in order to fully understand what they are being taught in schools (Krügel, 2005). When learners are expected to code switch, they begin to doubt themselves and they struggle to converse and explain what they mean to others. This affects their academic performance and the true reflection of their knowledge and understanding is unknown and this might hinder their learning process. Teachers might feel 'lost' and frustrated when they are unable to help learners make that connection from the mother tongue to the language of instruction. A language barrier affects the learning and teaching process, as teachers will need more time to educate them on

terminology and then connect with the lesson. This frustrates teachers and hinders their motivation. Kadar Asmal stated in The Daily News, that “language of instruction to be a major barrier to learning, not only in the foundation phase, but throughout the entire system” (Language as a barrier in education , 2003).

Learners’ poor academic performance is not only due to socio-economic problems or learning disabilities. One needs to be aware of the language barrier that places ESL learners at a disadvantage in comparison to their peers. According to Mayaba (2008) while the language policy is aimed at promoting multilingualism, English “still continues to dominate and despite it being the language of minority, it has become the language of power and of educational and socio-economic-advancement” (Mayaba, 2008, p. 16). Therefore teachers need to be aware of the inequality that ESL learners experience in the education system, a system designed for equal rights and the wellbeing of South African learners.

2.7 Scientific jargon in Natural Sciences classrooms

“Scientists attempt to establish themselves as professionals of their discipline by using specialist terminology” (Rosenberg, 2012, p. 1), this terminology is coined jargon. It is specialised vocabulary which scientists use to “signify that they are making progress in the field” (Rosenberg, 2012, p. 2). Scientific jargon refers specific technical terms within a discipline.

Within this study Natural Sciences teachers use scientific words which are tailored for the subject. These are the words which learners find difficult to understand as they do not form part of their daily vocabulary. These words are referred to as specialist terminology within the NS discipline. For this study I focussed specifically on Intermediate Phase science terminology. The selected words selected were, renewable and non-renewable energy; controlled variables; hypothesis; fair test; unfair test; input energy; output energy.

Scientific jargon complicates and already potentially dire situation in the teaching and learning of science in schools. Nedelsky, back in 1965, lamented that “Science is now taught badly” (Nedelsky, 1965, p. xi). He elaborates “school teachers do not know much science and learning science is a slow process” (Nedelsky, 1965, p. xi). The situation

today has change little in science classrooms, however, science teachers cannot deny underprepared learners access to their Natural Sciences classrooms and might, especially in the lower grades, be themselves, underprepared to teach science. Setati (2011, p. 20) states that learners "appear to have weak scientific knowledge and more seriously they are regarded as lacking the necessary linguistic tools to construct advanced Science concepts". Minimal effort is implemented to provide learners with the understanding of what science is or what scientists do, despite attempts to explicitly teach learners about the nature of science (NoS) (Akerson, Abd-El-Khalick, & Lederman, 1999, p. 296). Science teachers load their learners with facts about science instead of providing them with understanding and teaching them how to learn science (Nedelsky, 1965). Akerson et al. (1999) have conducted research which encourages the development of science teachers' views on NOS. Teacher need to understand content and not just teach facts, this may be achieved through science content courses (Akerson, et al, 1999, p. 297). Developing science teachers NOS views may be "embedded in the context for learning science content", this will benefit in "helping teachers translate their NOS understanding into actual classroom practices" (Akerson et al. 1999, p. 297).

A possible reason for NS teachers focusing on textbook facts and not on the understanding of scientific concepts is offered by Roth (2014, p. 362) who says:

> …elementary teachers lack the science content knowledge needed to teach science effectively, have little training in science-specific pedagogy, and have even less training in the scientific disciplines they are expected to teach.

While Cutting and Kelly (2005, p. 1) claim that "science is exciting and engaging in many of the ways in which it is already taught and explained". This might not be, for the reasons supplied by Roth (2014), the case for NS teachers in the IP. Teachers with science backgrounds have a clear and functional view of what science is and what is important in terms of teaching it (Cutting & Kelly, 2015). These teachers may have ideas of what "constitutes a scientific approach and quite strongly held views on what is really important for learners to understand about science methods" (Cutting & Kelly, 2015, p. 3). The pedagogies of these science teachers may set boundaries and even define their teaching approach (Cutting & Kelly, 2015). However, this is seldom the case for IP NS teachers

who are phase specialists rather than subject disciplinary specialists. In an attempt to address the gap in the IP NS teachers' science 'toolbox' the Department of Basic Education (2011a p.12) supplies teachers with relevant 'tools' such as textbooks, workbooks, apparatus and continuing professional development workshops to better equip them in dealing with the challenges of teaching NS in the IP. Teachers need to be competent when teaching science concepts and when conducting science investigations. They need to connect that which is known with what learners have learnt in science investigations (Mayaba, 2008). Despite all these interventions little has changed in the SA classrooms. Taylor, Draper, Muller and Sithole (2012) state in the National Evaluation and Development Unit (NEEDU) report that a number of teacher workshops were available to improve teacher qualification and skills. Although these in-service training (INSET) programmes were available to improve teacher subject knowledge, these Advanced Certificates in Education (ACE) programmes may have "provide(d) training on things teachers don't really need", and rather focus on teacher self-development (Taylor et al., 2012, p. 57). The NEEDU reported ESL teachers did not benefit from these workshops, this may be that "language is a barrier or that they were not getting adequate support", (Taylor et al., 2012, p. 59).

Cummins (cited in Mayaba, 2008) stated the following: "the inability of these learners to pass science and mathematics and other learning areas of high conceptual thinking is due to lack of fluency in the language of instruction". This inadequate command of the LoTL by ESL learners becomes even more problematic, as vocabulary becomes increasingly complex and technical, substantial demand is placed on reading and comprehension skills of learners who are already at a linguistic disadvantage (Kennedy, et al., 2017, p. 1).

When introducing scientific vocabulary to learners, confusion may arise, especially if the scientific definition of the word may be different from that which they use every day. "This confusion occurs with the use of scientific terms in different contexts" (Russell, Harlen, & Watt, 1989). For example, "force" is used in a coercive context e.g. 'the teacher forced me to…" (Russell et al., 1989; Skamp, 2004). However, science gives a scientific meaning to words which may have different definitions in everyday language. This affects the

teaching of science in the classrooms. Teachers need to find ways of first understanding the scientific content, and then delivering a powerful lesson to assist learners with scientific vocabulary.

Science words need to be transcribed into an explanation which will link with concepts and content, only then can it be understood in the context of science investigations.

2.8 Scientific Investigations and jargon

Scientific jargon is an important aspect of Natural Sciences investigations. Mayaba (2008, p. 15) highlighted a strategy that might enhance scientific literacy. The strategy encompasses "…reading to learn science; writing to learn science; classroom discussion and argumentation". All these components should be applied to conducting science investigations within an IP Natural Sciences classroom. Goldston and Downey (2013) suggest that in a world that is becoming more and more science and technologically orientated, that science teachers must be able to teach children the necessary content, skills, and habits of thinking necessary to be scientifically literate. Science educators "speak of science education goals aimed at developing scientific literacy in learners" (Greyson & Botha, 2016, p. 135). Science education should be interesting and broaden learners' knowledge as well as their personal experiences, enabling them to partake in science related discussions both at school and at home, this is what scientific literacy is (Greyson & Botha, 2016, p. 135). Scientific literacy by definition of the term literacy, implies an appreciation of scientific jargon, which relates to "the connection between science knowledge, the language of science, and how science is represented in various text forms" (Greyson & Botha, 2016, p. 137). It is this scientific jargon, present in the interpretation of investigations, compiling scientific reports and using resources to research information for decision making that contributes towards being a scientifically literate learner (Goldston & Downey, 2013). All these skills are required for learners to engage in science investigations. Therefore it is crucial for learners to understand science terminology. However, teachers are faced with unique challenges such as teaching complex concepts to ESL learners, "who are yet to fully develop proficiency in English" (Estrella et al., 2018, p. 2). According to Estrella et al. (2018, p. 2) "inquiry-based instruction has been shown to improve the science achievement of English-proficient

students". The nature of inquiry-based learning may be beneficial to ESL learners by posing questions, problems and scenarios to analyze (Estrella et al., 2018). Teachers may need to implement inquiry-based approaches to encourage science investigations and improve scientific jargon as "hands-on instruction makes science learning more engaging, concrete and meaningful", (Estrella, et al., 2018, p. 1).

Children enter the science classroom with prior knowledge and socio-cultural influences from their homes, communities, friends and the media. These external influences may affect what they are being taught and what they will learn, (Mayaba , 2008). Learners may developed negative stereotypes of science and towards science teachers. These stereotypes and misconceptions may have been from negative attitudes and/or undesirable experiences from previous science teachings, (Movahedzadeh, 2011). Other factors which may contribute to learners' misconceptions of science investigations are confusion, caused by information they are being taught contradicting the information they experience outside the classroom. (Movahedzadeh, 2011). The way science is taught plays a role in shaping learners perceptions of doing investigations. As learners progress from Grade to Grade they are faced with different challenges, e.g. having to adapt to new teaching methods (Movahedzadeh, 2011). However, when the learner is an ESL learner, all the above pale into insignificance when they are presented with challenge of trying to make sense of science that is shrouded in jargon. With this in mind, one must take note of what Mayaba (2008, p.1) suggests: "Research on science literacy suggests that teacher education and professional development strategies should assign a more important role to language in terms of learning and teaching science".

2.9 Concept Cartoons

The Concept Cartoon is a teaching tool used to stimulate learners' thoughts when addressing conceptual science topics (Naylor & Keogh, 2000). These Concept Cartoons give learners different methods or approaches and ways of thinking about scientific concepts. They stimulate different ways of how learners might respond or answer a question or investigation. Learners are encouraged to think deeper and further than what

is being observed and animated in the Concept Cartoon. Birisci, Metin and Karakas (2010, p. 3) explain what a concept cartoon is:

> They feature cartoon-style drawings showing different characters arguing about an everyday situation, are designed to intrigue, to provoke discussion and to stimulate scientific thinking and may not have a single “right answer”.

Science is always based on evidence or facts. Concept Cartoons enable learners to be confident in their opinions and answers when approaching scientific scenarios, even if their views and opinions are different from others (Naylor & Keogh, 2000).

Concept Cartoons use various designs and methods to trigger learners’ interests. Visual pictures are used as scenarios that addresses the interests of learners (Naylor & Keogh, 2000). The situation or context of the cartoon is aligned and related to the learners’ situation or context. By doing this Concept Cartoons attempt to iron out possible misconceptions that learners may have around a particular topic, concept or situation. Learners’ thoughts are directed in a direction that gets them thinking about the most suitable or almost perfect response to the cartoons’ prompting idea or question. The stimulus created by the Concept Cartoon gets learners thinking positively about applying their theories and answers to relevant scientific questions (Naylor & Keogh, 2000).

Whatever the scenario, question or investigation, the Concept Cartoon invites learners to discuss the concept in dialogue with each other, addressing the relevant scientific questions which in turn promotes learning new scientific terminology. Research has also uncovered evidence that Concept Cartoons have the capacity to enhance learners’ academic confidence (Naylor & Keogh, 2000).

Concept Cartoons are visual learning tools which are suitable for learners who struggle with reading. The cartoons tend not to intimidate learners with difficult words which they may struggle to pronounce and understand (Naylor & Keogh, 2000). It is this characteristic, not intimidating for ESL learners, that makes Concept Cartoons particularly attractive to teachers who teach, and learners who learn, in a second-language. The cartoons appear simple and uncomplicated. The short sentences in the callouts or speech bubbles coupled with an uncomplicated sketch contribute to making learners feel they are

interacting directly with the cartoon characters (Naylor & Keogh, 2000, p. 6). Learners are encouraged to view the cartoon characters as a replicas of themselves at school, home, sports field or engaging in discussions with friends. They compare themselves and their peers to the characters in the cartoon. These characters are accepted as familiar beings that co-exist in their world. This gives learners a comfortable platform which enhances their self-esteem, allowing them to comfortably address the scientific scenario (Naylor & Keogh, 2000). After the platform or scene has been set via the sketch in the cartoon, learners feel free to discuss their views and give answers about the topic or concept addressed by the cartoon. Learners experience a sense of safety or comfort when discussing the cartoon, because, even if their view is incorrect, they focus on the idea that they are merely expressing their understanding of what is being displayed by the cartoon itself. They feel safe expressing their incorrect views as they could later 'blame' the cartoon for misconceptions or false information (Naylor & Keogh, 2000).

Educators may teach in traditional ways when delivering content to learners without identifying the best suited method for each learner, however, "not all children learn the same way" (Naylor & Keogh, 2000, p. 8). Couple this with there being, in the class, learners who do not have a strong command of the LoTL, for example ESL learners, and a situation is created where learners may be being set up to fail. Concept Cartoons provide different ways of how a question can be addressed. This teaching tool allows the learner to cognitively design a method for themselves of how they will construct the answer and derive a conclusion. Learners identify with visuals and the short dialogue, in the form of 'callouts' or 'speech bubbles'. This has been shown to have the potential to awaken learners' scientific background knowledge and ideas. This method of learning may gear their thinking skills in a more logical and scientifically appropriate direction. Another feature is that Concept Cartoons assist in making the connection between conceptual and procedural understanding in science (Naylor & Keogh, 2000). Procedural understanding relates to hands-on investigative activities in science. The use of simple language within the Concept Cartoons thus has the potential to link concepts, jargon and practical activities for the learner.

While learners may not be consciously aware that, while they are engaging with Concept Cartoons, they are developing a variety of thinking skills. In addition to enhancing thinking skills, Concept Cartoons have been shown to provide opportunities for the development of other scientific skills, including, but not limited to: "…hypothesising; predicting; using analogies; evaluating evidence; asking questions and justifying point of views (Naylor & Keogh, 2000, p. 8). With careful planning and construction of the cartoons the potential exists to promote an understanding of the scientific jargon that scaffolds science concepts. This method of learning allows learners to connect prior scientific knowledge with what they have discovered while interacting with the cartoons. Concept Cartoons also broadens learners' ability to think cognitively as they process information. How they view the cartoon and interpret the information depends on their background literacy, prior experience, age, Grade and previously acquired scientific knowledge (Naylor & Keogh, 2000).

Opportunities to use Concept Cartoons appear to be endless. They have been used before, during and after a science lesson. Additionally, Concept Cartoons have been shown to be a suitable method for assessing learners both informally and formally (Naylor & Keogh, 2000). An informal method is when teachers have an open dialogue about the characters in the cartoon and what they are saying and doing. Learners can respond to this by raising their ideas and opinions and they can state why they agree or disagree with a certain character. Learners are granted an opportunity to defend their ideas by scientifically proving their theories informally and they can take a stance by agreeing or disagreeing with each other. This informal assessment method might, however, require teacher mediation. Also, pre- and post-discussions can take place to gather learners' levels of understanding about a particular topic (Naylor & Keogh, 2000). The cartoon might remind learners of functional writing in English, thus making them feel comfortable and at ease when completing assessment task. Naylor and Keogh (2000) claim that this form of assessing does not intimidate learners when completing formal assessment tasks either.

Concept Cartoons (Sexton, 2000) give little information about the character via the speech bubbles, and it is this that has been shown to intrigue learners' imaginations.

Learners' thoughts and ideas appear to be stimulated and it is this that makes them want to know more about the cartoon, the characters and the concept that the cartoon is addressing. This stimulated interest has been shown to encourage further reading about the topic in some learners. A carefully chosen and suitable Concept Cartoon is a great start to get learners thinking spontaneously about science. It is this spontaneity that guides the teacher with substantial information about how learners are thinking about the topic and how they can further guide learners' thoughts to encourage scientific thinking (Naylor & Keogh, 2000).

Concept Cartoons can be used for all age groups in every Grade. It is a learning method that expands the thinking skills of learners and gives learners the opportunity to conclude an answer on their own. This also depends on the different levels of understanding of each learner. Once these levels of understanding have been identified, gathering research about how much knowledge they have gained after using Concept Cartoons can be identified (Naylor & Keogh, 2000).

The key characteristic of Concept Cartoons is that they creates discussion or argument between cartoon style characters. These cartoon drawings provoked a positive response amongst learners as they see this as an invitation to express their views and opinions with their peers (Keogh & Naylor, 2000). Keogh and Naylor (2000, p. 10) stated, "Learners appear keen to join the discussion and are often eager to carry out an investigation to explore the alternatives". Teachers aspire to achieve this in their classrooms when teaching. The purpose of Concept Cartoons is to address learning needs through creative teaching ideas. Concept Cartoons have adapted the following aspects which has been identified in different learning environments:

- ✓ Representing scientific ideas in everyday situations wherever possible, so that connections are made between scientific ideas and everyday life.
- ✓ Using minimal amounts of text in dialogue form, in order to make the ideas accessible to learners with limited literacy skills.
- ✓ Using a simple cartoon-style presentation which is visually appealing and which empowers teachers and learners to create their own Concept Cartoons.

- ✓ Using published research to identify common areas of misunderstanding, which then provide a focus for the Concept Cartoons.
- ✓ Presenting several possible alternatives and ensuring that the acceptable viewpoint(s) is included amongst the alternatives.

Keogh & Naylor, 2000, p. 12

The Department of Basic Education (DBE), via the Curriculum and Assessment Policy Statement (CAPS), guides teachers on an almost daily basis with their lesson planning. One component of Natural Sciences IP CAPS document is the "pursuit of new knowledge and understanding of the world around us and of natural phenomena" (Department of Basic Education, 2011b). The first component of Concept Cartoons, consult the list presented above, is the representation of scientific ideas in everyday situations and Concept Cartoons may assist learners to connect the scientific ideas to that of everyday life (Keogh & Naylor, 2000). Another component of Concept Cartoons which interlinks with the (CAPS) document is that the cartoons aim at "challenging and developing the learner's ideas" (Naylor & Keogh, 2000, p. 11). The Specific Aim 1 presented in the CAPS NS document, namely, Doing Science and Technology, links to the characteristics of Concept Cartoons. This Specific Aim refers to "learners should be able to complete investigations, analyze problems and use practical process and skills in designing and evaluating solutions", (Department of Basic Education, 2011a, p. 10).

Teachers who have implemented Concept Cartoons have provided positive feedback about using them as teaching tools, emphasizing that Concept Cartoons do not restrict learners' ideas to those of the cartoon style characters. Teachers, by listening to learners' discussions as they interact with the cartoons and probing their thinking and perusing their class notes, find support for the idea that Concept Cartoons enable learners to add their own ideas to the mix presented by the cartoon characters (Keogh & Naylor, 2000).

Concept Cartoons are not only teaching and learning tools, but, as observed in this study, they can also be instruments used in research. Concept Cartoons can be utilized to research various aspects of teaching and learning, for example, cognitive conflict argumentation, formative assessment; the challenges presented by misconceptions, and certain features of teachers' professional learning. In this last case, they can be used to

research how teachers might implement constructive teaching approaches during lessons; or how their pedagogic subject knowledge might be influenced by these cartoons (Naylor & Keogh, 2012).

Further information provided from Keogh and Naylor findings suggest, and this is a common comment from teachers, particularly those working with learners who have behavioral difficulties, is that these learners were eager to engage in classroom discussion and share ideas when they worked with Concept Cartoons (Keogh & Naylor, 2000).

2.10 Concept Cartoons in the Natural Sciences

The creators and developers of Concept Cartoons, Stuart Naylor and Brenda Keogh, initially developed this teaching approach to challenge the thinking of teachers who attended science INSET (in-service teacher training) courses. Naylor and Keogh (2000) report that after the success of Concept Cartoons in teacher training they promoted their ideas extensively through conferences and writing articles for the Association for Science Education. They received feedback from numerous sources and were encouraged to make Concept Cartoons functional in other areas of teaching.

Webb, et al. (2008) used Grade nine learners to investigate the development of argumentation in Natural Sciences classrooms using Concept Cartoons as a learning tool. They concluded that learner participation in science lessons had improved when argumentation was implemented via these cartoon style drawings. It is this enhanced learner participation, during the use of Concept Cartoons, that might be attractive to NS teachers attempting to get hesitant ESL learners to actively engage and actively participate in the science classroom.

Letsoalo (2011) investigated how Concept Cartoons, accompanied by prompt sheets, could assist Grade nine learners to plan scientific investigations. The cartoon style characters helped her learners to understand the content, this then made it easier to construct science investigative questions and consequently promoted effective planning of the investigation. “The learners appeared to have aligned their views on the phenomenon with the conception expressed by a character depicted in the cartoon”

(Letsoalo, 2011 p. 81). In this case, the cartoon characters where able to assist learners in identifying investigable questions. Possibly also prompting the learners on how to approach the investigation. For example, the identification of the different variables. Furthermore the cartoon and the prompt sheets, which was Letsoalo's contribution, hold much promise as scaffolding mechanisms. These helped in addressing the challenges that are identified in learner-centred investigations, namely, the identification of variables.

2.11 Educative Curriculum Materials

Curriculum materials are considered to be resources, e.g. textbooks, work books, other material resources, posters, worksheets etc. that support the curriculum. Their primary aim is to promote learning in learners (Schneider & Krajcik, 2002). On the other hand, there is a category of curriculum materials that are designed to promote, teacher learning and teaching, but, as a consequence of enhanced teaching skills by the teacher, they should also promote learning in the learners. These materials that are designed to support both teacher and learner learning are referred to as Educative Curriculum Materials (ECM) (Schneider & Krajcik, 2002). According to Davis and Krajcik (2005, p. 3) "Educative Curriculum Materials should help to increase teachers' knowledge in specific instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations" (Davis & Krajcik, 2005, p. 3). ECM are learning materials designed to assist teachers in developing their skills with the curriculum they are teaching i.e. teacher learning. An educative curriculum material, enhances the learning of learners as well, by identifying the key areas that can help with learning barriers; dealing with learners from diverse backgrounds and achieving the learning outcomes set in the curriculum (Davis & Krajcik, 2005).

Teachers should use curriculum resources to guide their pedagogy. It is when these materials are used to guide their praxis (i.e. how they turn theory into practice), that these resources might be considered as ECMs (Beyer & Davis, 2009). According to Beyer and Davis (2009), ECMs guide and assist teachers to make carefully considered decisions about how best to promote learning in the classroom. While it is acknowledged by teachers that well designed curriculum materials are always useful, they are viewed as particularly helpful for teachers who are teaching subjects that might be outside of the

particular teaching specialization. Also, first-time teachers rely heavily on curricular tools as a guide for instructions on how to teach the subject, (Beyer & Davis, 2015). For this reason curriculum materials serve as crucial resources which add value to developing skills and creating effective teaching routines. As Beyer and Davis (2009) suggest, when any curriculum material, either in its entirety, or in parts or sections of it, are explicitly designed to promote teacher learning, then they can lay claim to being considered as and ECD.

Beyer and Davis (2009, p. 680) explain that while ECM might not only inform teachers on what and how to teach, they also engage teachers in "the ideas underlying the writers decisions and suggestions". ECMs assist teachers to make informed decisions on how to craft their instructional practices, allowing for teacher reflection that enables teachers to review their work "by developing their knowledge and beliefs about content and learners".

Drake, Land, and Tyminski (2014) argue that the development of Educative Curriculum Materials has changed the belief that good teachers do not use, or need, curriculum materials to interpret subject knowledge. In the past it was suggested that good teachers are those who do not need to refer to textbooks and other related resource material. Good teachers were considered to be those teachers who crafted and implemented their own curriculum. With the development of Educative Curriculum Materials this myth has been consigned to the rubbish bin. Educative Curriculum Materials are designed to support teacher knowledge and develop skills necessary to meet specific needs of the learners, as well as delivering content structured according to the intended material outcomes, (Drake et al. 2014). Furthermore ECM are used to promote teacher learning, and should be viewed as opportunities for teacher learning (Beyer & Davis, 2009).

According to Davis and Krajcik (2005, p. 3)

> Educative Curriculum Materials should help to increase teachers' knowledge in specific instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations.

It is this latter part "…(to) develop more general knowledge that they can apply flexibly in new situations", that, according to Davis and Krajcik (2005) is what differentiates an

educative curriculum material from basic curriculum materials such as textbooks and teacher guides. These basic curriculum materials are designed to assist teachers with strategizing their lessons, but it is ECM that explicitly set out to enhance teacher learning.

2.12 Concept Cartoons as an educative curriculum material

The short response to the question *"Can Concept Cartoons be considered to be an example of an Educative Curriculum Material?"* is "yes". The creators of Concept Cartoons (Naylor & Keogh, 2000) initially generated these materials to be used in the training of in-service teachers. Their aim was to provide materials that would assist teachers with the teaching of scientific concepts as well as assisting these teacher with their own understanding of the concepts. Concept Cartoons can assist teachers with developing their own subject knowledge and understanding, (Naylor & Keogh, 2000). One advantage of Concept Cartoons is that they might mask teachers' uncertainty. As part of teacher preparation, teacher can review their own understanding before content is taught, and during this review their can support their own understanding of the science concept and thus ensure they can justify which alternatives in the cartoon are correct and motivate for the rejection of incorrect or inappropriate cartoon character statements (Naylor & Keogh, 2000). Teachers are not expected to know it all.

The focal aim of this study was to investigate whether Concept Cartoons have the potential to be an Educative Curriculum Material (ECM) with respect to assisting teachers to promote ESL learners understanding of scientific jargon specifically in scientific investigations. As such the study involved teacher learning and their perceptions of whether Concept Cartoons helped with learner understanding of scientific jargon. As claimed in the previous section, ECM materials possess specific qualities in contrast to the characteristics and intentions of teacher guides or other teaching materials. Teachers' guides and similar resources assist teachers to teach better, whereas ECM are "intended to increase teacher knowledge" as well as enabling to improve their teaching (Neuman, Pinkham, & Kaefer, 2015). Neuman et al. (2015, p. 988) suggest that the intention of an ECM is to focuss on "instructional decision making and to develop more general knowledge, that may be applied flexibly in new situations". The purpose is for teachers to understand these educative elements as they interpreted the curriculum, focusing

primarily on designing lesson plans that align with the theoretical intentions and instructional features of the curriculum resources (Neuman et al., 2015). This, they claim, would help teachers to conduct successful lessons. Further information indicated Educative Curriculum Materials are especially useful for novice teachers, who might need guidance and support. These teaching tools would provide novice teachers with new strategies necessary to support learners' construction of knowledge (Neuman et al., 2015).

Previous studies identified a gap in vocabulary knowledge and incorrect sentence interpretation among ESL learners. ESL learners do not possess previous knowledge to interpret scientific words correctly. They end up studying the meaning of scientific words, sometimes they misinterpret them or use them incorrectly because some scientific words have multiple meanings. This leads to misunderstandings of sentence construction and interpretation, (Chalermbunti, Kittipol, Na Ranong, & Tangworakitthaworn, 2017). One of the elements of Concept Cartoons is that it promotes language and literacy learning (Naylor & Keogh, 2000). An aim of Concept Cartoons is to address these language barriers which learners have by making learning fun, interesting and not monotonous.

2.13. Chapter summary

This chapter used relevant resources from the literature to provide an insight of how different aspects are affected in teaching science investigations to ESL learners.

The chapter starts by situating the study within the context of teaching Natural Sciences in the Intermediate Phase. While the study involves a particular curriculum material, namely the Concept Cartoons, it really is about how teachers perceive this material as being useful for teaching jargon in science to ESL learners and how Concept Cartoons assist them with their own learning and teaching. As such the CAPS section is followed by a section that deals with teachers' own learning.

This chapter provides a brief attempt at understanding the daily struggles teachers experience in the Natural Sciences classrooms when conducting science experiments and scientific investigations for assessment purposes. Factors such as language barriers; lack of teacher resources; terminology restraints and lack of teacher pedagogies are

reported on. Chapter two introduces a potential game changing tool and strategy, namely the Concept Cartoon, which might positively promote teacher learning and teaching and learner learning in the challenging teaching environment where the LoTL is not the main language of either the teachers or the learners. The final part of the chapter attempts at making an argument for Concept Cartoons to be considered as an Educative Curriculum Material i.e. is resource that promotes both teacher and learner learning.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The purpose of this chapter is to explain the research design and methodology of this study. The instruments used for data collection are explained and justified as well as how these data were collected and analysed.

The aim of this study was to investigate how Concept Cartoons were implemented as a potential Educative Curriculum Material (ECM) to influence the teachings of Intermediate Phase (IP) Natural Sciences (NS) teachers with respect to scientific jargon within the context of scientific investigations.

The chapter is structured around the following ideas: 1) different paradigms, with reason as to why the constructivist approach was chosen as the theoretical framework 2) the research design focusing on a qualitative approach, with sub-sections as to why this research fits into a case study. Included here is an exposé of the design of the research instruments and how they were suited for this study. Reliability and validity of these tools is discussed. Furthermore the data collected, demographics of the chosen school and participants and how they contribute towards conducting this research is presented. The strengths and potential weaknesses of the data and the analysis of data follows; 3) the research methodology and rationale for its use. Other factors which have been highlighted in this chapter are: 4) the limitations of this study and what issues could have been addressed if the circumstances of the study were different. Last, 5) the ethical procedures are noted explaining how the researcher had gained access from the different ethical boards and persons before conducting interviews with participants.

3.2 Philosophical assumptions and different paradigms

Creswell (2007, p. 15) claims that “The design process in qualitative research begins with philosophical assumptions that inquirers make in deciding to undertake a qualitative study”. A reason for the selection of a qualitative study was an intention to probe participants’ understanding and opinions and views on the use of Concept Cartoons in

their own learning and teaching environment (Zainal, 2007). This is in contrast to a quantitative research approach that might have provided only limited information and in-depth explanations of social and behavioural insight of people. The intention of this study was to really probe the teachers on their experience of using Concept Cartoons in their classrooms with the focus on assisting ESL with the scientific jargon associated with scientific investigations. I adopted a qualitative approach, as "…qualitative research can help interpret and better understand the complex reality of a given situation and the implications quantitative data" (Mack, Woodsong, MacQueen, Guest, & Namey, 2011, p. 2). This type of study has embedded itself within the principles of a case study, which are the selection of "a small geographical area along with a limited number of individuals as the subject of the study" (Zainal, 2007).

The implementation of a method, which Creswell (2003, p. 5) describes as specific "techniques or procedures" used in the study, were semi-structured interviews conducted with primary school Natural Sciences teachers. These interviews helped "with the interviews characterised by increasing levels of flexibility" (Edwards & Holland, 2013, p. 3).

The theoretical perspective of any study, i.e. "the philosophical stance" or "worldview" (Creswell, 2003, p. 4) that lies behind the methodology might be, for example: positivism; post positivism; interpretivism; constructivism etc. Creswell (2007) states "a paradigm or worldview is, a basic set of beliefes that guide action", (Creswell, 2007, p. 19). There are many different such paradigms and they continue to evolve over time. The paradigm or worldview which I chose, and that shaped this study, is based on my beliefs and how I have interpreted the world through the eyes of the participants in this study (Creswell, 2007).

For the purpose of this study I have included a brief outline of the different paradigms or theoretical frameworks that might, under specific circumstances, be appropriate to certain studies that are situated in an educational setting. This current study fits into a specific worldview, and the selection of that will surface once the reader has progressed through

the brief introduction to possible paradigms (or theoretical framework) that might underpin any study in education.

3.2.1 Positivist view

A positivist approach is when results are generated using a "scientific method". In this approach McGregor and Murname (2010, p. 5) claim that "It is imperative that the entire research process be objective to reduce biased interpretations of the results". Positivist researchers believed "…that the social world can be studied in the same way as the natural world, that there is a method for studying the social world that is value-free and that explanations of a causal nature can be provided" (Mertens, 2010, p. 11). Researchers who situate their studies within the positivist paradigm believe there is one true reality which exists. Such studies are associated with quantitative research, where the researcher sets out a structural approach using statistical and mathematical techniques to gather data; and tests theories using hypothesis. Positivists separate themselves from the participants so as to avoid being emotionally involved and to remain neutral when distinguishing between what is truth and feelings, (Edirisingha, 2012). Lichtman says that positivists assume that the role of the researcher is neutral and that their role is to describe an objective reality (Lichtman, 2013). When a researcher implements a positivist approach, they remain objective and observe an environment without interacting with participants. They attempt to create and maintain a distance between themselves and the respondents (Edirisingha, 2012). My current study does not fit within this worldview as interviews and interactions with participants prove to be a valuable source for gathering data. This study requires an in depth probing of participants' views and opinions, and as such the positivist approach is completely inappropriate for responding to this study's research question.

Lichtman (2013, p. 10) claims that as "…it became evident that capturing a reality that was 'out there' was difficult if not impossible to achieve", other worldviews began to emerge. It was in this context that spawned the post-positivist paradigms.

3.2.2 Post-positivist view

Post-positivists assume that one should attempt to explain reality via multiple methods, ensuring that these methods are logically connected to each other (Lichtman, 2013; Creswell, 2007). This results in an opportunity to identify multiple possible realities rather than a single reality. This approach sets out to recognize patterns and casual effects of culture about communicative behaviours and practices (Blackwell, 2016). This worldview follows the positivist paradigm and it focused on measuring and comparing cultural norms on emotion display rules (Blackwell, 2016). In a positivist approach the intention is to remain absolutely objective and unbiased and stringently maintain an independence between the researcher and the respondent[3], whereas a post-positivist approach accepts that epistemology can influence what is observed (Cresswell, 2003). Post-positivists psychologists rejected "the positivist view that what could have been studied was limited to only that which could be observed" (Mertens, 2010, p. 12). However, the purpose of the post-positivist was not to overlook or disregard all positivist ideas and claims about scientific methods, but rather elevate and upgrade their ideas by accepting the potential for a degree of subjectivity in certain areas of research (Adam, 2014). Adam (2014, p. 5-6) says that post-positivistism "does not reject quantitative methodology, but it does attempt to harness it within a more complex research design". The knowledge that develops in a post-positivist worldview is defined by careful observation and measurement of the objective reality which exists "out there" in the world, (Creswell, 2003, p. 7). Acknowledging that observation is fallible, one cannot accept the existence of an external reality as generated by post-positivist research when observing or studying the environment of humans.

3.2.3 Interpretivist view

An interpretivist sees the world through the perceptions and experiences of participants (Thanh & Thanh, 2015). When collecting data the researcher respects the opinion and views of the participants. The interpretivist researcher is aware that there is an

[3] Note that positivist tend to use the term 'respondents', suggesting that the subjects respond to external prompts, whereas the interpretivist and constructivist researchers prefer to use the term 'participants', thus creating a more merged interaction between the researcher and the 'subject'.

interconnectedness between values and facts and the two are inseparable when reaching consensus and uncovering data (Creswell, 2007). This paradigm is characterized by the need to understand the situation the participants are faced with from a subjective point of view, therefore the researcher is actively involved throughout the research process (Ponelis, 2015). Furthermore, "…interpretivists avoid rigid structural frameworks, such as the positivist research and they adopt a more flexible research structure" (Edirisingha, 2016, p. 4). In an interpretivist approach, findings are understood differently to that of the positivist paradigm. While in a positivist paradigm the results of the evidence gathered might be generalized to a wider population, the interpretivist results might only reflect on a small section of the population. Findings which evolved from an interpretivist paradigm are harmoniously agreed upon by the opinions of the participants (Ponelis, 2015). The interpretivist approach has the potential to be used in my study, however, it is the constructivist paradigm that presented a better choice for my study in that it considers the participants as acting on prior knowledge, experiences and social contexts. It is considered that these prior constructs shape how the participants might interpret the world.

3.2.4 Constructivist view

Once you have identified a topic you want to study and investigate, you need to think how you will address this problem, and your approach will determine how you solve it. Every researcher has his/her own opinion of what represents truth and knowledge. These views steer our thinking, beliefs, values and knowledge about society and the world we live in. Paradigms used by qualitative researchers vary with the set of beliefs they bring to research, and these paradigms have continually, evolved over time, (Creswell, 2003). People's interpretation are changing and the way we conduct research is evolving. These interpretations are influenced by our beliefs and how we investigate and involve ourselves as researchers.

A constructivist approach, relies on information from the participant, through social interaction (Creswell, 2003, p. 20). This approach is focused on individual development, in relation to the social world and interaction with gained experiences and fostered ideas. Within a constructivist worldview the "…individual seeks understanding of the world in

which they live and work…and their feelings are influenced by experiences" (Creswell, 2003, p. 20). As a researcher, I am not a participant of what constitutes my study, however, I am involved, in that I facilitate the learning process that occurs in the study. A relationship exists between the data gathered and the world which constitutes my studies. I am external to the data collected, yet internal to the emergence of the world which constitutes my studies (Levers, 2013). The constructivist approach was best suited for this study as the inquirer bases their feelings on what they have experienced. They develop opinions about these experiences and interpret these into valuable resources which will benefit the participant, (Creswell, 2003, p. 20). The researcher will translate these meanings into different views that will be coded into data. Interviews were conducted to gather information, regarding Natural Sciences teachers intuitive experiences gained from teaching with Concept Cartoons. For a researcher to have an objective opinion about their studies remains difficult. It was difficult for me to separate myself from this study as I have my opinions about the context in which my study was situated.

3.3 Research design

The research design of this study are the particular steps taken to effectively carry out the research procedure. This design is established by certain "decisions regarding what, where and when" and it also "constitutes the blueprint for the collection, measurement and analysis of data" (Kothari, 1990, p. 31). This means the design provides an outline of what the researcher will do, starting with the formulation of the problem statement through the operational implications of the study until the "final analysis of data" (Kothari, 1990, p. 31).

The researcher had received approval from Nelson Mandela Metropolitan University (now known as Nelson Mandela University) to conduct research on the topic*: The potential of Concept Cartoons, as educative materials, to teach the jargon of scientific investigations in Primary School Science* (see Appendix 1). After approval was granted, the researcher approached the Department of Basic Education in the Eastern Cape to gain access into the Northern Area Schools. It was important for this research to be conducted within this specific area, focusing primarily on schools situated in the Northern Areas, as these

schools have a large school-going population of English Second Language (ESL) learners. Approval was granted for entrance into four schools in the Northern Areas (Appendix 2). Once this letter of permission was completed, the researcher scheduled a meeting with the principals of these schools. This meeting was held to formally introduce the research proposal to all principals, and inform them of how this research might benefit IP NS teachers and learners. After the principals granted the researcher access and informed IP NS teachers, an introductory workshop was scheduled to formally introduce this study, its purpose, benefits and implications to the potential participants.

A total of nine teachers were interested in participating in the study, three teachers from each Grade (Grade 4; five and six). All teachers attended an introductory workshop which was scheduled after school, a total of three workshops were planned for each IP Grade. During those workshops the researcher displayed a PowerPoint presentation of the expectations of the study (Appendix 10) and teachers were introduced to each other, creating a network of relationships and mutual understanding of the content relevant to their specific Grade. The teachers had the opportunity to ask questions, and clarify uncertainty they may have about the investigation.

All participants completed a biographical sheet which was used to categorise teachers based on their experience and qualification gained (Table 1). The researcher explained to participants that they would each be expected to conduct an investigation with their learner during a Natural Sciences investigative lesson. This was done at the start of term 3, this lesson had to be embedded with prior content from each Grade.

3.3.1 Orientation session

An orientation session was conducted with the nine IP NS teachers who participated in this research. This orientation session was important to introduce myself as the researcher and provide participants with the expectations of this study. Three sessions were held to accommodate the times when participants were available to meet after teaching hours. The researcher designed a PowerPoint presentation to briefly explain who the originators of Concept Cartoons were and how their research has impacted teaching and learning. This presentation also summarised how this topic, Concept Cartoons, ignited interested within me, both as a researcher and as a Natural Sciences

teacher. Participants were informed about how the researcher has implemented this researched tool in the subject Natural Sciences specifically focusing on investigations.

Further it was emphasised as to how this teaching tool might benefit, not only those teaching in the Northern Areas Schools, but all teachers who desire fun and interesting teaching strategies to enhance their teaching and learning of science knowledge and vocabulary. Participants were informed that feedback is crucial and would provide valuable information towards this study. Their role was clearly explained and the relevant ethical documents were designed for each participating member to complete. A biographical information sheet was used to gain further information about each participant's qualifications and teaching experience. Each participant had agreed to partake in this study and implement the teaching tool with their learners, provided that this did not divert from what they would have been teaching as per the Curriculum Assessment Policy Statement. All participants agreed to partake in this study and provide feedback to the researcher about their experience of implementing Concept Cartoons in their classrooms.

3.3.2 Introductory workshop

An introductory workshop was planned, to introduce participants to each other, creating a network of relationships between IP NS teachers, who were going to partake in a similar experiment within their class Grades.

Participants were informed how the teaching tool, Concept Cartoon, should be implemented and what needed to be observed during this lesson. Teachers did not need any apparatus or resources, beside the Concept Cartoon, to conduct the investigative experiment. They needed to observe learner interaction with the Concept Cartoon, as such, they would be the eyes and ears of the researcher. After the investigative lesson was implemented, interview dates were scheduled to meet and discuss what transpired from the implementation of the Concept Cartoon during Natural Sciences investigations lessons.

3.3.3 Questionnaire

For this study there were two questionnaires, the first one was the biographical questionnaire (Appendix 9), completed by each participant. This was considered a pre-interview, consisting of general questions about the participants teaching history; their subjects they taught; their teaching experience and skills they have obtained throughout their teaching careers. Furthermore this provided information of the participants' science concept knowledge. This information is summarised in Table 2, where pseudonyms were used instead of the participants' real names.

The second document was an interview questions sheet (Appendix 3). This sheet was designed as a guide for the researcher. It eliminated unnecessary questions, which may have arisen during interviews, and allowed for a continued flow of relative and meaningful questions to be asked. Not all questions were asked as this was a qualitative study specifically focusing on semi-structured interviews as a means of gathering data. These questions were a guide during the interview process which allowed for participants' responses to influence the substance of the interviews, thus promoting the gathering of rich data. The researcher designed the interview questionnaire, which was used as a guide throughout the interview process. This was done to make sure all relevant questions were asked after teachers had conducted investigation of Concept Cartoons with their learners.

3.3.4 Interview

This study relied on information from participants' engagement with the teaching tool Concept Cartoons in a Natural Sciences investigation classroom. Interviews were conducted to identify the potential of Concept Cartoons to assist teachers with Natural Sciences investigations. A qualitative research approach was applied as knowledge was gained through interviews. The method incorporated was semi-structured interviews of educators only.

An interview question sheet was designed to assist the researcher in gathering meaningful questions, due to limited time constraints with each participant. The teachers had informed the researcher, they wanted these sessions to be meaningful and

productive as they administrative duties and moderation workshops to attend. This interview sheet was a guide to assist with semi-structured interviews.

3.4 Research methodology and rational for its use

Research is defined as the “search for knowledge”…”through objective and systematic method of finding solutions to a problem” (Kothari, 1990, p. 1). Methodology is when the researcher takes a stance when doing research and he/she identifies an appropriate way of acquiring knowledge and what particular method should be employed to acquire this knowledge. The methodology is an arrangement of how the researcher aimed to answer the research question. It indicates “the main path to a destination”, (Jonker & Pennink, 2010, p. 33).

For research to be conducted, a problem will emerge or be identified and you will need to determine a way of addressing this problem. Every researcher has an opinion about their topic and how the research question should be answered. As a researcher one must identify in which paradigm your study exists and in which worldview your research belong. Research methodology “is a way to systematically solve the research problem” (Kothari, 1990, p. 8).

In this study I attempted to understand how teachers responded to implementing Concept Cartoons in their own classroom environment. I wanted to capture participants’ perceptions and their experiences and try to understand how they experienced working with Concept Cartoons. A qualitative study is associated with opinions, worldviews and involve the study of research problems aimed at understanding how participants refer to, and interact with social or human challenges (Creswell, 2003). As such this study involves a qualitative research methodology using a case-study approach.

This study is associated with the constructivist paradigm, as the researcher sought to understand whether Concept Cartoons, focusing on the use of scientific jargon in investigations, served as a potential Educative Curriculum Material for teachers. The study involved English Second Language (ESL) learners, and as such, the social situation or context of these learners has an influence on what and how they experience the Natural Sciences classroom. This experience will be coloured by their own personal experiences

inside and outside the classroom. By the same token, the participants in this study were practicing teacher, who were Intermediate Phase Natural Sciences teachers and this context influenced the way that they experienced the ECM, namely the Concept Cartoon. The paradigm in which this study is situated, allowed the researcher to remain objective and obtain data from participants about their interaction and views on working with the teaching materials. They reported and discussed their experiences with working with these teaching materials both in their lesson planning and classroom enactment. This was a single case study (Zainal, 2007), as the events are limited to a single occurrence specifically targeting schools within the Northern Areas of the Nelson Mandela Bay Metropole, focusing on a small group of Intermediate Phase Natural Sciences teachers.

3.5 Qualitative approach

This study was a research process that adopted a qualitative approach with Natural Sciences teachers. A qualitative study is "one person asking another person questions on a particular topic or issue and the other person responding" (Edwards & Holland, 2013, p. 1). Creswell (2007, p. 40) says, "We conduct qualitative research because we want to understand the contexts or settings in which participants in a study address a problem or issue". We cannot separate what participants say about their experiences or emotions they have encountered during a study. These experiences add meaning and must be interpreted to understand from a participant point of view. When extensive information is gathered only then can we draw conclusions of the study.

A qualitative approach was followed to answer the main research question: *Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?* Pilot and Hungler (1995, p. 517) claim that "qualitative research focused on people in their immediate surroundings. How they interact within their environment, and thus share their experiences with the researcher". For this reason I decided to choose a qualitative study to gather rich data about IP Natural Sciences teacher's experiences while using Concept Cartoons in their teaching of scientific investigations.

One technique used in qualitative research involves interviewing participants to gather information. An effective means used in such interviews is by making use of open-ended questions (Sofaer, 1999). This study adopted the qualitative approach, as semi-structured interviews was best suited to gather responses by asking probing questions. Meaningful answers was gained from interviewing teachers about their experiences. Probing questions allowed the participants to answer freely and give unrehearsed answers.

One potential weakness when conducting qualitative research (within a particular group of participants) is the information received cannot be assumed for the entire population. As such, this study is constrained to draw conclusions only with respect to the nine participants and cannot even be assumed to be true of all IP NS teachers who teach in same geographic location. Another factor which could hinder the findings of this qualitative research study was that the researcher may at times find it difficult to remain objective. This becomes especially problematic when participants were giving their opinions on a topic on which the researcher already had an opinion. For this reason, the researcher had focused on Intermediate Phase Natural Sciences teachers, and excluded the senior phase, to avoid being biased, and influence the participant's answers. The researcher was a senior phase NS teacher.

I choose to adopt a qualitative approach for gathering data, as a quantitative method does not fit with this type of study. As suggested earlier, quantitative data relies on collecting numerical data, empirically, from a large number of resources. These data are then analysed and translated to be presented in a mathematical form (Muijs, 2004, p. 1). By adapting a qualitative approach I aimed to capture the participants' true opinions and experiences by conducting semi-structured interviews. This would be difficult without interacting with participants and exercising sensitivity relating to teachers' knowledge about science terminology, (Creswell, 2007, p. 40). As the qualitative approach of interviewing participants continued, more and more rich data were accumulated, thus providing an opportunity to begin to respond to the main research question of this study.

3.6 A Case study approach

A case study is best suited when the researcher has identified a problem with specific limitations and wants to find an in-depth understanding of the case or investigation, (Creswell, 2007, p. 74).

According to Baxter and Jack (2008, p. 544):

> A case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the issue is not explored through one lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood.

This current research study limited itself to investigating how a small group of nine IP NS teachers, from a single geographically area, i.e. schools from the Northern Areas of the NMBM, implemented and experienced using Concept Cartoons as a teaching tool or strategy in their classrooms. Creswell (2007, p. 74) states that "…a case study can be single or collective, multi-sited or within-sited, focused on a case or on an issue", as such, my study adheres to Creswell's description of a case study. This study focused on a single learning problem, that of the difficulty for Natural Sciences teachers to teach scientific jargon to ESL learners within their own specific classrooms. By implementing data collection, by means of interviews, a comprehensive description of the case emerged. I recorded an array of information, such as the history of the teachers; their teaching experience and skills obtained as well as how they rendered the teaching tool, i.e. Concept Cartoons, to their learners. Data were also gathered via conducting interviews with the nine IP NS teacher participants of the study. Flowing out of the interview data certain issues arose which guided me to answer or respond to the research question. These issues translated into common themes that helped guide the data collection process and as such provided possible answers to the research question, that is, whether Concept Cartoons can assist teachers with scientific jargon in Natural Sciences investigations.

A case study was chosen to determine the potential of a teaching tool, Concept Cartoons, to positively influence the learning of scientific jargon within the context of the participants'

classrooms when they were teaching about scientific investigations (Baxter & Jack, 2008, p. 545). The case could not be considered without the context. This includes, but is not restricted to: the school environment; the teachers who had to implement the teaching tool, and more specifically the learners who provided the information gathered to their teachers.

3.7 Research instruments

Hinds (2000) states that research is usually constructed through rigorous, systemic inquiry, and research instruments are the tools you use to collect and structure data thus transforming it into useful information (Hinds, 2000). A research instrument is a measuring tool which researchers use to gather data to conclude their findings. These research instruments assist the researcher with answering the research questions. According to Wilkinson and Birmingham (2003, p. 3) “research instruments are simple devices for obtaining information relevant to a research project”. There are different ways of collecting data using research instruments, popular research tools include: questionnaires, interviews, content analysis, focused groups, observation etc.

Mertens (2010, p. 249) suggests that in a qualitative study the researcher herself might be considered a research instrument when collecting data via interviews. What follows is a discussion on how I might have viewed myself as a research instrument in this study. When I conducted the interviews it was I who decided what questions needed to be asked and when they were appropriate (Appendix 3). This was done so as to help guide my study in a direction where the participants’ response would provide the data required to answer or respond to my research questions. I designed the layout of the questions by, first asking general information of the implementation of Concept Cartoons, then focussing, by asking how Concept Cartoons might have influenced, or not, the teaching of Natural Sciences investigations to ESL learners. Every question guided the next. I carefully observed the participants by conscientiously listening to what they had say about Concept Cartoons, responding to what they found significant by asking a follow-up question. As a NS teacher myself, I found it difficult to remain unbiased and not give my own opinion on aspects of their responses that really interested me. As a researcher I incorporated my own values, assumptions and beliefs to the study by being a research

instrument. This should not be seen as something bad. I learnt a great deal and progressed in my understanding of implementing Concept Cartoons from a participant perspective. In a way the participants and I educated one another about the variety of ways that Concept Cartoons might be implemented in a classroom and how to use this approach in other learning areas. This might have influenced the data and how I interpreted this information and concluded my findings. This is what sets a qualitative study apart from a positivistic quantitative approach.

Besides the researcher viewing myself as an instrument in this study, the semi-structured interviews themselves were the main data collecting instrument of this study. The semi-structured interview “is a qualitative data collection strategy in which the researcher asks informants a series of predetermined but open-ended questions” (Ayers, 2008, p. 1). These questions were designed to probe and investigate whether the learning process, (that the teachers conducted), had assisted with the improvement of scientific jargon for learners. Also whether the teaching tool had helped teachers in teaching scientific jargon. The focal aim of the designed questionnaire was to steer the interview process in the right direction, asking participants meaningful questions in an attempt to gather rich data. It is this gathering of rich data that is one of the strengths of a case study. This granted the researcher flexibility in asking certain questions, and it influenced how participant responded. “Flexibility is the key to unstructured interview” (Edwards & Holland, 2013, p. 30).

For this type of interview the researcher has more control over the selected topic than unstructured interviews, in contrast to structured interviews which use closed-ended questions with a fixed range of responses to questions, semi-structured interviews provided rich data about how Concept Cartoons had influenced the teaching of Natural Sciences investigations by using open-ended questions. The information gathered was based on how data were collected. By communicating informally with teachers, I was able to construct information, and structure this according to my research questions.

All teachers who participated in this research study completed a biographical sheet. This was considered a pre-interview, consisting of general questions about the participants

teaching history; their subjects they taught; their teaching experience and skills they have obtained throughout their teaching careers. The biographical questionnaire, assisted me to understand the experience and skills the participants had obtained in teaching Natural Sciences in the Intermediate Phase. According to Nugent (2013) these survey instruments provides participants history and behavioural patterns (Nugent, 2013). These research instruments were relevant, influenced the interview process and gave the researcher a perspective of participants. Willis (2007) states the use of survey research tools are beneficial to assist with quantifying data (Willis, 2007, p. 246).

I presented the participants with an introductory workshop on Concept Cartoons prior to their implementing Concept Cartoons in their classrooms. Once teachers understood the teaching strategy and materials, namely Concept Cartoons, they were able to apply the knowledge learnt to their third term science investigative lessons. Each teacher received a Concept Cartoon relevant to their Grade, along with a relevant scientific investigation. The Concept Cartoon was designed by myself, the researcher, according to the themed topic which was taught during the Phase. I relied on pictures from the internet to construct the cartoon in order to make it applicable to the specific Grade and topic being taught at that time. These ideas were taken from Keogh and Naylor Teaching & Learning in science using Concept Cartoons. The question was aligned to the CAPS document (Curriculum Assessment Policy Statement) and specifically tailored for Term 3. Teachers used this as their formal assessment task for Natural Sciences.

Interviews were audio recorded, however, one participant preferred to write answers down and then allow me to ask follow-up questions if I had any based on her written response questions. All data was transcribed and themes identified for further analysing.

This qualitative study focused on semi-structured interviews as the main source of collecting information from participants. Semi-structured interviews best suites this research study because the study was a learning process that involved teachers, implementing a teaching tool, which may assist with scientific jargon in science investigation. Having a guided questionnaire to assist the researcher, provided good use to avoid asking the same questions twice, also to restructure questions to gain valid and

reliable information. Therefore the purpose of conducting semi-structured interviews with participants was, valuable information would be exchanged of whether or not this learning process had influenced the teachings of scientific jargon in Natural Sciences investigations, it allows for the participant to be honest and not prepared to answer questions methodically

Appendix 6 is a design of a Concept Cartoon that was used by Grade 6 teachers to teach learners about good and bad conductors of electricity. The cartoons were adapted from the work of Keogh and Naylor (2000) teacher resources. I slightly changed the original Concept Cartoon so as to apply to the content Intermediate Phase Natural Sciences teachers were teaching in Term 3. For the Grade 6 Concept Cartoon I constructed three circuit boards with different types of metal and non-metal materials. All three circuit boards have wire attached to a battery and a light bulb. I had three different items which connected the circuit, a wooden box; a key (metal); and a coin. Learners observed these three circuit boards and engaged in a discussion about which one would conduct electricity and which would not. Teachers found this useful and Grade specific.

Stuart and Naylor (2000), said the cartoon style characters encourage scientific talk, amongst learners, (Naylor & Keogh, 2000). Included in the cartoon labelled as figure 1 are misconceptions about electrical circuits, such as all materials will conduct electricity, this, however, is false. In the labelled cartoon (figure 1) there are three electrical circuit boards, the first circuit provides a cell battery a light bulb and a wooden box between the wires. The circuit with a wooden box was designed to indicate poor conductors of electricity. I deliberately created this in the cartoon to address misconceptions learners have about electrical circuit boards. Learners had to discuss this with each other. Teachers had to intervene and educate learners about conductors and insulators. This was an indication for teachers to guide their learners when necessary, while observing their discussions. Along with this cartoon was a questionnaire attached as Appendix 6. Learners answered the questions as part of a formal practical investigation.

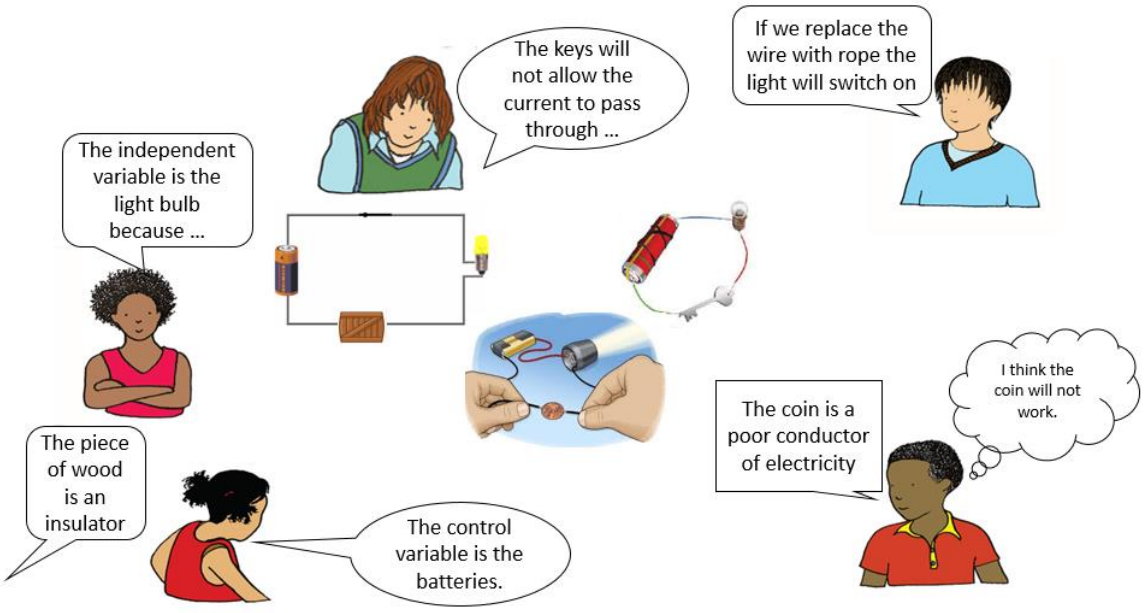

Figure 1: Concept Cartoon of children discussing, the testing of different types of materials which will conduct electricity.

This type of interviewing was designed to research the main theme, which was whether the learning tool, Concept Cartoons, might assist Intermediate Phase Natural Sciences teachers to teach scientific jargon, the research instruments and design accommodated this study and accommodated the needs of Intermediate Phase Natural Sciences teachers. It was imperative that every aspect of this research assisted with teacher enhancement and curriculum development.

3.8 Participants

The Department of Basic Education regional district office in the NMBM was approached with a proposal to invite IP NS teachers, particularly those teaching in the Northern Areas of Port Elizabeth. Hereafter a formal invitation was drawn up by the departmental head to address four schools situated in the Schauderville suburb. For privacy and confidential reasons, pseudonyms were used to identify the four schools (Appendix 2). The names allocated to the schools were: School A; School D; School St and School L. School A had predominantly Afrikaans and isiXhosa speaking learners. School D had Somali, Afrikaans and isiXhosa speaking learners, as well as Zimbabwean learners, all travelling from

different townships and areas to get to school. School L has mostly isiXhosa and Afrikaans speaking learners. School St is a Catholic school which practices strict Christian values, this school has Afrikaans and isiXhosa speaking learners.

After approaching each of the school principals, a formal introduction was done at each of the site schools. Once the principals were aware of the research and what it entailed I received permission to formally meet with the teachers and present them with the benefits and expectations of my research study. After the teachers were briefed and agreed to partake in this research, consent forms were signed by each teacher acknowledging their participation and involvement. As part of this research teachers names were not mentioned and their identity was kept anonymous throughout this study. However, pseudonyms were allocated to identify each teacher in a specific Grade, namely: teachers 4A, 4B, 4C, 5A, 5B, 5C and 6A, 6B 6C. Table 1 indicated the school names as well as the Grade of each teacher.

Table 1: School names as well as the Grade of each teacher

	School A	**School D**	**School St**	**School L**
Grade 4		4C	4B	4A
Grade 5	5A	5C	5B	
Grade 6	6A	6C	6B	

Table 2: Academic history and teaching experience of each teacher.

TEACHER	**HISTORY AND TEACHING EXPERIENCE**
4A – School L	Teacher 4A has obtained a four year degree, in Education specializing in languages, 4A has one year teaching experience.

4B- School St	Teacher 4B has taught for 22 years, with 15 years teaching experience in the subject Natural Sciences and Technology. She has obtained her honours in education as well.
4C- School D	Teacher 4C has 3 years teaching experience and has only taught Natural Sciences and Technology for 1 year. She has obtained a four-year degree in the Intermediate Phase.
5A – School A	Teacher 5A, has obtained a Bachelor Degree in the Intermediate Phase specializing in Languages, teacher 5A has been teaching Natural Sciences and Technology for two years.
5B – School St	Teacher 5B has a three-year Diploma in Senior Phase Education specialized in Biology, and has studied further to obtain a Bachelor Degree specialized in Mathematics and Science Senior Phase. 5B has been teaching for 31 years.
5C – School D	Teacher 5C has 23 years teaching experience. 5C has obtained a teachers diploma in education and has specialized in Mathematics and Natural Sciences. 5C is currently a moderator in the Intermediate Phase for Mathematics and Natural Sciences and technology.
6A – School A	Teacher 6A is currently studying towards a Bachelor Degree in Education, she has been teaching Natural Sciences for one year in a school governing post.
6B – School St	Teacher 6B has obtained a Bachelor Degree in Education, 6B has been teaching for 24 years, with 20 years' experience in Natural Sciences and Technology. Teacher 6B has been a lead Natural Sciences and Technology teacher in the district and has trained teachers in the IP and senior phase CAPS (Curriculum Assessment Policy Statement).
6C – School D	Teacher 6C has obtained a Three-year Diploma in Education. She has 25 years of teaching experience. She taught 8 years in the Foundation Phase; 2 years in the Intersen, teaching special needs learners; 1 year teaching ABET Level 1 & 2 (Adult learning) and 14 years teaching Natural Sciences & Technology as well as Mathematics in the Intermediate Phase.

The method of selecting these teachers as participants was purposive sampling in that there was a specific target group and set criteria for being a potential participant in the study. The first criterion was that the teacher had to be teaching the subject Natural Sciences in the IP. Second, teachers had to be teaching at a school particularly in the Northern Areas. The population in this area is predominately Afrikaans speaking families, with a few Somali families. The majority of the schools situated in Schauderville area are English medium schools where the LoTL is English. These schools do, however, attracted isiXhosa speaking learners who travel daily from outlying areas to attend schools in this area.

A total of ten teachers were interested in taking part in this research process, however, only nine were interviewed due to uncontrolled circumstances where the tenth teacher was unavailable to proceed with the interviews. Three teachers from each Grade were interviewed by the researcher. The study was able to fulfil the initial brief, as approved by the Nelson Mandel ethics committee, in that a maximum of 10 teachers could have been interview and a minimum of four were require to conclude the findings of this study.

3.9 Data collection and analysis

The function of this research was strategic and diagnostic, where a specific strategy was suggested, via a workshop, to assist Natural Sciences teachers with teaching scientific jargon to ESL learners. The teaching strategy involved an Educative Curriculum Material (ECM), namely Concept Cartoons, and the diagnoses was via interview feedback on what both teachers and learners might have gained from the experience of using Concept Cartoons.

Factors which contributed to the collection of data during the interviews was that the participants had to refer to the lessons they conducted with their learners that related to using the learning tool, namely Concept Cartoons. The participants referred back to the previous lesson’s experience, when responding to interview questions. The lesson sheets are attached as Appendices 3, 4 and 5. One participant declined to be recorded after the first interview was conducted. She was hesitant with fully participating in the study. The participant responded to questions in her own time, in writing, and whenever answers

required clarity, the researcher would respond by requesting the participant to elaborate with further information. This might be considered as a “semi-interview” as the participant and researcher were in the same room, although a different approach was applied to accommodate the participant. During the first interview with this particular participant, all questions were asked, she was nervous and said she did not feel comfortable being recorded.

After data were collected using a qualitative approach, namely a semi-structured interview, these data were translated into themes. As suggested previously, qualitative research was best suited for this study as it is about “uncovering knowledge about how people think and feel about their circumstances in which they find themselves, rather than about making judgements about whether those thoughts and feelings are valid” (Thorne, 2000, p. 68). Data were analysed using constant comparative analysis to unlock information gathered. “This strategy involved taking one piece of data (one interview, one statement, one theme) and comparing it with all others that may be similar or different in order to develop conceptualisations of the possible relations between various pieces of data” (Thorne, 2000, p. 69).

A total of nine IP teachers participated in this research study, three from each Grade. A comparison was made amongst the participants from the same Grade, hereafter the interview transcripts was divided into themes. The themes were based on similar words and sentences the participants used to express their ideas and views when answering the same interview questions. These words and sentences were integrated to help respond to the phenomena of this study.

3.10 Limitations

A limitation in this study was that, if there was more time and facilities available, I would have liked to have more participants from each Grade taking part and sharing their teaching experiences with implementing Concept Cartoons to address the challenge of scientific jargon in their classrooms. However, this study was restricted to only Schauderville teachers situated in the Northern Areas of NMBM.

I would have liked to observe the learners while they are using and interacting in real classrooms with Concept Cartoons. This would benefit me as a researcher to see what works and what does not work, what learners understand and what they need clarity about. Once you engage with learners during their learning process it gives you a better understanding of how they (learners) interpret information and this may enhance my teaching approach.

Teachers working together in a communal setting, to solve a common learning problem would have enriched this research study. The sharing of information to help each other and learn different ways of tackling a common problem shared from the same schooling communities would have been ideal to further enhance learning.

Also to extend workshops on how to implement Concept Cartoons, as well as pre- and post-class activities to compare, the before- and the after-effects of the implementation of Concept Cartoons. This would give a better reflection of how learners engage with this particular teaching material. However, due to the nature of my study, I attempted to remain objective. This was a case study from a constructivist perspective, where I uncover and interpret the information provided by teachers. They are a key research instrument whereby they provided me with information to conduct my study and respond to the challenge of teaching scientific jargon to ESL learners as articulated in this study's main research question: *Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?*

3.11 Ethical consideration

Nelson Mandela Metropolitan University (NMMU) ethics board granted the researcher ethical clearance to conduct this study. The institution provided the researcher with the relevant ethical clearance reference number is **H17-EDU-ERE-005** (Appendix 1). The teachers signed a consent form, from Nelson Mandela University acknowledging this investigative procedure as well as the relevant stakeholders involved. A declaration was embedded in the consent form which highlights the intention of participants to partake in

this study and that they fully understand the expectations and commitment outlined by the researcher.

This study focused primarily on interviewing teachers and not learners, as the research is based on a learning intervention which assisted Natural Sciences teachers. A formal letter was drafted to invite participants partake in this study (Appendix 8).

Pseudonyms was used, so that the participants would not be identified and the data cannot be traced back to participants. Teachers were given a number according to the Grade they taught in and a letter to indicate how many teachers in that specific Grade was interviewed, and who participated in this research. This study had no intention of harming any of the participants who partook in this research, however, participants may find that they do not fully understand the jargon used in the curriculum materials. The risk is reversible in that the whole point of an Educative Curriculum Material is to empower the teacher's science knowledge. Furthermore these participants have worked with each other in small group setting for departmental workshops. These participants including the primary researcher are from the same circuit group (Northern Areas teachers) who has worked in a similar setting before.

3.12 Validity, reliability and trustworthiness

All studies must be seen to be both valid and reliable (or trustworthy), it is important to note how reliable and valid the information was before it could be concluded as data for research. Roberts and Priest (2006) defines reliability and as "a thorough way of communicating the research process, as well as the trustworthiness of the research findings", (Roberts & Priest, 2006, p. 41). Reliability explains how certain research tools, such as a questionnaire will provide similar results in different circumstances (Roberts & Priest, 2006, p. 41). Within this study, the researcher designed a questionnaire which was aligned to ask all questions relating to the main research questions as well as the sub-questions. All participants were asked the same questions, which related to their curriculum material designed particularly for the Grade they were teaching. This resulted in reliable results, even though the curriculum material was different in each Grade, it was designed with the purpose of answering the main research question. "Validity is about the

closeness of what we believe we are measuring to what we intend to measure", (Roberts & Priest, 2006, p. 41). All participant were interviewed, each were given a Grade specific curriculum material to exercise with their learners. After the implementation teachers were interviewed to gather information about their experience. Each were asked Grade specific questions. Therefore this study has produced valid as well as reliable results in terms of measuring the accuracy of this research process using a qualitative approach to measure data, by asking probing questions that was aligned with the main research question.

3.13 Chapter summary

This study originated because primary school teachers struggle to teach their learners scientific jargon, especially when these learners are English second-language speakers. This often results in them being unable to answer scientific questions in Natural Sciences investigations. The chapter starts by showing how this study is most suited to be situated within a qualitative paradigm using a constructivist theoretical framework. This is done by introducing both qualitative and quantitative paradigms and various positivist and interpretive approaches. An argument is then made that this study fits in with a constructivist worldview. The research design that involves an intervention in the form of a workshop to introduce Concept Cartoons to the participants and follow-up interviews. These interviews interrogate the participants' perceptions of implementing Concept Cartoons in their classrooms. The motivation for using a case study method is motivated. The claim is made that the best way to identify if Concept Cartoons have the potential to be perceived by teachers as an Educative Curriculum Material and is a useful teaching strategy to use in a classroom, is to probe, in as detailed a way as possible, the participants' experiences and views. One of the most effective ways of doing this is via a case study approach. This chapter introduces the participants and the sites of the study. Ethical considerations and a section on the validity and reliability (or trustworthiness) constructs of the study conclude the chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter reports on the qualitative data which were gathered mainly via semi-structured interviews. How these data were gathered was explained in Chapter 3. The qualitative data were produced from conducting semi-structured interviews with nine Intermediate Phase (IP) Natural Sciences (NS) teachers. The information that they shared during the interviews was based on their observations of learners during classroom activity where they used the teaching tool, Concept Cartoons, to assist with the teaching of NS investigations. The focus of their observation was specifically on the use and understanding of scientific jargon with a particular reference to ESL learners. The data are presented and discussed separately for each Grade. The chapter concludes with a section where the main ideas encompassing all three Grades are summarized.

The data and discussion in the chapter responds to the main research question which is:

Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?

This chapter concerns itself with interpreting data which were collected using a qualitative research methods, namely the semi-structured interview. Creswell (2003) identified the qualitative research methodology as being best suited to social and human science research because data are gathered from participants in their natural environment. Analysing participants' experiences and feelings is, according to Creswell (2003), an appropriate way to make sense of the phenomenon. Interviewing teachers within their own classroom setting about learners they are familiar with, provided rich data for this type of investigation.

As a NS teacher myself, I know how ESL learners find scientific jargon problematic and difficult to understand and comprehend. Learners struggle with science investigations because they do not understand the terminology used. This places them at a disadvantage when answering scientific questions in formal for assessments. For this

reason, it was important to me to investigate the gap between the teaching of the jargon of scientific investigations and the understanding of this scientific jargon by ESL learners. As such, I, on an almost daily basis, identified the need to narrow this teaching and learning barrier. This study is an attempt to research if the use of Concept Cartoons can contribute to narrowing this gap.

A list of questions (Appendix 3) was compiled in order to guide the process of the semi-structured interviews. Information offered by the participants during these interviews was gathered and collated. During this process a number of themes emerged from this rich data and these themes were used to form conclusions of this research.

4.2 Interviews

The qualitative data were produced during a series of nine semi-structured interviews (one with each of the participating IP NS teachers). The data from these interviews were grouped into three groups. Interview information were collated for the three teachers from each Grade. This meant that there was collated data from the three Grade 4 teachers, another group for the three Grade 5 teachers and a third for the three Grade 6 teachers. All nine participating teachers signed a consent form and an introductory session was held with all nine teachers to inform them of the expectations of this research.

A questionnaire (Appendix 3) was used to guide the researcher when conducting the semi-structured interviews with participants. All participants were asked the same guiding questions, which took place after the workshops were completed and the teachers were confident to deliver the lesson to their learners. The data collection procedure identified semi-structured interviews with all participants, it was, however, important to ask meaningful questions to participants which resulted in rich data gathered during interviews. Teachers made it clear that they were only available for one interview after research was done with learners. They were strict on this as they had other educational duties to conduct. Being prepared with the interview questions guaranteed valuable data and time spent with participants.

Interview dates were scheduled to report back on their experience and gather information. Once all interviews were completed I created a spreadsheet and converted the

information into themes that constituted the data-base for the discussion of the results and the conclusions drawn from this study (Appendix 7). These data were collated per Grade.

Table 1 and 2 in Chapter 3 presents the participants and their respective schools. Teachers' names were not used, instead pseudonyms were allocated to protect the identity of all teachers who participated in this study. Therefore teachers were named according to the Grade they taught and then given a letter ranging from A, B and C. This has been done to protect the identity of those teaching who voluntarily participated in this research. Without their participation and involvement this study would not have been possible. This method of naming teachers has made it easy for me to identify the teachers during interview sessions and for gathering and compiling of data. Added to the spreadsheet was a final column labelled findings, which the researcher used to conclude the data collected from the teachers (Appendix 7). This column linked the data with theories from various authors' work that was presented in Chapter 2. This added meaning to the information collected from the teachers. Hereafter the researcher, divided the information into themes, according to Grade specific. This rich data assisted with responding to the research questions.

All nine teachers were asked the same questions, which guided the researcher with the next question. Hereafter particular themes were drawn from each Grade specified. A few of the questions were linked to draw rich data from the interviews which resulted in reliable themes surfacing from each interview. Themes were obtained from the data, which guided the researcher to make substantive statements with references to support information from other researchers.

The biographical information of each teacher was converted in a table form (Table 2). One of the factors which was included is the total number of years teaching experience and specialities each teacher had obtained thus far. This has definitely impacted towards the results of this study and contributed to the findings of this research.

4.3 Grade 4 findings

There were three Grade 4 teachers who participated in this research study, these teachers agreed to the participation and attended an introductory workshop which gave them clarity of what to expect throughout the research and how it would benefit them as IP NS teachers. The workshop was a resource tool to educate teachers on how to implement Concept Cartoons in their respective classroom with their learners. The workshop was presented for teachers to understand what they are required to do when conducting NS investigations, and for the researcher to gather information about the participants. Research questions were used to guide the researcher when interviews were conducted. This made it easier to gather reliable data and ask questions which related to the study. This allowed for interviews to take place as all the guiding questions was designed in the research questions (Appendix 3). It was important for each person involved to understand their role in this study. The teachers placed a condition on the research process: if this research was conducted during their teaching time, it needed to be aligned to their content material, as well as include appropriate assessment tasks. Attached as Appendix 4, 5 and 6 is an outline of the resource materials (i.e. the Concept Cartoon and assessment sheets) used by teachers when they conducted this activity in their Grade 4 classroom. This has definitely benefited the teachers, by lessoning their administrative duties of designing assessment task for their learners based on content taught.

Teachers were given a Grade specific cartoon, according to the curriculum content they were currently teaching at that time. Grade 4 teachers were teaching the topic of sound energy, it was Term 3 curriculum content. The cartoon was therefore designed to assist the teachers with enhancing the learning and understanding terminology used during the topic of sound energy in science investigations.

The illustration in Figure 1 is for Grade 4 Natural Sciences Term 3, practical investigation and refers to the input and output of sound energy. The teachers used the Concept Cartoon to teach learners about sound energy as part of their practical investigation. The cartoon itself is about learners having a discussion, they are agreeing and disagreeing about which drum will make the most noise. This involved learners talking and using

scientific words to understand the input and output energy of sound. This Concept Cartoon showed a variety of scientific thinking and concepts which learners had been exposed to prior to this investigation. However, these words are new concepts which did not form part of learners' social language. Hinds et al. (2001) states the difference between the science language in science education and the social language has an impact on how learners interpret science concepts. The terminology used in the Concept Cartoon and the Assessment sheet are: control variables; prediction; output and input. This may be difficult for learners to understand, due to these words being used in a different context in their social language. The term 'control variable' and 'prediction' is uncommon to Grade 4 learners (particularly from the schools where research was done) and does not form part of their social vocabulary either. The words 'input' and 'output' are new concepts for Grade 4's they are taught 'put in' and not 'input'. This may confuse them, it may sound as an incorrect way of speaking.

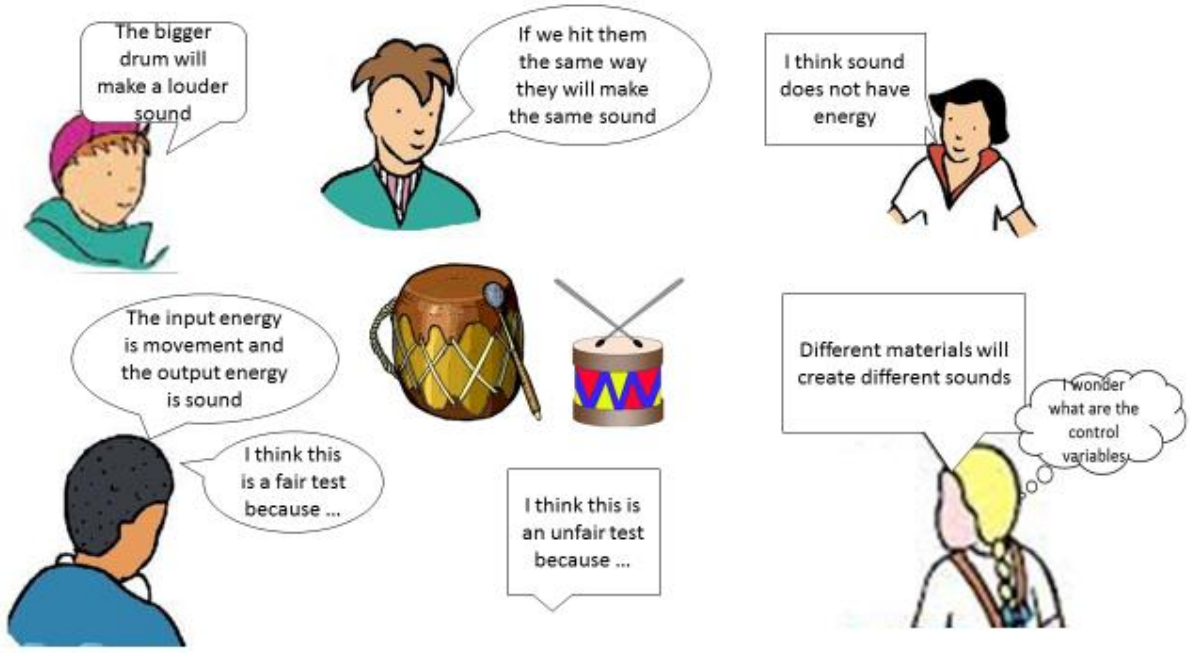

Figure 2: Concept Cartoon of children discussing their opinions of the input and output of sound energy.

The Grade 4 participant teachers observed this discussion and guided the learners with their understanding of the cartoon. Hereafter a practical investigation sheet was given to

the learners to complete. The practical investigation sheet asked relevant questions relating to the Concept Cartoon. Key concepts were included to identify whether learners understood the questions asked and whether the Concept Cartoon had assisted learners with scientific jargon (Appendix 4).

After the practical investigation task the teachers were interviewed and asked various questions about the learning and teaching experience and what their thoughts were of the use of Concept Cartoons within the context of their 'normal' everyday teaching.

The Grade 4 participant teacher cohort comprised of two young teachers starting out their teaching careers and another experienced teacher. The young teachers had only been teaching Natural Sciences for a year or two, whereas the experienced teacher had been teaching it for 15 years.

The findings was concluded from similar answers the participant teachers gave after conducting the teaching tool Concept Cartoons with their learners. These answers were interpreted and grouped into particular themes.

To start off the interview process, I, the researcher, asked all participants the same introductory question:

How has this scientific experiment helped you as a teacher to benefit your understanding of scientific jargon in investigations?

Hereafter, an informal interview process continued as the questions were asked after the first introductory question. These follow-up questions led the interview process. I have grouped the interview questions into particular themes as many of the interview responses had similar themes. This might be considers to add some credence to the reliability of this study. Below are the grouped themes categorised according to what questions were similar in response. First I present a table of the six identified themes followed by an exposé of each theme in narrative format.

The table below represent the concluding themes which were presented from the results and the discussions held with participants. The six themes were identified and explored after interviews were conducted.

Table 3: The main themes gathered from research questions

Theme #	Theme
#1	Concept Cartoons: teachers and scientific investigations
#2	Concept Cartoons: design, characters and speech bubbles
#3	Concept Cartoons: enabling scientific talk
#4	Concept Cartoons: scientific jargon
#5	Concept Cartoons: scientific jargon and ESL learners
#6	Concept Cartoons: teacher learning

Theme 1: Concept Cartoons: teachers and scientific investigations

Concept Cartoons are a visual teaching tool which teachers may use to help learners who struggle with reading during science investigations (Naylor & Keogh 2000, p. 6). These Concept Cartoons provide different ways of how a question can be addressed, thus allowing the learner to cognitively design a method for themselves to construct answers and derive a conclusion. When used in practical investigations, learners will identify with the visuals and short dialogue sketched. This may create new scientific knowledge and foster ideas.

Theme 6 will address as to whether Concept Cartoons might be characterized as an Educative Curriculum Material (ECM), however, it is informative in this section to observe how Concept Cartoons were perceived by the participants, mainly from the perspective of their teaching strategies and how they believed it impacted or influenced their learners' learning. One might argue that some of the following discussion might be more appropriated to be discussed in Theme 6, the focus here is on teachers and their interactions with Concept Cartoons within the context of scientific investigations.

Teacher 4B was the most experienced teacher of the Grade 4 participants and it is informative to observe how she perceived Concept Cartoons. She claimed that "*This method has helped the learners to think out of the box, it stimulated learners understanding of science concepts and got learners thinking in different ways*" (4B). Webb et al. states of Concept Cartoons that they "are able to provoke discussion and stimulate thinking", (Webb et al., 2013, p. 6). However, teacher 4B refers to the learners' knowledge

being improved but does not mention how this teaching tool has enhanced her own teaching knowledge. Teacher 4B has been categorized as an experience teacher based on 22 years of teaching experience complemented by her furthering her educational knowledge by obtaining an honours degree in education. Even though teacher 4B had years of teaching experience, she did not hesitate to conduct the experiment with her learners. Here 4B's response was most effective in terms of whether the teaching tool, Concept Cartoons, improved learners' understanding of science concepts. Concept Cartoons broaden participant 4B's teaching and thinking strategies, and has impacted on her teaching skills and strategies. Putman (2012, p.28) states, "Efficacious teachers were also more likely to seek ways to improve their teaching methods through alternative methods of instruction and experimentation with innovative instructional materials" (Putman, 2012). Her interactions and use of this, new to her, teaching approach, might go some way to supporting the idea that she is considered to be a good teacher within her school environment.

The other two Grade 4 participant teachers, (4A) and (4C), had given substantive evidence that this scientific experiment has benefited their understanding of scientific jargon in scientific investigations. Teacher 4A adds, "*it is a new method to teach my learners science terms*". Both participants said that the curriculum material, Concept Cartoons, encouraged scientific talk amongst their learners with 4B claiming that "*learner's attention was on the cartoon and speech bubbles, it immediately grabbed their attention*".

During this experiment the learners had the opportunity to become scientist themselves. They were interested in the Concept Cartoon and were questioning the characters. They investigated the cartoon, and debated about what the characters were saying. Teacher 4B said "*It was much easier to explain science concepts in this way*", she further adds, this activity "*helped with reading and critical thinking*".

Teacher 4A said the learners could relate to the cartoon, as they saw the characters as being on their level of communication. The marks of these Grade 4 learners have definitely improved when they did the practical investigation using CC. They connected their prior knowledge to the lesson which helped with certain scientific words.

One of the features of Concept Cartoons is it is relatable for learners, the learners are being challenged as they need to decide which character they agree or disagree with. 'Concept Cartoons provoke discussion and stimulates thinking', (Letsoalo, 2011, p. 8)

All three teachers enthusiastically embraced the use of Concept Cartoons within the context of scientific investigations.

<u>Theme 2</u>: Concept Cartoons: design, characters and speech bubbles

One of the key features of Concept Cartoons are drawings of speech bubbles with characters engaging in a discussion. The aim of cartoon characters using speech bubbles is to promote discussion amongst learners and stimulate thinking. Ramnarain (2011, p. 51) claims that "The cartoons have been used in a variety of ways in facilitating science learning". The purpose of using speech bubbles and characters taps into one of these ways i.e. to promote science discussion, and help learners understand by using a teaching tool that engages learners in science vocabulary in a simple, fun and motivating ways. All three Grade 4 participating teachers conveyed sentiments that support the use of both characters to whom the learners could relate as well as the potential of the easier text within the contents of speech bubbles. Teacher 4A said: "*The speech bubbles were easy, the learners were able to read and understand*". Both the other two teachers also proposed evidence that the Concept Cartoons characters were related to by the learners, and in 4B's case, the language, albeit after limited prompting, was understandable to the learners. These teachers' comments were "*Yes learners could relate, I had to explain certain words but they enjoyed the cartoon and could connect the speech bubbles to Natural Sciences investigations*" (4B), and "*Yes they did they could relate each character, and they understood what they were saying*" (4C). This suggests that learners were able to read and understand the characters statements via the speech bubbles. The short sentences in the callout or speech bubbles coupled with uncomplicated sketch contribute to making learners feel they are interacting directly with the cartoon characters. Teacher 4C did, however, say that "*They could relate each character, and they understood what they were saying, however, certain words they did not understand the meaning for example independent and control variable*". These were the words Grade 4 learners were struggling to comprehend and understand as they were not taught the meaning of these

words prior to this investigation. This suggests that when Concept Cartoons are used in Grade 4 that it might be advisable to either explain terms carefully before presenting learners with the cartoon or, preferably chose or generate cartoons that do in fact more closely address the level required of that Grade. All three teachers, however, agreed that the Concept Cartoon itself was effective and it attracted learners' attention while being relatable to their knowledge and understanding.

A caveat to this effectiveness was raised by the teachers. They all noted that initially these young learners were confused and assumed all the speech bubbles were correct. "*What threw the learners off was they assumed all the statements in the cartoon, was correct they were naive*" (4A). It is possible for Grade 4 learners to misinterpret the conversation and feel confused. Grade 4 learners believe what their teacher tells them, they tend to be more vulnerable to this 'teacher is always correct' syndrome compared to the older learners. They do not see fault or misconceptions in the Concept Cartoon, which in and of itself is a positive for Concept Cartoons in that the key characteristics of this teaching tool is it presents credible false information or misconceptions in the speech bubbles. Learners feel safe expressing their incorrect views because they could 'blame' the cartoon (Keogh & Naylor, 2000). It might therefore be sometimes necessary for the teacher to explain that not all the statements are true or completely accurate. Teachers are encouraged to ask probing questions which will eventually guide learners' thinking and reasoning to understand. Teacher 4A further adds that she had to "…*inform learners these are just opinions they are not necessary correct"*.

Other information which surfaced from interviewing participant 4A, B and C was, teachers noticed the errors learners were making when discussing the Concept Cartoon. Teacher 4C said: "*It helped me identify both common and uncommon misconceptions the learners had relating to scientific jargon*" (4C). These are one of the key features of Concept Cartoons, some of the speech bubbles have misconceptions. Misconceptions are included for teachers to recognize them and address it immediately during the lesson (Naylor & Keogh, 2012). Teacher 4C admitted, once the learners were able to identify and understand the misconceptions it became easy to move on to the next concept (4C). Teacher 4B said: "*The learners found it easier to read the cartoons and relate their*

thinking to the cartoon, and the speech bubbles". Chin and Lay-Yen Teou (2016, p. 108) states, "because they use minimal text, the ideas depicted in the cartoons are accessible to pupils with weak language skills". The teaching tool, Concept Cartoons, made it easy for learners to understand the scenarios, or topics being discussed because they are intrigued by the characters and speech bubbles. "*Some of the learners tried to imitate the characters in the cartoon, by repeating what they read*" (4C).

The above statements by teacher 4A and teacher 4C, indicates that this teaching tool has benefit their understanding of scientific jargon in Natural Sciences investigations. Evidence shows this teaching tool, had a positive impact on those teachers who has less teaching experience.

Theme 3: Concept Cartoons: enabling scientific talk

One of the key features of Concept Cartoons is that they stimulate scientific talk amongst learners (Naylor & Keogh, 2000). They stimulated learners' thoughts when addressing questions. The cartoon-style drawing showed different characters arguing about an idea or topic. "The cartoon style characters are designed to intrigue and provoke discussions, and stimulate scientific thinking" (Birisci, et al., 2010, p. 3). Teacher 4A: "*It definitely encouraged scientific talk amongst the learners*". This is supported by Webb et al. (2013, p. 6) who claim that Concept Cartoons can encourage scientific talk amongst learners, they further add: "These simple visual representations maximize learner involvement, particularly those leaners who are not fluent in formal language and who may be intimidated by scientific terminology". Participant 4A claimed that "*it was refreshing and a new way of teaching science investigations*" and it was *"…a new way to teach my learners science terms*".

From the above findings it was evident that Concept Cartoons enabled scientific talk for Grade 4 learners. All three teachers agreed that it improved their teaching methods of teaching science investigations with 4C claiming "*It was more relaxing and fun approach to learning science investigations, also learners were able to look at different approaches identify it and relate to it*".

What was evident throughout the interviews was that all three Grade 4 teachers admitted that they do not use scientific words to teach Natural Sciences because their learners do not grasp or understand scientific words. However, all three teachers agreed that this scientific experiment has assisted them while teaching Natural Sciences investigations.

Theme 4: Concept Cartoons: scientific jargon

Jargon is specific vocabulary used by people with common interests. This is when the writer intends to deliver specific content to readers who are aware of these terms (Literary Devices, 2018).

The teacher participants had positive experiences of, and with, Concept Cartoons. They agreed that this teaching tool assisted them with teaching Natural Sciences investigations for Grade 4 learners, however, they did note that learners struggled with certain scientific words i.e. jargon, claiming that the words were not on their level of understanding. Using Concept Cartoons to promote an understanding of scientific jargon was the explicit aim of this study. The Curriculum Assessment Policy Statement (CAPS) confirmed that scientific words are part of Grade 4 learners' curriculum content and are a requirement. However, although the teachers said the cartoons assisted with learning scientific jargon, the focus is whether the learners understood the scientific terminology used in the cartoon. Teacher 4A said: "*The terminology was a bit foreign to them, they asked me: 'teacher, what is constant variable', and I had to explain it to them on their level for them to understand*". Teacher 4B said: "*I had to explain the word control variables*". Teacher 4C said: "*They did struggle a bit because it is not Grade 4 requirement, to understand the type of scientific jargon, so it was new to them*". Participant 4A further adds, "*it was a new method to teach my learners science terms*".

It is evident that learners did not meet the criteria of this investigation because the scientific terminology was above their level of comprehending science vocabulary. This may be the general assumption of the teachers, or it could be that the teachers do not have the necessarily skills and knowledge to teach learners scientific vocabulary. Scientific jargon is introduced in Grade 4 content and should be implemented in the curriculum content with Grade 4 learners. Teacher are expected to teach learners scientific jargon, and at the same time, they should simplify these words for the learners.

As noted in a brief interview with the Natural Sciences and Technology subject advisor of the Northern Area schools, scientific vocabulary should be implemented by Grade 4 teachers, for example, learners should be taught about the independent and dependent variables. Teachers do not possess an adequate understanding of the topics that they teach. Tshiredo (2013, p. 15) states "as a result their lack of deep and coherent understanding of the subject matter may also limit their ability to design and use higher order thinking skills to probe students' understanding needed by constructivist approach in teaching of science" (Tshiredo, 2013, p. 15). Teachers' inability to teach scientific jargon to their learners may be the reason as to why learners are unable to comprehend the science words used in the Concept Cartoons. As a result teachers are unaware that their lack of teaching science concepts might be hindering the learning of their learners to understand scientific terminology.

Davis and Krajcik (2005) states "Educative Curriculum Materials (ECM) should help to increase teachers' knowledge in specific instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations" (Davis & Krajcik, 2005, p. 3). Curriculum materials are resources designed to support teacher learning. These materials (ECM), created in the form of Concept Cartoons, enhanced teaching skills of teachers and they also promote the learning of learners. Concept Cartoons promotes the understanding of scientific concepts as well as assist teachers with their understanding of the concepts.

<u>Theme 5:</u> Concept Cartoons: scientific jargon and ESL learners

Jargon is specific vocabulary used by people with common interests. As new words are created within a discipline, these words are defined as jargon (Rosenberg, 2012).

English Second-Language (ESL) learners face multiple challenges in the classroom, the first being the communication barrier. Learners need to translate certain words or sentences into their home language, process the information, then translated back into the original language, before attempting to respond to a question or participate in classroom discussions. *Teacher 4B said: The jargon investigations helped the learners to think out of the box, it stimulated learners understanding of concepts and got them thinking in different ways".*

Teacher 4A said: "*It was a learning experience for my learners and I. The new teaching materials enhanced my understanding of the content and improved my science knowledge. However, the terminology was foreign to them (learners). I had to explain it on their level of understanding what certain words meant".*

Although learners found the terminology difficult the teachers enjoyed this stimulating tool to teach science investigations. Teacher 4B said: *"This is new it is different and great for teaching concepts and to enhance critical thinking".* The learners were eager to read the cartoon speech bubbles and discuss this. It was these characteristics of CC which makes it particularly attractive to teachers who teach learners who learn in a second language. Also it does not intimidate learners as science jargon does.

Teachers may see this as a continuation to create scientific awareness and enhance science learning. With the use over time they may observe improvements in their learning process of science investigations.

<u>Theme 6:</u> Concept Cartoons: teacher learning

Educative Curriculum Materials (ECM) are defined by Schneider and Krajcik (2002) as curriculum materials designed to promote primarily teacher learning and teaching, but, as a consequence of enhanced teaching skills by the teacher, they also promote learning in the learners. They are designed to support both teacher and learner learning (ECD) (Schneider & Krajcik, 2002).

Teacher 4B, who had been teaching Natural Sciences for a long period, agreed that Concept Cartoons do function as an ECM (although she did not know of this construct at the time). During the interview she acknowledged that Concept Cartoons are a teacher resource and being exposed to them was a learning process for teachers and learners. Teachers 4B said: "*It definitely changed the way I taught scientific investigations*". Teacher 4A said, "*it was a learning experience for me and my learners*", she further adds "*It was refreshing and new, teaching materials which enhanced my understanding of the content and improved my science knowledge*", (4A). The above statement, suggests that this teaching tool, Concept Cartoons, is a teacher resource as teachers gained knowledge from implementing Concept Cartoons to their learners. Teacher 4A said: "*It definitely*

improved teaching as a whole for myself. I have observed that the learners participated more, their understanding is much better, than what it would have been if there were no Concept Cartoons". Teacher 4A said, "*It was a learning experience for me and my learners*" (4A).

ECMs, by definition, promote teacher learning. An argument can therefore be made, based on the comments by two of the three Grade 4 participant teachers, that Concept Cartoons were for them, an ECM. They perceived Concept Cartoons as supporting and enhancing their learning. David and Krajcik (2005) state the following: "An educative curriculum material should help teacher's knowledge in specific instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations" (Davis & Krajcik, 2005, p. 3).

Summary of Grade 4

When considering the six themes above (section 4.3) one can conclude that Concept Cartoons are viewed as a learning tool for the Grade 4 teachers. The teachers acknowledged and observed the incorrect statements learners had relating to the scientific terminology and information relating to the topic. This was an indication of both the common and uncommon misconceptions learners had about Natural Sciences content. Novice teachers benefited from this research as they have gained insightful knowledge and information of how their learners interpret scientific concepts. Teachers recognized the difference Concept Cartoons had made towards learners science knowledge. This had enhanced teachers' understanding of the content and improved teachers' scientific knowledge. It also inspired their teaching methods of teaching science investigations. Teachers observed and noted that learners were able to read and understand the characters' speech bubbles content. This activity helped with reading and critical thinking, it therefore has the potential to be integrated with the subject English. All three teachers agreed Concept Cartoons was effect as it grasped the attention of learners. It was relatable to learners' knowledge and understanding. Teachers admit that certain words the learners did not understand, this was evident due to learners not being taught the meaning of these words, which were used in the cartoon.

4.4 Grade 5 findings

There were three Grade 5 teachers who participated in this study. All teachers were present and had attended the introductory workshop. The workshop explained to the participants what their expectation of this research could be and how this research process might benefit them as IP NS teachers. All three teachers were willing to participate and try out a new teaching strategy in the anticipation that Concept Cartoons might assist them with their teaching of the Natural Sciences. The teachers were concerned with how this teaching strategy might only be beneficial in teaching Natural Sciences. This concern arose as the IP the Natural Sciences is combined with the subject Technology. I explained to the teachers the research purely focuses on Natural Sciences investigations and that the content is aimed at science terminology and concepts. I further explained the Grade 5 content material was designed according to the Curriculum Assessment Policy Statement (CAPS) document, focusing particularly on the investigative side of Term 3 content of Natural Sciences and Technology (NS&T) subject. In the IP NS&T, the content has a practical investigation for each term (Department of Basic Education, 2011a). One such investigation is designed to investigate what will happen to a burning candle when oxygen was removed using different sized containers. Once participants heard that the teaching material was in line with their assessment and teaching content, they were happy to introduce the teaching tool, Concept Cartoons, to their learners and participate in this research process.

The Grade 5 teachers involved in this study had multiple differences in terms of age; skills obtained and years of teaching experience. The participants comprised of one novice teachers who had two years of teaching experience in the subject Natural Sciences and Technology, and had obtained a four-year Bachelor degree in Education, specializing in Languages. The other two teachers who participated had both obtained a diploma in Teaching Education, and had between 20 – 31 years teaching experience. Both teachers had furthered their qualification by specialising in Mathematics and Natural Sciences. Teachers are identified by pseudonyms to hide their identity, thus allowing them to participate with freedom of expression, not being restricted or obligated to be cautious when providing their opinion during interviews. This was important because some of the participants held departmental titles, and are involved in continuous assessment and

moderation, as well as curriculum development proceedings. Additionally they are contracted to Department of Basic Education (DBE) in the Eastern Cape. One of the conditions imposed by the DBE is that on successfully completion of this study that I provide a bound copy (or DVD e-copy) of this study to the local district office of the DBE.

Teachers were given a Grade specific cartoon linked to the curriculum content they were currently teaching. Grade 5 teachers were teaching the Term 3 curriculum content topic of Energy and Change. The cartoon was designed to assist the teachers with enhancing the learning and understanding of scientific terminology used during the practical task to investigate what happens when a flame is deprived of oxygen. Figure 2 is from the Grade 5 NS Term 3 practical investigations. The aim is to determine how long a candle will burn when given different amounts of oxygen. The teachers used the Concept Cartoon to teach learners about energy and change as part of their practical investigation.

The cartoon itself is about learners having a discussion where they are agreeing and disagreeing about the size of jars used to cover the burning candle. The cartoon characters are engaging in a discussion using scientific words, aimed at understanding whether different size jars would allow the candle to burn longer.

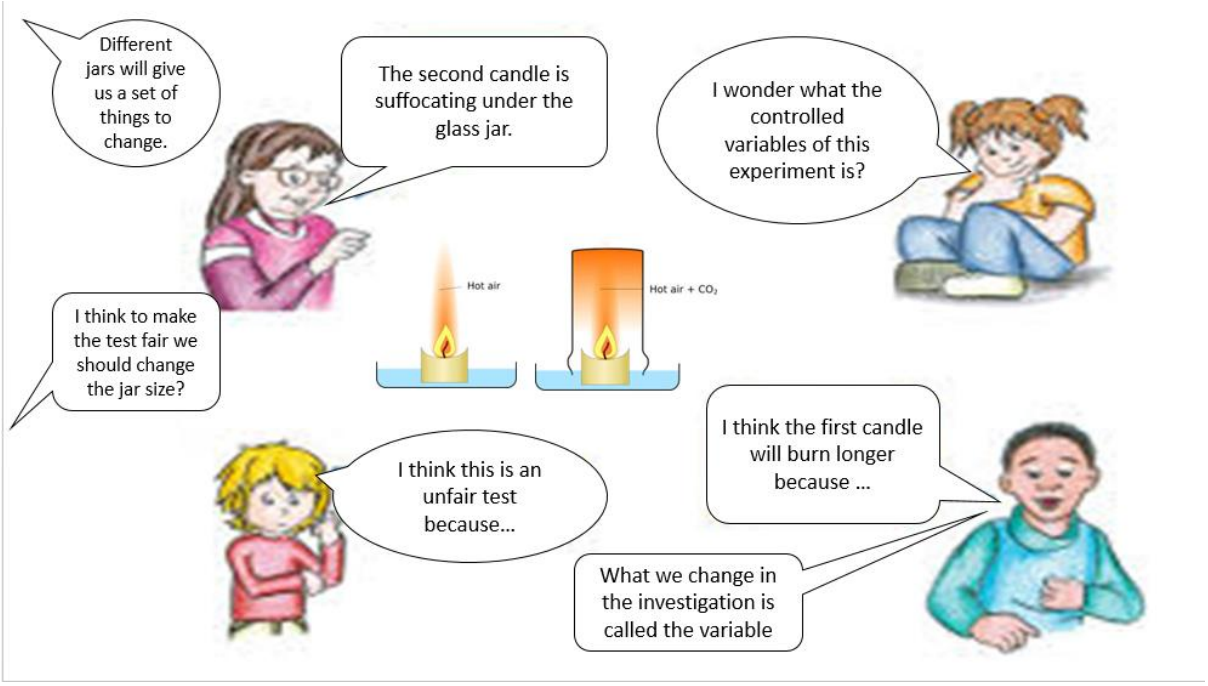

Figure 3: Concept Cartoon of children discussing, the oxygen levels of burning candle.

Hereafter learners engaged with the Concept Cartoon and discussed their answers with their peers. Some learners answered the questions of the characters in the Cartoon. The teachers observed this interaction and probed the learners with possible answers. After the discussion process, the learners completed a practical investigation sheet which they needed to answer based on the investigation of the cartoon. The practical investigation sheet asked relevant questions relating to the Concept Cartoon. Key concepts were included to identify whether learners understood the questions asked and whether the Concept Cartoon had assisted learners with scientific jargon (Appendix 5).

After the practical investigation task the teachers were interviewed and asked various questions about this learning and teaching experience, and what their thoughts were of Concept Cartoons and the implementation of these in their classrooms.

After teachers had conducted the research with their learner, interviews were conducted with each of the three participants. Themes were developed based on responses to the interview questions. As note for the Grade 4 interviews, I, the researcher, asked all participants the same introductory question, which was:

How has this scientific experiment helped you as a teacher, to benefit your understanding of scientific jargon in investigations?

Hereafter, an informal interview process continued as the questions asked after the first introductory question led the interview process. I have grouped the interview questions into particular themes as most of the interviewed responses were similar. Below are the grouped themes categorised according to what questions were similar in response.

Theme 1: Concept Cartoons: teachers and scientific investigation

During the conceptualising of this research, at the stage where the problem of scientific jargon was identified, the search for a suitable teaching and learning tool lead me to Concept Cartoons. CC invites learners to discuss in dialogue with each other, addressing scientific questions which promotes learning new scientific terminology and enhances learner's academic confidence (Naylor & Keogh, 2000 p.3).

When teachers were asked what their thoughts and opinions of Concept Cartoons were they provided positive feedback that would contribute to future studies relating to this

research topic. Teacher 5A said: "*It is a good starting point*" a. "*It caters for visual learners, learners struggle to interpret or to put things in their own words, whereas this gives a picture, it gives you an idea it gives a guide. All that needs to be done is to discuss the content".* She thoroughly enjoyed working with the materials provided and commented that as a teaching strategy, "*all that needs to be done is to discuss the content*". 5B's observation that "*It is a fun way to integrate the English language and science*". This observation of the potential of Concept Cartoons to support language learning and science, or vice versa, might assist in addressing the challenge Natural Sciences teachers have with learners. These learners arrive in the Natural Sciences classroom "unprepared for learning science concepts" also they "have weak scientific knowledge and they lack necessary linguistic tools to construct advance Science concepts" (Setati, 2011, p. 20).

If learners struggle with language, we as teachers, cannot assume they will perform badly in all learning areas. Teachers need to create content and strategies, such as Concept Cartoons, to try and fill the gap created by various learning barriers. Teacher 5C saw Concept Cartoons as a "*useful tool to help learners understand scientific jargon. With more use over time, I think it will encourage learners to participate in scientific talk*". This suggests that with continued and sustained use, Concept Cartoons might have the potential to further assist with the challenge of limited language proficiency when dealing with science concepts.

Teacher participants did, however, find the scientific words used in the Concept Cartoons difficult for the learners to comprehend. Teachers 5A said, "*Learners communicated in a way that was more simplistic*", than what was provided in the cartoon. She further adds that the words that were in the cartoon had to be broken down for learners to understand as "*the words were big for them*" (5A). While 5B acknowledged that "*This was a fun way to introduce concepts*", a key feature of Concept Cartoons being to make learning fun and interesting for learners (Naylor & Keogh, 2000), she added: "*I find some of the concepts difficult to teach because of the language barrier*". In Chapter 2 it was noted that second-language learner's poor performance in certain subjects may be caused by "limited proficiency in English and weak mastery of academic language" (Estrella, et al., 2018, p.

15). Estrella et al. (2018) stated that for ESL learners to acquire and understand science concepts requires the language intensity of the mother tongue. Teacher 5C said: "*I hardly use scientific jargon, because it is confusing for the learners to understand*" (5C). She does not implement science jargon when teaching science investigations stating: "*I use simple terminology to explain concepts*".

Although the teachers feel that Concept Cartoons have not significantly changed learners understanding of scientific jargon, they do recommend CC as a pre-activity to intrigue learner's scientific thinking, as it was a fun learning approach, however, they all three agreed the terminology used in the CC was difficult and above Grade 5 and above their learners' Grade performance. The Concept Cartoon Assessment sheet was, however, Grade appropriate as the content was aligned according to the Curriculum Assessment Policy Statement (2011).

Theme 2: Concept Cartoons: Design, characters and speech bubbles

Concept Cartoons are suitable for learners who struggle with reading as the cartoons have visual representations which capture the interest of learners, and the speech bubbles with text do not intimidate the learners with difficult words. The cartoons appear simple and uncomplicated, presenting short sentences in the call out speech bubbles. The cartoon style sketch contributes to making learners feel they are interacting directly with the cartoon characters (Naylor & Keogh, 2000, p. 6).

The Concept Cartoons intrigued learners' interests, they were having fun, and learning scientific concepts all at the same time. Similarly to the Grade 4 teacher-respondents' experiences, while understood by learners, within the statements there were still some words that presented challenges, for example, "*The learners understood the speech bubbles and enjoyed the characters*" (5A); "*Yes they enjoyed the characters and what they were saying in the speech bubbles*" (5C), while Teacher 5B claimed that "*They understood the speech bubbles although they struggled to grasp the word 'variables*'". So while Concept Cartoons are motivating and the statements are largely understood by learners, this is by no means universal, especially when new jargon words are introduced via the speech bubbles. As with the Grade 4 teachers' experiences, it might be advisable

to expose learners to new jargon before engaging with the cartoon and rely on the cartoon characteristics to assist in the clarification of these jargon words.

<u>Theme 3</u>: Concept Cartoons: enabling scientific talk

Teachers struggle when teaching learners scientific jargon, because learners lack the basic scientific vocabulary and they have limited scientific knowledge from their previous experiences, e.g. school and out of school experiences, to build on. Concept Cartoons, however, captured the attention of Grade 5 learners during this investigative activity. It would be assumed if learners had prior knowledge of scientific terminology, the implementation of Natural Sciences content would be easier to grasp for learners when using Concept Cartoons as a teaching tool. This assumption is made due to teacher 5C recommending a pre-science activity using Concept Cartoons. Participant 5B said: "*The learners were interested in reading the cartoon and identified the difficult concepts*", another teacher pointed out the concepts were difficult for the learners, to identify. Teacher 5B further adds: "*They struggled to understand variables*". What is evident from the teacher interviews is that, while Concept Cartoons were favourably accepted by learners, there is a gap in that Grade 5 learners' exposure to scientific terminology. Exposure to science terminology appears to be minimal.

While the intended aim of using these particular Concept Cartoons was to teach science, 5B said the learners thought the lesson was an English activity, because they associated the explaining of concepts as an English lesson. "*I think they saw this as an English lesson because I teach English to them as well. This task dealt with explaining words which is done in my English class*" (5B). The learners were confused as they linked the science lesson with that of an English activity, where they would search and define the meaning of words. The approach which teacher 5B initiated was similar to that of an English lesson done during an English period. So while the intention was to teach science using the concept cartoon, learners misunderstood the main aim. The teacher might have attempted to explain the science concepts to the learners in a similar manner as she would in an English lesson. Setati (2011, p.1) states, "the use of language is one of the situational factors that need careful consideration by the educators". The statement is directed at why teachers need to be clear when explaining certain concepts. It may be

possible for the content to be misinterpreted or mistaken for another lesson or subject. Clarity needs to be given to learners, and constant repetition of the lesson activity is important. Although teacher 5B acknowledged the confusion, learners had assumed the Concept Cartoon investigative activity was an English lesson, part of the implementation of this activity was the integration of language as concepts needed to be defined and understood. One focal aim of Concept Cartoons is to assist ESL learners with scientific concepts in Natural Sciences investigations. It is "suitable for use outside a student's home language. In some countries they are used in science lessons, with the English text being used to complement English language learning elsewhere in the curriculum" (Naylor & Keogh, 2012, p. 9). Keogh and Naylor (2012, p. 9) stated Concept Cartoons are implemented by teachers in different countries, "this extensive use outside the UK raises the question of the suitability of the characters for diverse teaching situation", (Keogh & Naylor, p. 9, 2012). Not only is this teaching style popular worldwide, it consists of dialogical teaching styles; formative assessment and an interactive learning environment which effective for all learning areas.

The Grade 5 teachers voiced different opinions of whether scientific talk was established or not. Teacher 5C said the characters and speech bubbles helped make the experiment "*more interesting for learners*", she continues, "*However, it did not encourage scientific talk*" (5C). While acknowledging that this *"…was the first introduction of Concept Cartoons and scientific jargon*" that her learners had experienced. The teacher admitted to not using difficult terminology when teaching science content to learners as she felt that they did not understand. This approach is not uncommon, with Setati (2011, p. 1) claiming:

> In science where so much of the work is concerned with describing observations, this becomes a special handicap. The language barrier would seem to be a very obvious source of difficulty since science is hostile with unfamiliar technical words.

The investigative activity implemented with the Grade 5 class has highlighted the language factor, which is part of this research study. Concept Cartoons have shown integrated learning strategies with the English language. Teacher 5B had to explain the terminology to the learners before completing the investigative activity. Teacher 5A said

the learners did not understand all the words in the Concept Cartoon, such as variables, however, they managed to identify the word ‘control variable’.

This investigation with the Grade 5 teachers exposed evidence which was new for both the researcher as well as the teachers. It is evident that Grade 5 learners have limited scientific concept knowledge, therefore is was difficult for learners to use scientific language during this investigation. The teachers had to explain certain words to the learners using simple language, admitting at the same time that they used minimal scientific vocabulary.

Webb et al. (2009, p. 314) states, “Language in science is not only an issue for second-language learners and teachers. Teachers prefer teaching the basic terms and avoid difficult concepts as they claim that these confuse learners, making the teaching process harder”.

<u>Theme 4:</u> Concept Cartoons: scientific jargon

This study was aimed at implementing a teaching tool, Concept Cartoons, to enhance the learning of scientific vocabulary in Natural Sciences. Learners were introduced to an activity and teaching material which was designed to introduce techniques to promote discussion, as well as writing and argumentation in the science classes (Webb et al., 2013, p.15). Additionally, and perhaps more importantly, this discussion and argumentation revolved around an understanding of science jargon used throughout science investigations.

When teacher-participants were asked if Concept Cartoons had improved the understanding of scientific jargon, teachers had voiced the following:

“*Yes the cartoon itself helped with the learners’ understanding of how to do this type of investigation*” (5A).

“*I think Concept Cartoons has improved their understanding. They found the cartoon a fun way to learn*” (5B).

“*Yes after I explained the words and we read the cartoon again, they then understood*” (5C).

One should bear in mind that this research is about teacher perceptions of the influence of Concept Cartoons on the understanding of scientific jargon. As such, the sentiments expressed by the participants might not actually be accurate, with learners not really understanding the jargon better. When asked if Concept Cartoons had positively impacted on the learning of science investigations, all three teachers agreed. Teacher 5B said: "*Most of the learners could relate*". Teacher 5A added: "*Also they had prior knowledge of certain words*". It is evident when learners have gained prior knowledge about certain concepts, it makes it easier to build on from the known to the unknown.

Concept Cartoons are a teaching tool used to stimulate learners' thoughts when addressing conceptual understanding (Naylor & Keogh, 2000). The purpose of CC is to address learning needs through creative teaching ideas with in science classrooms. Repetitive use of CC will definitely improve scientific concept knowledge of learners.

Theme 5: Concept Cartoons: scientific jargon and ESL learners

Themes 2, 3 and 4 align with what Naylor and Keogh (2000) claim Concept Cartoons can actually achieve for any learner. This study originated when I taught in the Northern Areas and realised that many learners were being taught in their second or even third language. This might have also been the case with their teachers. Within this context, while Themes 2, 3 and 4 might be applicable to any learner, they become even more important for the English Second-Language (ESL) learner. This may be true of the ESL teachers as well. Teachers and their learning forms the subject of Theme 6: Concept Cartoons and teacher learning.

From themes 3 and 4 teachers claimed that the terminology which was implemented in the Concept Cartoon speech bubbles was difficult for the learners to comprehend. When the teachers were asked if Concept Cartoons had encouraged scientific talk amongst learners the teachers said 'no', but felt that the way the activity was designed had an educational impact towards the learning of scientific investigations. Thus they said the learners were interested in the speech bubbles, and reading what each character was saying. The learners enjoyed the method of teaching scientific investigations. When the question was posed about whether the learners understood the scientific terminology in the cartoon, the teachers had a different response. Teacher 5A said: "*Second language*

learners found it easier than those whose home language was English". Teacher 5A said second-language learners understood the concepts better than English home language learners. Teacher 5A adds: "*Second-language learners put more effort into understanding the content, and show more interested, especially when it came to understanding scientific terminology*". Teacher 5C said "*English home language learners struggled with the scientific words as it is not words they would often use in their everyday vocabulary"* elaborating by saying that "*Learners who speak English struggled with this activity because they do not use these words in their normal day-to-day vocabulary, and they do not understand the meaning of these words*". However, Cobbing (2011, p. 3) states that "Second language speakers of English, the great majority of South Africans are at a disadvantage when faced with bewildering jargon-rich English in its various forms and must divert extra time and energy to learning it". It is to the credit of Concept Cartoons that this instrument can be very motivational to all users (Naylor & Keogh, 2000, p. 3).

This interview conducted with teacher 5C broaden my perspective and understanding of my research. This study originated from a desire to strengthening ESL learner's scientific jargon. However, what these participants were sharing begs the question: How might English home-language learners interpret and experience Concept Cartoons in Natural Sciences investigations for strengthening their understanding of jargon? Setati (2011, p. 3) said "it should also be borne in mind that language problems in Science are not confined to second-language learners only".

All three teachers made use of a probing technique when they implemented this activity. They had to pose meaningful questions to get their learners thinking about scientific terminology and guide their thinking in the correct direction. After teachers assisted the learners, they were able to complete the activity. Teacher 5B said: "*I had to probe them by asking certain questions thus leading them in their group discussions to understand scientific words*".

During the interview process with the Grade 5 teachers it was evident that the learners' true potential might not have been unlocked as their past experiences of science suggested that they are spoon fed with information. The teachers have made attempts to enhance their learning, but from the data gathered during this study, little support is

provided for teachers in dealing with the different learning barriers, one being ELS learners' understanding of scientific jargon. Teachers are trying, but it seems difficult to teach concepts when learners lack more than just science knowledge, i.e. they are hamstrung by having to learn science in a second-language. The learners lack more than just science concepts, they lack language competency and they do not know how to access prior knowledge learnt from previous Grades. This makes the job of a teacher much harder, especially within the Northern Area Schools, where they are faced diverse with learners with different language competencies.

The three teachers had positive contributions to add about how Concept Cartoons had assisted second-language learners with their learning. Teacher 5A said: "*The characters and the speech bubbles helps and the visuals itself*". She said the words were difficult for her learners to grasp, but once she had explained it, the learners understood. She further adds "*When it comes into character in the cartoon it made sense for them*". Teacher 5B said: "*This was a fun activity, however, it could have been introduced in stages then it would definitely help with the understanding of scientific jargon*".

There are a variety of characteristics which are embedded within CC to assist ESL learners with scientific jargon. Learners' thoughts are directed in a direction that gets them thinking about the most suitable or almost perfect response to the cartoons' prompting ideas or questions. Concept Cartoons encourage hesitant English Second Language learners to participate in science investigations and discussion. It maybe these kinds of features which attracts NS teachers to engage and encourage this teaching resource in their science classrooms.

Theme 6: Concept Cartoons: teacher learning

Educative Curriculum Materials are aimed at increasing teachers' knowledge in specific instances of instructional decision making, but they also help teachers develop skills with the curriculum they are teaching i.e. teacher learning. An Educative Curriculum Material enhances the learning of learners as well by identifying the key areas that can help with learning barriers; dealing with learners from diverse backgrounds and achieving the learning outcomes set in the curriculum (Davis & Krajcik, 2005).

The Grade 5 teacher-participants unanimously agreed that Concept Cartoons were a teacher resource which benefited them. Teacher 5B said: "*The cartoons was learner friendly*". She said the learners were eager to read the speech bubbles and discuss the comments of each character, and this type of teaching generated excitement (5B). Teacher 5A said: "*It was a different way of explaining science investigations to my learners*". She added that she liked how the speech bubbles was incorrect, "*it made them think*". One of the features of Concept Cartoons are that some of the characters will make challenging statements on the topic. This is done to prompt learners' knowledge and develop critical thinking. Some of these statements are misconceptions learners may have about a particular topic. These are indicators for teachers to be aware of, and that after they have taught a lesson/topic, some of their learners may interpret information incorrectly. Concept Cartoons are designed in such a way, that after learners have discussed their views and given answers, and then find out that their standpoint was incorrect, they have a backstop position. Learners may claim that while their views might be incorrect, they are merely expressing their understanding of what is being displayed by the cartoon itself, or the characters of the cartoon. Learners feel safe expressing their incorrect views because they would blame the cartoon character for the misconceptions or false information (Naylor & Keogh, 2000, p. 7). Teacher 5A further adds: "*It manipulated the situation to stimulate the learners thinking and reasoning, this method tested learner's ability of understanding*".

Teacher 5C said: "*I have observed how Concept Cartoons has made the learners interested in the science investigation, the learners enjoyed it when I taught the practical investigations in this way*". She further said: "*I have also learnt that I should not underestimate the learners. If I explain the scientific jargon clearly they will understand it*". A crucial lesson emerging from the study was that, we as teachers, underestimate our learners' capabilities. For this reason, teachers avoid scientific jargon, hiding behind the idea that scientific jargon is too difficult to grasp for these young learners; or that the previous Grade teacher did not teach the basics, therefore it becomes harder to branch further and continue because the learners have not been taught the basic science concepts. Other teachers feel it is time consuming and a few teachers do not understand

the concept themselves and are unable to explain it in such a way that the learners will understand it.

Nedelsky (1965) said that teachers' lack of science knowledge has had rippling effects towards learners' understanding of science. It is important for teachers to equip themselves with science knowledge and break the barrier of science learning. This can only be accomplished if teachers remove themselves from a comfort zone, and take initiative to further educate, not only themselves, but their learners as well.

Concept Cartoons guide the teacher with substantial information of how learners are thinking about a topic and how they can guide learners' thoughts to encourage scientific thinking. Also the use of simple language within the cartoon has the potential to link concepts, jargon and practical activities for the learner. The creators of Concept Cartoons (Naylor & Keogh, 2000) generated these materials which would assist teachers with the teaching of scientific concepts and assisting them with their own understanding of science concepts. Teacher 5C said: *"This experiment helped me to have a better understanding of scientific jargon. It helped me realize the importance of teaching scientific jargon" (5C).* As stated by Naylor and Keogh "Concept Cartoons can assist teachers with developing their own subject knowledge and understanding" (Naylor & Keogh, 2000, p. 13).

Summary of Grade 5

The Grade 5 finding differed somewhat when compared to the other Grades' findings. Less content was covered and the effect of the teaching tool had minimal effects towards enhancing scientific jargon for Grade 5 learners. The teachers struggled with terminology, especially when working with second-language learners. They found that they had to continually explain the words to the learners. Teachers had admitted the activity was difficult because the learners had limited exposure to scientific language. Also minimal effort was made to help bridge the gap of science concepts. Concept Cartoon were associated with the subject English by the learners, possibly because the teachers explained the concepts and definitions in their English class.

The teaching tool, Concept Cartoons, was not considered as effective in the Grade 5 phase, it was associated with the subject English. The aim of this teaching activity was to

assist ESL learners with scientific concepts. Tthere is evidence that Concept Cartoons were associated with language content, with learners assuming that the cartoon was intended as an English lesson. Concept Cartoons formed part of, and were integrated in the subject English.

Furthermore, the data collected suggests that the way the Concept Cartoon activity was designed had an educational impact, as the cartoon intrigued learners' interests. They were having fun while learning. It also enhanced learners' understanding of how to do science investigations. The cartoon style characters caters for visual learners and it was a fun way to learn.

Participating teachers felt that they may have underestimated their learners' abilities and capabilities. After conducting this experiment they claimed that they would from now on more often encourage their learners to explore with science concepts, thus tapping into this previously untapped characteristic of their learners.

From the data gathered, evidence showed the main focus should not have been second-language learners but rather first-language English speaking learners as less effort appeared to be was made by learners whose mother tongue was English compared to the efforts of second-language learners when working with the Concept Cartoons. The teachers claimed that the second-language learners applied more effort into their learning of science concepts. This has introduced another aspect to the ongoing researching of Concept Cartoons and their uses.

4.5 Grade 6 findings

There were three Grade 6 teachers who participated in this research study. All three teachers attended an introductory workshop held by the researcher that introduced this type of study to participants as well as informing them of their expectations. As stated before, the workshop was a resource tool to educate teachers on how to implement Concept Cartoons in their classrooms. The workshop's intention was to facilitate teachers' understanding of what would be required of them when conducting Natural Sciences investigations. At the same time the researcher was able to gather information about the participants. It was important for each person involved to understand their role during this

investigation. The teachers had a condition, if this research was conducted during their teaching time, it needed to be aligned to their content material, as well as include appropriate assessment tasks. Appendix 6 contains the Concept Cartoon resource materials used by teachers when teaching science investigations. Coupled with the Concept Cartoon is an assessment task which assisted the Grade 6 teachers with assessment after implementing this Natural Sciences material.

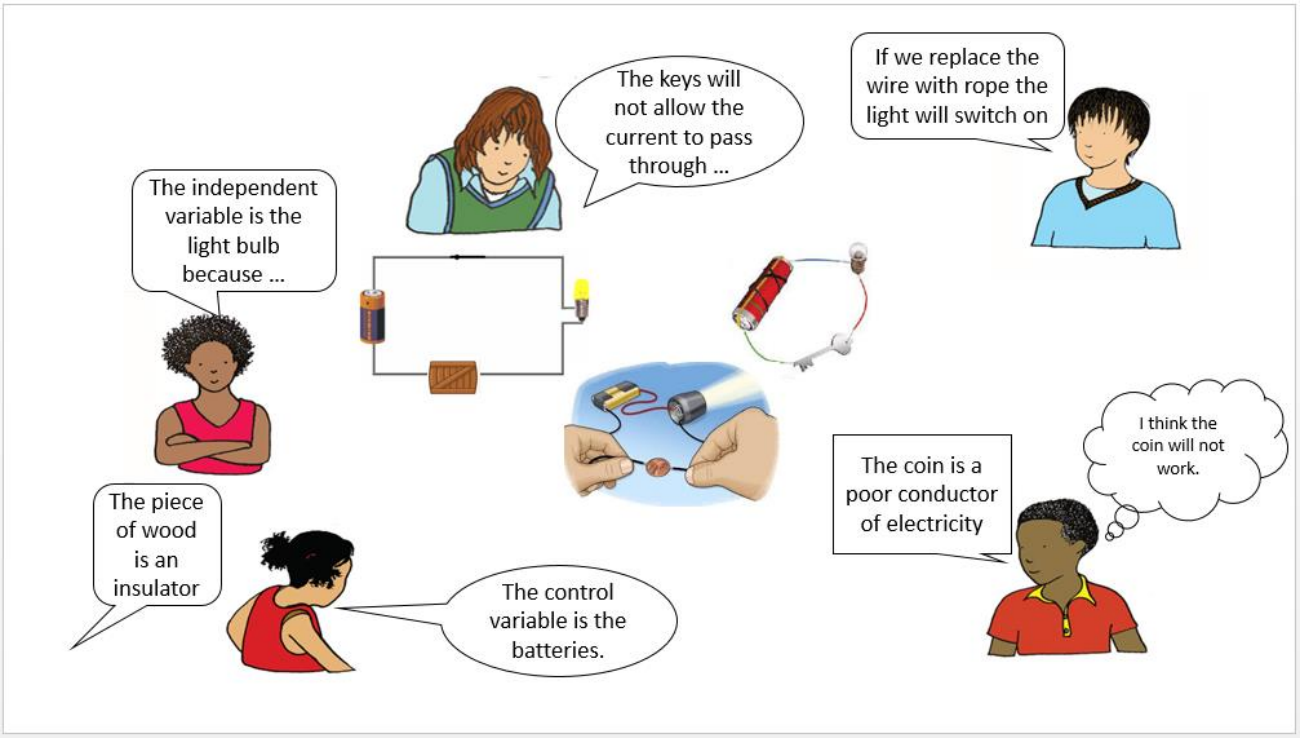

Figure 4: Concept Cartoon of children discussing, the testing of different types of materials which will conduct electricity.

The Grade 6 teachers were given a Grade specific cartoon, according to the curriculum content they were teaching during the third term. Figure 4 is for Grade 6 Natural Sciences Term 3 practical investigation, focusing on electrical circuits. The practical task focuses on investigating how to design a circuit using cell/ battery, conducting wires, lightbulb and design and make a switch to control the circuit. The key concepts of this investigation were scientific terminology to explain which materials were good or bad conductors of electricity. The teachers used the Concept Cartoon to teach learners about insulators; independent and dependent variables as well as the control variables.

The cartoon is about learners having a discussion where they are either agreeing or disagreeing about which material will conduct electricity, or rather which material will allow for electricity to pass through. Learners are talking and using scientific words to understand and figure out whether the different types of materials will allow for electricity to pass. This Concept Cartoon showed a variety of scientific words which learners are familiar with due to prior knowledge taught.

Although the teaching strategy was different compared to how the teachers conducted their practical investigations, all three Grade 6 teachers agreed there has been improvements in learners' scientific knowledge and approach to answering scientific questions. Evidence was drawn from the semi-structured interviews conducted after the practical tasks were done and results were positively concluded. Below are the different themes created based on how the data were captured and transcribed according to what the interviewees had said about their experience after conducting practical investigations with their learners using Concept Cartoons.

Theme 1: Concept Cartoons, teachers and scientific investigations

The Grade 6 teacher participants, to greater or lesser extents, identified with the accepted literature characteristics of Concept Cartoons. These characteristics include: alignment with scientific information relating to the topic/theme, being based on everyday situations; relatable to learners', containing plausible alternatives that are based on research evidence about learners own ideas at different stages and, relevant to this study, drawings and texts that makes them accessible to learners who are not fluent with English by using informal language and science terminology (Naylor & Keogh, 2000).

All three Grade 6 teacher participants' commented on the use of Concept Cartoons to engage with learners and improve understanding:

> *It created more interaction amongst the learners. Concept Cartoons allowed learners to be more proactive. It is clearly learner-centred. The cartoon captured learner's interest. Learners referred back to the cartoon when in doubt, and the cartoon was on the learner's level of understanding* (6B).

Constantinou (2016, p.13) claims that “The children were at the centre of their own learning, discussing and debating scientific concepts with their peers and learning from each other”. This supports the Grade 6 teachers’ experiences with Concept Cartoon. Teacher 6C stated scientific talk was encouraged, “*especially the new words variables and non-variables*” (6C). Teacher 6B said: “*There was a lot of interaction taking place amongst the learners, they were discussing the characters and what the characters were saying, and scientific talk was encouraged”*.

While 6A claims that “*It is an easy way for learners to study*”. 6C concurred, and focussed on the visual aspects of the instrument: “*Concept Cartoons makes it easy for learners to understand the investigation, learners could visualise this happening and not just read it*”, She agreed that learners understood the words used in the investigation, therefore they were comfortable with answering the scientific questions and concluding the practical investigations. Having said that it was an easy way for learners to study, 6A claimed that some of the concepts were not taught to learners before, therefore they did not understand certain words in speech bubbles, however, using Concepts Cartoons made it easier for her to explain what the words meant. The speech bubbles and characters supported her teachings “*It was easy for me to understand explain these words for the learners*” (6A). Teacher 6A, being a novice teacher, agreed that Concept Cartoons assisted her understanding of scientific investigations. This teaching material made it easy for the teacher to interpret the content and then explain it to the learners. This idea of Concept Cartoons assisting with teacher learning is explored in more detail in Theme 6.

What became evident from the teachers during the interviews was that they did not want to overload their learners with science terminology, especially for second-language learners, as it becomes more difficult to interpret concepts in a second language, as opposed to learners’ mother tongue. The teachers who are teaching in the Northern Area schools appeared to prefer not to overload their learners with new information, rather they introduce certain content of Grade 6 Natural Sciences in stages. In the long run, Concept Cartoons used on a consistent basis, might well assist learners’ understanding of scientific terminology. Teacher 6C said: “*I started off teaching them the meaning of these*

words, it was big words, and it is just about getting the learners to understand the terms. Confusing words in science such as hypothesis, which means prediction in Technology".

The Curriculum Assessment Policy Statement (CAPS, 2011, p. 13) for IP NS states that learners "must be supported when doing Investigations" also "they need to expand on the concepts or knowledge to which they have been introduced and deepen their understanding of the subject matter". The CAPS document clearly states that concepts must be "organised to promote clear progression of concepts across the Grades and in the Phase". With the assistance of Concept Cartoons, scientific concepts may be a fun way to learn new terminology, and encourage a clearer understanding of terminology, but only if presented sustainably over a longer time period. Teachers who might be hesitant to move away from the tried and tested official teaching strategies and materials can take comfort from the same CAPS document that prescribes what they must do. CAPS (2011, p. 14) includes statements such as: "Teachers have the freedom to expand and to design and organise learning experiences according to their own local circumstances" further on in the document, teachers are encouraged to make use of additional resources to assist with the learning of scientific concepts.

Grade 6 teachers enjoyed using Concept Cartoons and they identified mentioned characteristics which CC have embedded within their teaching design, such as, the cartoons are relatable to learners everyday situations; they provides plausible evidence of how learners identify with particular investigations and they provide drawings and text which makes them potentially easier for learners who are not fluent with English to use. These are key areas which benefited Grade 6 teachers during science investigations. The teachers agreed that the teaching tool improved learners' understanding. Using CC made it easier for teachers to explain what certain concepts meant and then explain it to their learners referring to the relevant cartoon to aid their explanations.

<u>Theme 2</u>: Concept Cartoons: design, characters and speech bubbles

As suggested in presenting and discussing the data in the previous two Grades, Concept Cartoons created scientific talk amongst learners. Learners need to take into consideration what each character in the cartoon stated, and then debate whether the statements the characters made were correct or incorrect, based on prior knowledge

learnt (Project, 2011). Teacher 6A admitted this type of teaching "*was something new*" to her, and in her opinion it had benefited the learners. She found this type of teaching easier and convenient, as it promoted talk amongst her learners. She further adds the curriculum material encourage scientific talk as "*most of the learners understood the speech bubbles and could relate to the characters, and answer when these characters made incorrect statements with regards to information*" (6A). The learners reflected on prior discussions and used this as knowledge to build on new information. Teacher 6A said the speech bubbles helped the learners understand the scientific words, after she had explained them and that "*Learners identified false information from the speech bubbles, and responded well to false requests from the speech bubbles*" (6A). Teacher 6B said that the process was a learning cycle where learners kept on referring back to what the characters said. There were differences and agreements amongst learners because of the speech bubbles. The learners could pick up when some of the characters were not making sense.

Naylor and Keogh (2000) says the speech bubbles include common misconceptions, and these are one of the characteristics associated with Concept Cartoons. The teachers noted that learners were aware of the incorrect statements the cartoon characters made. This informed teachers about learners' thinking and reasoning strategies when communicating with their peers in group discussions.

<u>Theme 3</u>: Concept Cartoons: enabling scientific talk

During the interviews all three Grade 6 teachers agreed that Concept Cartoons had encouraged scientific talk amongst their learners during the practical investigations. Teacher 6A, a novice teacher, concurred that the teaching material created classroom talk saying that "*This was something new, the cartoons created talk, the learners were afraid to answer but eventually they spoke when they realised their peers disagreed with what the characters were saying*". Participant 6B said it was her first time using cartoons to teach science investigations, and her response was "*it helped, it brought about talk amongst the learners, and created positive interaction".* One of the key features of Concept Cartoons is to create scientific talk and encourage peer discussions (Naylor & Keogh, 2000). Constantinou (2016) agrees that Concept Cartoons can be used to promote discussion and exploration of children's ideas. To provide evidence that Concept

Cartoons has created scientific talk, 6C stated "*it assisted a lot, learners were able to answer questions regarding hypothesis – key words in science investigations*". She further adds that "*debates took place amongst the learners, and after this activity they understood scientific words, and this has refreshed my understanding of the scientific words*".

All three teachers agreed their learners understood the terminology used in the Concept Cartoons. Teacher 6C said once she had explained certain words that learners had forgotten about, they then understood. She further adds that the pictures were a clear guide for the learners, and while they may have confused themselves during their discussions, they all understood the speech bubbles.

Webb et al. (2013) says that Concept Cartoons are designed to provoke discussions and stimulate thinking while consisting of simple drawings and minimal text which show characters arguing about everyday situations.

<u>Theme 4:</u> Concept Cartoons: scientific jargon

Concept Cartoons are designed to provoke discussions and stimulate thinking, they consists of simple drawings and minimal text which show characters arguing about everyday situations (Webb, et al. 2013). The minimal text consisted of scientific words designed to assist learner understanding of science investigations. Teacher 6C said: "*learners understood the words used in this investigation".*

The short and simple text of CC makes it easy for learners to link words with prior knowledge and build on their understanding. Teacher 6B said: *"Yes they understood it, some of the learners looked at the cartoon as a guide to make sense of what the character said".*

Teacher 6A stated: Some words were not taught to the learners, however, once explained they immediately understood what the characters meant within the speech bubbles".

Concept Cartoons use various designs and methods to trigger learners' interests. Visual pictures are used as scenarios that address the interests of learners (Naylor & Keogh, 2000). The cartoons are aligned with that which learners can relate to, and build knowledge to better their scientific understanding.

<u>Theme 5:</u> Concept Cartoons: scientific jargon and ESL learners

English proficiency and cognitive language skills are essential for the achievement of Natural Sciences learners. Second-language learners low performance standard in science may be "attributed by limited proficiency in English and weak mastery of academic language" (Estrella, et al., 2018, p. 3). Natural Sciences teachers devote time and effort to find solutions to support these identified language barriers which may hinder the learning of NS.

All three teachers agreed that they perceived that the teaching tool, Concept Cartoons, did assist ESL learners with scientific terminology during Natural Sciences investigations. Teacher 6A said: "*What helped was the visuals, characters interacting with each other. Most learners prefer visual tasks*". Teacher 6B said:

> *It helped the slow learners, they related the cartoon characters to what they see on the television. Every cartoon has a message which gets carried over. This was beneficial for the learners with learning barriers. It would improve their knowledge concerning specific science topics and investigations/science jargon*.

Teacher 6C concluded that the material was explained in such a way that it made it easy for ESL learners to understand. Concept Cartoons use visual representation which are intriguing for learners and they remember what they have seen from the characters, therefore they remember the content taught. Teacher 6B concluded the interview by saying:

> *There's a saying first impressions last, so when second-language learners see the pictures they will be attracted to it, the nitty gritty will fall into place later on. So I can see their imagination is triggered and their interests are triggered, they will want to know what is going on, once they see the Concept Cartoons, and then hereafter you start teaching science concepts and learning begins.*

Concept Cartoons captured the imaginations of learners via their teacher's guidance and possible had a positive impact on the learning in science classrooms for second-language learners.

<u>Theme 6</u>: Concept Cartoons: teacher learning

Concept Cartoons may be viewed of an Educative Curriculum Material, as stated by Beyer and Davis (2015, p. 4), they are "materials designed to promote both teacher and student learning may help novice teachers learn how to engage in productive curricular planning". The double purpose of an Educative Curriculum Material to improve both teacher and learner learning appears, in this study, to have been illustrated.

The teachers enjoyed the teaching tool with Teacher 6A saying "*It was fun and different for myself and my learners compared to rote learning from the textbook*". She further adds that trying something new is exciting and cartoons can be educational as well. She was so taken up with Concept Cartoons that she expressed excitement trying to develop and implement her own Concept Cartoons in Natural Sciences lessons. Teacher 6B said "*It was a fun way and made the lesson interesting for the learners*". She said:

> *I liked the idea of falsifying some of the speech bubbles, this was a brain teaser for myself and the learners, this allowed for critical thinking. This activity gave my learners space to think outside of the box. With this teaching tool, I have learnt it is not about me and how I perceive the learners to grasp these concepts, but if I use this technique in other practical's it will work as my learners perform better. I would like to implement this going forward, the aim is to master the basics and the concepts*".

Teacher 6C claimed that

> *I learnt that by using Concept Cartoons learners will be able to develop skills to make decisions and come to their own conclusions. This teaching tool helped with limited resources and materials which is needed in science investigations, therefore it is beneficial for myself and my learners*.

The teachers enjoyed this teaching tool. It completed a lesson for them knowing their learners understood the content and remembered the concepts used. This teaching tool has had a positive outcome towards the teachers' own learning as well. Concept Cartoons did assist teachers with science investigations by keeping learners interested and asking questions to each other. The cartoons generated talk amongst the learners. However, it

is evident from the interviews conducted with the teachers, who are teaching in Northern Area schools, that it is difficult to build learners' science vocabulary as learners struggle with scientific language at this stage. Furthermore CC assisted teachers who had limited resources, participant acknowledged that it is possible to conduct a 'paper' science investigation using only the CC material.

Summary of Grade 6

It is evident that Concept Cartoons had a positive impact towards the learning process, and empowered teachers with the facilitation skills to deliver practical investigations in a fun way. The teachers agreed that Concept Cartoons brought about positive talk amongst the learners and scientific talk was created as well as encouraging peer discussion.

Another observation was that Concept Cartoons assisted with academically challenged learners. These cartoons might be viewed as a remedial activity to help learners understand Natural Sciences investigations and difficult concepts. The design of the cartoon made it easier for ESL learners to interpret the content because of the fun, almost casual design of the Concept Cartoon with these learners possible related this as an activity similar to a television show. From the evidence provided, the Grade 6 teachers agreed that the teaching tool, Concept Cartoons, has assisted with second-language learners. The cartoon style character had a lasting impact towards their learning.

Concept Cartoons could be viewed as study material that could be used to refresh prior knowledge that was taught, and to remind learners of science concepts. All three teachers agreed Concept Cartoons is a fun way to learn and is different from reading a Natural Sciences textbook. This type of teaching challenged the teachers' definitions of certain science concepts, as some of the speech bubbles had falsified information which encouraged critical thinking. This was an opportunity for teachers to observe how their learners interpret content.

Concept Cartoons broaden teachers' thinking and is a constant reminder for them to focus not only on content, but also on how learners perceive information and how they interpret it. It places the focus back to the learners' learning. Concept Cartoons were not only fun for the teachers, but they also identified and highlighted for the teachers important

components of the topic that might not have previously been aware of, such as little known science misconceptions. They give teachers a clear indication of what needs to be taught, also acting as a resource material for schools who have big class groups and might lack resources*. 6B stated: Being in predominantly socioeconomic circumstances where we have little resources. Most of the time we need to improvise with what we have especially when it comes to science investigations. However with this (CC) the learners could be proactive.* This visual material brings reality to the classroom in a fun way to learn and explore investigations.

Teachers teaching in the Northern Areas struggle to teach scientific jargon, this teaching has been assisted by using Concept Cartoons. However, if Concept Cartoons were introduced at an earlier stage of the teaching year, they may positivity affect the learning of second-language learners. This investigation would assist learners with scientific jargon if continuous implementation of Concept Cartoons in the learning process occurred.

4.6 Summary of the themes

This section provides a summary of all six themes to conclude the data collected.

#	Main theme	Will respond to
1	Concept Cartoons: teachers and scientific investigations	SQ2
2	Concept Cartoons: design, characters and speech bubbles	SQ2
3	Concept Cartoons: enabling scientific talk	Science investigations
4	Concept Cartoons: scientific jargon	SQ1
5	Concept Cartoons: scientific jargon and ESL learners'	
6	Concept Cartoons: teacher Learning	ECM, SQ 3

Theme 1: Concept Cartoons: teachers and scientific investigations

Theme one concludes teacher's perceptions of their learners understanding after they had implemented the teaching tool, Concept Cartoons, in their classrooms. It was evident

that Concept Cartoons had improved learners' knowledge as they stimulated their understanding of science concepts and got them thinking about science investigations in different ways.

Concept Cartoons made it easier to teach science concepts, especially for learners who lack science knowledge. Speech bubbles and the cartoon characters provided support during NS investigations. Concept Cartoons broadened teachers' teaching and learning strategies and positively influenced their understanding of the scientific jargon used in science investigations. However, Grade 5 teachers did not completely benefit from the teaching tool. They did, however, agree it was a fun and interesting teaching approach which, with continuous use, will benefit their teaching. Also agreeing that these cartoons have the potential to further assist with the limited language proficiency possessed by learners when teaching science concepts.

Furthermore CC made it easier for teachers to teach science concepts, especially for learners who lack science knowledge and science background. Speech bubbles and the cartoon characters provided support during NS investigations. Teachers believed that this teaching strategy assisted their understanding of scientific investigations. This was especially true novice teachers who will relied on using a CC teaching strategy for practical science investigations.

Theme 2: Concept Cartoons: design, characters and speech bubbles

The teachers conveyed sentiments that support the use of characters within the cartoon, stating that learners were able to relate to the characters. The short; easy to read text within the speech bubbles, assisted with the explanation of scientific content during investigations.

The learners enjoyed the characters and were able to read the statements, however, certain scientific concepts were difficult, due to the complexity of these words. The teachers said the scientific concepts were by no means universal. Learners did not understand the science and once new jargon words were introduced this compounded difficulty with understanding of the science content. Teachers said that only when these words were explained did learners have a better understanding of the statements. This

kept learners focused and it intrigued their interests. Teachers advised that one should expose learners to new jargon before engaging with the cartoon and rely on the Concept Cartoon to assist with clarifying these jargon words.

Teachers believed the Concept Cartoon were effective as it attracted learners' attention, and to some extent, their knowledge and understanding. It created scientific talk especially when learners had debates with each other about the misconceptions stated by characters within the speech bubbles. It helped learners tap into prior knowledge and it substantiate their point of views when answering investigative questions.

Theme 3: Concept Cartoons: enabling scientific talk

One of the key features of Concept Cartoons is to encourage scientific talk amongst learners. After reading the cartoon sketch learners felt free to discuss their views and give answers about the topic or concept addressed in the cartoon, (Keogh & Naylor 2000).

The finding for Grade 4 and Grade 6 teachers were similar, they agreed scientific talk was generated during science investigations using the cartoons. The data showed evidence that, after conducting the activity with learners, they better understood the science words used in Concept Cartoons. The teachers agreed that the cartoons improved their teaching methods of science concepts during investigations. What added to this understanding was the visual representation of the cartoons, which intrigued learners.

Apart from gaining learners' attention, the Grade 5 teachers had a different point of view and stated the cartoon itself did not generate scientific talk. These teachers suggested that the terminology in the speech bubbles did, however, create an awareness in learners that they did not understand the terminology, thus enabling the learners to point out difficult terminology to their teachers during the investigation. This is due to learners having limited scientific concept knowledge therefore scientific language was difficult to use during the investigation. The learners did not initially know what they did not know. The Grade 5 teachers stated there is a gap of scientific terminology, if learners had prior knowledge of science concepts the implementation of NS content would be easier to grasp for learners when using Concept Cartoons as a teaching tool.

Theme 4: Concept Cartoons: scientific jargon

The teacher participants gave positive responses of their Concept Cartoon experience. They agreed the teaching tool assisted them and their learners with teaching NS investigations.

Data were concluded as the learners progressed from Grade to Grade their understanding of science concepts has improved. Although in Grade 4 the teachers admit the words were out of the learners' depth of understanding. However, the majority of teachers agreed that CC assisted their understanding of science investigations and positively impacted towards the learning process.

Various aspects of CC had promoted learner understanding of science concepts. The drawing of characters stimulated a playful, informal learning environment; minimal text encouraged scientific thinking and the visual representation of CC addressed the interests of learners.

Theme 5: Concept Cartoons: scientific jargon and ESL learners'

"Concept Cartoons are designed to stimulate scientific thinking…" (Birisci, et al., 2010, p. 92). The teachers agreed the science investigation helped learners to think outside of the box and it stimulated science understanding. More importantly, they perceived that the teaching tool CC did assist second-language learners with scientific terminology during NS investigations.

Teachers benefited from the teaching tool, observing how Concept Cartoons improved science knowledge and enhanced both theirs' and learners' understanding of science content. Specific characteristics such as less intimidating language was most attractive for teachers who taught second-language learners. Concept Cartoons were designed in such a way that it made it easy for ESL learners to understand and consequently they had a lasting impact on the learning of science concepts.

Theme 6: Concept Cartoons: Teacher Learning

Analysis of the data suggests that Concept Cartoons enhanced and improved the understanding of the teachers. The cartoons acted as a resource for the teachers, guiding

them with the identification of potential learner misconceptions. As such assisting teachers with the identification and remediation of these misconceptions. In South Africa the lack of teacher's knowledge to assist learners with language barriers is a major problem (Hind, et al. 2001). Sometimes teachers misinterpreted language barriers as rudeness or they assume the learner has no way of addressing an adult (Van Roekel, 2008, p. 3). Concept Cartoons, however, assist teachers with substantial information on learner thinking about a topic and this helps teachers to guide learner thoughts and encourage scientific investigations. This might go some way to assist learners who struggle merely because of a language barrier.

The participants unanimously agreed that Concept Cartoons are a teacher resource, as they benefited from, and gained knowledge, from using them in their classroom. This teacher resource was enjoyable for both the teacher and learner, enhancing decision-making and scientific skills. The purpose of implementing Concept Cartoons as a potential Educative Curriculum Material are to improve "the quality of science teachers being produced as well as the development of in-service teachers" (Villanueva, 2010).

4.7 Chapter summary

Concept Cartoons can be used as a teaching and learning strategy as well as for teacher professional development. They capture the learners' imaginations and interests; present alternative ideas; use familiar situations which learners can relate to; create opportunity for differentiation and the teaching scientific jargon. All this and more can be achieved by teachers using easily manageable strategies for both the teacher and learners (International, 2017).

The researcher, identified and adapted or modified three different Concept Cartoons, all of which were aligned with the CAPS IP NS&T policy guidelines. There was one unique Concept Cartoon per Grade. Each cartoon was designed for a specific Grade, with a particular topic related to Natural Sciences investigations. It was important that the researcher did not deviate from what was required to be done in Term 3 for IP NS as this was a condition for participating set by the participants themselves. Therefore the content had to be aligned with a specific topic which related to what was being taught in the curriculum for Term 3. Grade 4's topic focused on energy and change and structures

relating to sound, energy and music. The learners were instructed to create different sized drums using a variety of materials to test the sound of each materials. Grade 5 focused on life and living and mechanisms, learners had to observe energy from a burning candle. The Grade 6 topic involved matter and materials, where learners had to investigate different types of good conductors compared to poor conductors of electricity, using different types of materials.

The data were reported on and discussed using six identified themes, namely:

1. Concept Cartoons: teachers and scientific investigations
2. Concept Cartoons: design, characters and speech bubbles
3. Concept Cartoons: enabling scientific talk
4. Concept Cartoons: scientific jargon
5. Concept Cartoons: scientific jargon and ESL learners
6. Concept Cartoons: teacher Learning

Data for each of these themes is presented and discussed per Grade, this is followed by compiling the different Grade discussion by theme.

CHAPTER FIVE

CONCLUSIONS

5.1 Introduction

This, the concluding chapter of the study uses the data presented and discussed in Chapter 4 to respond to the main research question and the three sub questions of this study entitled:

The potential of Concept Cartoons, as Educative Curriculum Materials, to teach the jargon of scientific investigations in Primary School Sciences

This study originated from one of the major concerns I had as a novice science teacher, namely, learners' lack knowledge and understanding of scientific jargon. After a number of years of teaching science in the primary school, and attempting various strategies to improve children's knowledge usage of scientific jargon, I got the opportunity to research a particular strategy, Concept Cartoons. My interest in Concept Cartoons was sparked when I saw their implications in the Intermediate Phase science classroom as a means of improving, not only the use and understanding of scientific jargon, but also as a means of assisting teachers understanding of investigations i.e. using Concept Cartoons as an Educative Curriculum Material (ECM).

I identified in the eyes of my learners lack of enthusiasm and dismay towards science investigations and this frustrated me during my teaching. I realized I needed to find a solution to assist them with scientific terminology in investigations, hoping that this would go some way to filling this gap in their motivation towards learning and understanding science. My subject choice, Natural Sciences was influenced by the type of learners I was teaching. These learners came from different socio-economic backgrounds from the Northern Areas of Port Elizabeth, which meant English was not their home language. Was science jargon a source of their struggles with science?

Overtime I realized that teaching in a traditional manner (e.g. chalk and talk) was not always successful, possibly because my learners interpreted information differently because of their home language which is different to my teaching. They struggled with

scientific jargon (e.g. hypothesis; predict; dissolve and variables) which made science lessons somewhat ineffective.

Teachers, including myself, think learners have grasped the content taught in previous Grades. We assume learners have basic scientific knowledge which is taught in previous science classrooms. However, while many learners are able to read, they might not understand the terminology used in Natural Sciences content, therefore they struggle with the subject.

Learners may learn the terms by rote, but they lack a deeper understanding of these terms, it is for this reason they find scientific jargon difficult. Furthermore what contributes to this is the language of instruction is not the learner's home language, which definitely places these learners at a disadvantage. This was what led me to search for teaching methods and styles to make learning Natural Sciences concepts interesting and effective, focusing specifically on Natural Sciences investigations.

Therefore the purpose of this research was to investigative whether Concept Cartoons might assist with the understanding of scientific jargon in Natural Sciences for English Second Language (ESL) learners.

5.2 The research question

This study was framed by a main research question and three sub-questions. The intention of the sub-questions was to gather data and discuss this so as to inform the final response to the main research question.

The research questions were:

Main Question:
Can Concept Cartoons promote an understanding of scientific terminology used in investigations, thus assisting Natural Sciences teachers to teach science?

In order to respond to the main question three sub-questions, each addressing and aspect of the main question were asked:

Sub-question 1: What are a group of Port Elizabeth educator's perceptions of their learners understanding of selected science terminology?

Sub-question 2: What are teacher's perceptions of the effects of using Concept Cartoons for their learners understanding, after trying them out in a classroom?

Sub-question 3: What evidence is there to suggest that Concept Cartoons have enhanced teacher's capabilities to teach terminology with respect to scientific investigations?

Each of these sub-questions is considered, within the context of the presentation and discussion in Chapter 4, culminating with a response to the main research question.

Sub-question 1:

What are a group of Port Elizabeth educator's perceptions of their learners understanding of selected science terminology?

Intermediate Phase (IP) Natural Sciences teachers' stated that their learners struggle with scientific terminology, especially within the context of Natural Sciences investigations. IP teachers agreed that the learners struggle when addressing investigative questions due to their lack of understanding of science concepts, coupled with their having to do this within the context of a second or even a third language. These teachers observed how the teaching tool Concept Cartoons had improved learners understanding of science concepts, it also stimulated their thinking of and during science investigations. The teachers felt, learners who initially lacked science knowledge were able to understand science terminology due to the teaching tool Concept Cartoons, which appeared to make it easier for them to comprehend science terminology.

Sub-question 2:

What are teacher's perceptions of the effects of using Concept Cartoons for their learners understanding, after trying them out in a classroom?

The IP teachers had a positive response towards the implementation of Concept Cartoons (CC). They were user friendly and effective during their teaching of Natural

Sciences investigations. The participants stated learners were able to relate to the cartoons, often 'seeing' themselves as having similar ideas as the cartoon characters. The short, easy to read text within the speech bubbles, made it less intimidating for Intermediate Phase learners.

Teachers identified certain science concepts as being difficult due to the complexity of these jargon words, however, the design elements of Concept Cartoons had assisted in learners' cognitive understanding and, once further explanation was implemented by the teachers, learners appeared to better understand the investigative questions. Teachers advised, and agreed that with sustained and longer usage of CC, learners would benefit from and better understand scientific concepts. They observed how CC intrigued and interested learners in science investigation, resulting in positive attitudes overall. Teachers believed that Concept Cartoons were effective as they attracted learners' attention, and to some extent, their knowledge and understanding. CC created scientific talk. This exploratory talk was especially noticeable when learners had debates with each other about the misconceptions stated by characters within the speech bubbles. It helped learners tap into prior knowledge and it substantiate their point of views when answering investigative questions.

Sub-question 3:

What evidence is there to suggest that Concept Cartoons have enhanced teacher's capabilities to teach terminology with respect to scientific investigations?

The purpose of this question was to identify if the teachers learnt anything from their usage of Concept Cartoons, i.e. could Concept Cartoons themselves be considered as being Educative Curriculum Materials: functioning as tools to promote both learner and teacher learning? Concept Cartoons had made it easier for teachers to teach science concepts, especially to learners who lacked science knowledge. The speech bubbles and the cartoon characters provided support during NS investigations. These Concept Cartoons acted as a resource guide which identified misconceptions learners had, and guided teachers to identify and eliminate these misconceptions immediately, informing them of how learners were thinking about a topic and how they might guide their thoughts to encourage scientific investigations.

The concept Cartoons assisted teachers with their own understanding of scientific terminology, this is especially true of novice teachers who rely on teacher resources to assist them with their teaching. The key features of CC appeared to improve the teachers' skills of implementing scientific investigations in the IP. As such, resulting in their capabilities being enhanced for the teaching of NS investigations. In addition to enhancing their own personal understanding of science concepts the teachers agreed that using Concept Cartoons were a great teaching resource. They claimed that this was a fun and interesting teaching approach which would definitely improve their teaching strategies with respect to NS investigations.

Main question

Can Concept Cartoons promote the understanding of scientific terminology in investigative questions to assist Natural Sciences teachers?

The findings of this study, as portrayed in the responses to the three sub-questions, suggest that Concept Cartoons are not only a teacher resource used to assist learners with their own learning and understanding, but also the embedded characteristics of an Educative Curriculum Materials can be perceived by the teachers. These benefited Natural Sciences teachers with their own understanding of scientific terminology and their concept of how to effectively teach scientific jargon to English Second Language (ESL) learners.

The conclusion of this study is that, the teaching tool, Concept Cartoons, has assisted the teachers with their teaching of investigations in the subject Natural Sciences. Concept Cartoons benefited teachers, to improve their teaching of science jargon to the majority of their learners. The teachers found the teaching content easy to work with and it was understandable. They observed the learners throughout the lesson and they commented that it was easier to teach Natural Sciences investigations through the medium of these cartoons. The learners enjoyed the cartoon style characters and they were able to read and understand what the cartoon characters were saying. The Grade 5 and Grade 6 learners understood the terminology, being able to apply reasoning skills as well as question the speech bubbles that were deliberately incorrect in the cartoon.

Concept Cartoons created awareness; enabled questioning amongst the learners, and igniting different teaching mechanisms for the teachers. It alerted teachers own knowledge of the science investigations and helped teachers to feel comfortable when teaching scientific terminology. The findings of this study suggest that Concept Cartoons are an effective teaching strategy, which influences the understanding of Natural Sciences investigations. Teachers benefited from implementing Concept Cartoons in their Natural Sciences classrooms. Not all teachers may have had the same responses, but the teaching tool has impacted the learner's process of interpreting information regarding science terminology.

This study elicited positive responses from the majority of the teachers who took part in this research study. The structure and implementation was easy to understand, and did not intimidate any of the teachers. Therefore they each had a positive response regarding certain aspects of implementing Concept Cartoons in their Natural Sciences investigation teaching.

The teachers observed and commented on the characteristics of Concept Cartoons, it was evident, that this teaching tool has had a lasting effect on their learners' learning. It was a fresh approach, different as to how they normally assess their learners. The teachers enjoyed the cartoon style characters, and found the assessment tasks easy to mark. All the teachers asked for clear copies of the content according to their teaching Grade to implement in their teaching approach.

Without a doubt, the fun and entertaining aspect of Concept Cartoons was achieved, and the teaching tool was not only enjoyed by learners and teachers alike, but learning also happened in the different Grades.

5.3 Implications of the findings

Teacher participants struggled to effectively teach Natural Sciences investigations. Factors which may contribute are, English Second Language (ESL) learners' converse with their peers in their mother tongue. According to Probyn (2005) many learners speak their first language at school with their peers and during classroom discussions but when reading; writing and being assessed, they complete these tasks in English. This results

in code switching to develop working definitions to be able to translate terms and concepts to understand.

In the classrooms where the language of learning and teaching (LoLT) is not the same as the primary language of the learners and even the teachers, traditional teaching strategies (e.g. chalk and talk) do not work well enough. This is particularly noticeable when one is possible teaching another language, namely, 'science jargon'. In these situations alternative strategies must be explored. This study suggests that using Concept Cartoons to teach the science jargon of investigations might be a profitable route to attempt.

5.4 Delimitation of study

The study was restricted to teacher participation, due to ethical procedures and considerations, I would have liked to observe the learners while they were using and interacting in their classrooms with the Concept Cartoon. This would benefit my research to see what works and what does not work, what learners understand and what they need clarity about. This observation would also influence the design of the cartoon style.

5.5 Future directions of research/ fields

It might be interesting to explore whether teaching experience in science influences teachers' willingness to try new and often innovative teaching strategies. Novice teachers found the strategy used in this study useful, but for different reasons to those offered by the more experienced teachers.

Teacher 6B advised that Concept Cartoons were beneficial for learners with learning barriers. An interesting and useful area to be researched might be how beneficial Concept Cartoons might be for remedial learners and learners with challenges that might mitigate against their effective learning and understanding of science concepts.

A Grade 5 teacher noted that during classroom activities, English Home language learners spent more time trying to understand the content than English Second Language (ESL) learners. The teacher stated that English Second Language (ESL) learners were accustomed to devoting time translating difficult concepts compared to English home

language learners who simply assumed that they understood the terms. A profitable area of future research is how different language groupings perceive the use of Concept Cartoons..

5.6 Conclusion

I enjoyed the feedback the teachers gave and acknowledge the changes they would have liked to implement along with the teaching tool. This study has broadened my perspective of the topic and given me insight as to how other teachers approach this teaching tool in their Natural Sciences classrooms with their learners. Conducting this research has definitely broadened my perspective of Natural Sciences content particularly with NS investigations. This study has sparked creativity of applying different teaching styles and approaches I could implement in science pedagogy.

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Appendix 1: Ethics Approval

Nelson Mandela Metropolitan University
for tomorrow

FACULTY OF EDUCATION

22 May 2017

Ms WE Abrahams / Dr L Meiring
Education Faculty
NMMU

Tel . +27 (0)41 504 4568

Dear Ms Abrahams

The potential for Concept Cartoons to assist Natural Sciences teachers with developing scientific jargon for Primary School learners.

Your above-entitled application for ethics approval was approved by the Faculty Research, Technology and Innovation Committee of Education (ERTIC) on 4 April 2017.

We take pleasure in informing you that the application was approved by the Committee.

The ethics clearance reference number is **H17-EDU-ERE-005**.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

Ms J Hay
Secretary: ERTIC

Appendix 2: Letters of permission

DEPARTMENT OF EDUCATION

NELSON MANDELA BAY METRO DISTRICT OFFICE

✉ Private Bag X3915, Sutton Rd, Sidwell, Port Elizabeth

☎ (041) 403 4445 0820754793 / 🖷 0866552800

E-Mail pedro.vanvuuren@edu.ecprov.gov.za

TO: MS. WARDA ABRAHAMS

FROM: MR PJ VAN VUUREN (ACTING CES – IDS&G)

RE: PERMISSION GRANTED TO CONDUCT RESEARCH AT SCHAUDERVILLE

SCHOOLS

DATE: 26 MAY 2017

Dear Ms. Abrahams

Warm Greetings

Permission is hereby granted to conduct research towards your maters in education the following selected schools:

1. Dietrich Primary
2. St. Theresa's Primary
3. GJ Louw Primary
4. Adolph Schauder Primary

The research however must be based on the following provisos:

1. This letter is given to the selected schools' principals.
2. The principals will be fully consulted and known in all arrangements
3. All current policies/prescripts of the DoE will be honoured
4. There will be a minimal disturbance iro teaching and learning
5. This will in no way distract from the current programme of the school and its concomitant programme with the DoE.

We would like to wish you well with your endeavour, knowing that it will not only benefit the educators/leaners from the Schauderville area but the broader community would ultimately benefit from it.

Thank You

Pedro J van Vuuren

Acting CES – IDS&G

Appendix 3: Interview questions

The below interview questions were designed, to assist the researcher with semi-structured interviews. The participants requested that meetings were scheduled after the research process was conducted with learners. They were strict with this and insisted the allocated time be used sufficiently as they were unable to schedule multiple meetings throughout the term. Teachers had moderation deadlines and administrative duties therefore they had limited time and wanted the scheduled appointment to be constructive. The researcher designed interview questionnaire, which was used as a guide throughout the interview process. This was done to make sure all relevant questions were asked after teachers had conducted investigation of Concept Cartoons with their learners.

Interview questions

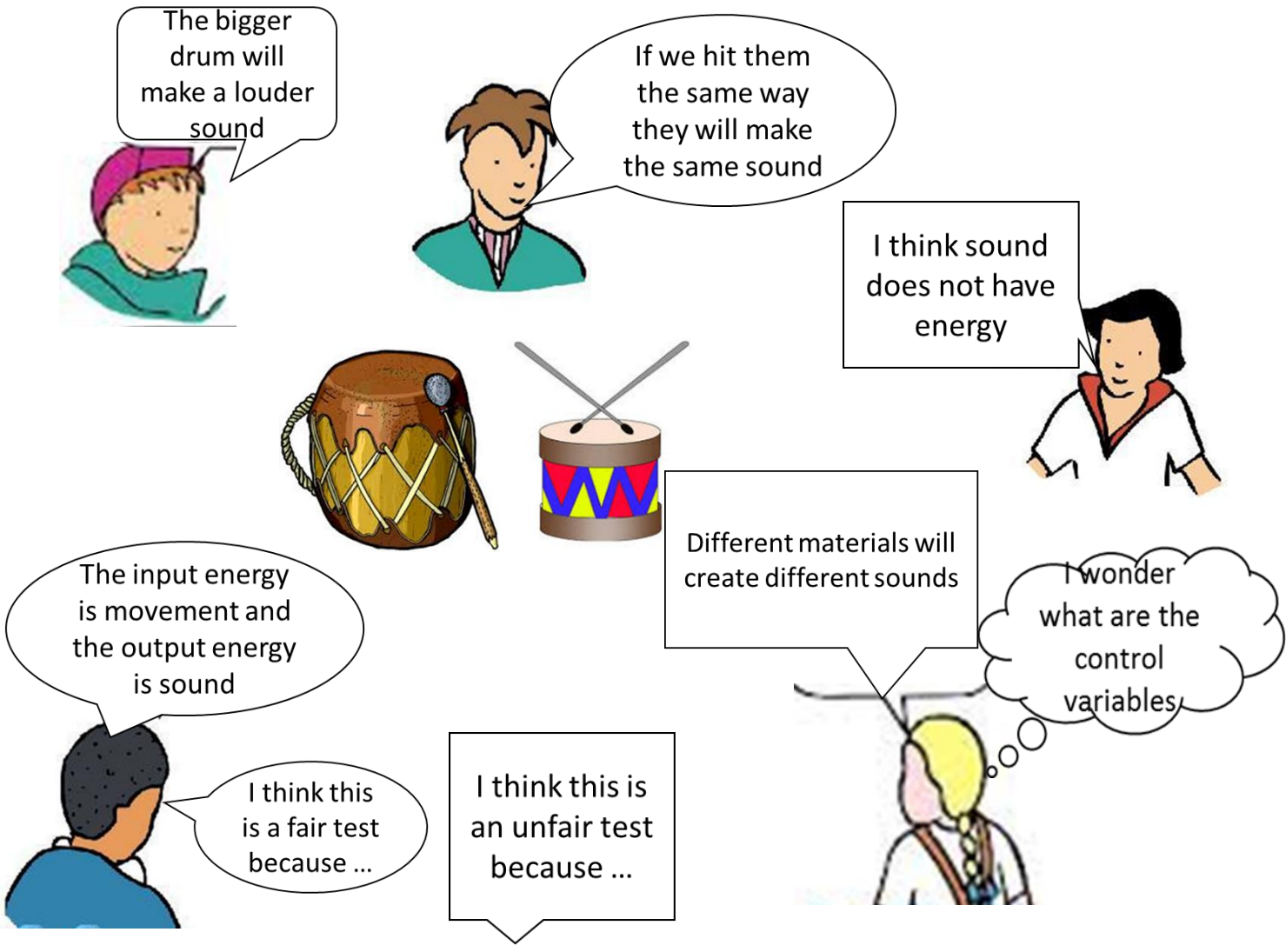
1. How has this scientific experiment help you as a teacher, to benefit your understanding of scientific jargon in investigations?
2. Did the curriculum material, Concept Cartoons (characters, speech bubbles) encourage scientific talk amongst the learners?
3. Did the learners understand the scientific terminology used in the cartoon?
4. Did the learners understand the speech bubbles, and what each character was saying?
5. Has Concept Cartoons improved the understanding of scientific jargon in Natural Sciences investigations in your classroom?
6. Has this teaching material improved the understanding of scientific jargon in Natural Sciences investigations for second-language learners?
7. What is your opinion of this curriculum material, Concept Cartoon?
8. How can the researcher improve this curriculum material for further investigating within the subject Natural Sciences?
9. What have you learnt by implementing the teachings of Concept Cartoons in the subject Natural Sciences?
10. Will you continue to use this teaching material, when conducting science investigations?

Appendix 4: Grade 4 Concept Cartoon

NATURAL SCIENCES & TECHNOLOGY GRADE 4:

FAT 1 – INVESTIGATIONS TERM 3

INVESTIGATE THE VARIABLES OF A MUSICAL INSTRUMENT



ANSWER THE FOLLOWING QUESTIONS:

1. Make a prediction. Which drum do you think will make the most noise? Why do think this will happen?

_____ (2)

2. Does the materials affect the output sound of the instrument? If yes why is this?

_____ (2)

3. Is this a fair experiment? If no why do you think so?

_____ (2)

4. What is the input energy of this investigation?

_____ (2)

5. What is the output energy of this investigation?

_____ (2)

6. Identify the control variables of this investigation?

_____ (2)

7. Complete the flow diagram to show the input and output energy of the above instrument:

Input energy Instrument Output energy (3)

[Total: 15 marks]

FORMAL ASSESSMENT TASK – MEMORANDIUM

Answers:

1. Learner's answers will differ, according to how they interpret sound from each drum. **Note:** A prediction is when you determine the outcome/ results of the investigation before conducting the experiment.

- Possible answers: The bigger drum will make a loud noise.
- The silver drum will make a loud noise.
- It depends on how hard you hit each drum

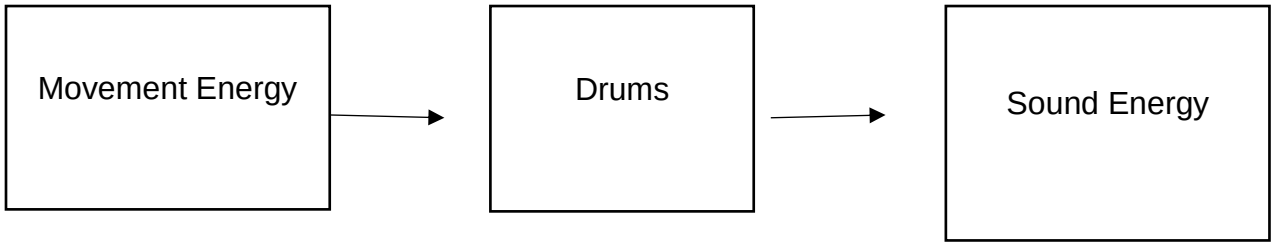
(Any of the above answers)

2. Yes, different materials creates different sound.
3. No it is not a fair test.

Reason: The materials are different
The size of the drums are different
The person hitting the drum will not hit it the same way.

4. Movement energy / kinetic energy.
5. Sound energy – the drum will make a sound (noise)
6. Both drums have drum sticks to hit with (mallets).
7.

Input energy Instrument Output energy (3)

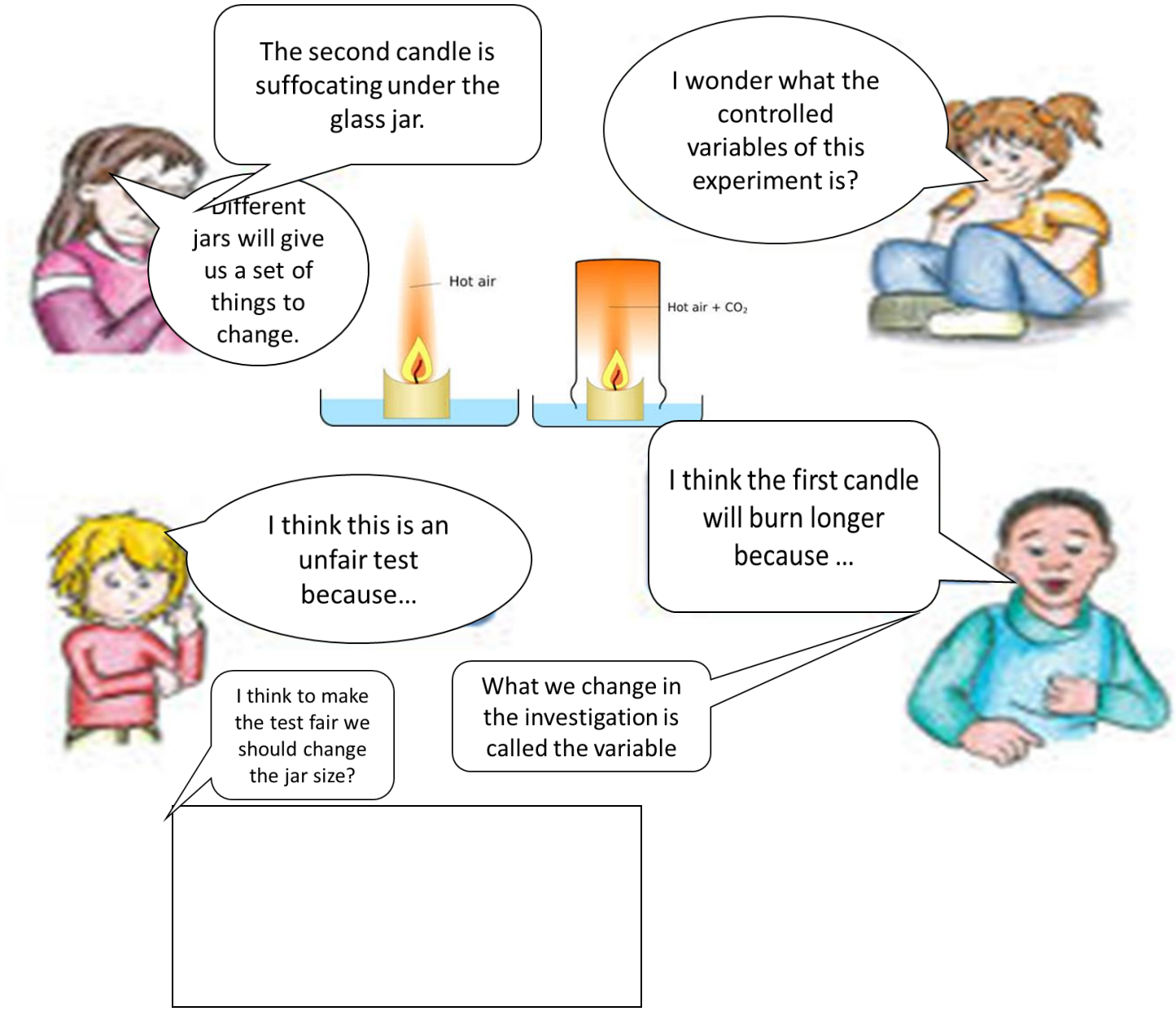


Appendix 5: Grade 5 Concept Cartoon

NATURAL SCIENCES & TECHNOLOGY GRADE 5:

FAT 1 – INVESTIGATIONS TERM 3

INVESTIGATE HOW LONG A CANDLE WILL BURN



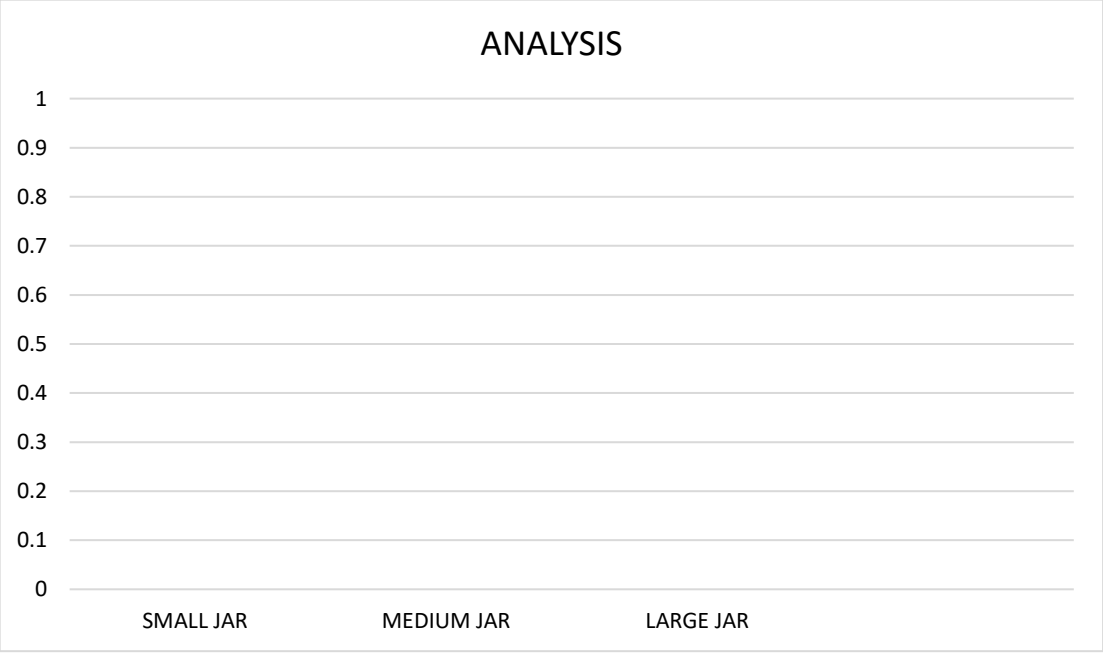
METHOD:

1. Stick the candle down onto the saucer / side plate by melting it.
2. Light the candle with a match.
3. Place the small jar over the burning candle and time how long it takes until the candle goes out.
4. Record the time taken in the results table
5. Repeat the experiment with the medium and large jars.

RECORD & OBSERVATION:

SIZE OF GLASS JAR	TIME TAKEN FOR CANDLE TO GO OUT (SECONDS)
SMALL	
MEDIUM	
LARGE	

(3)



(3)

ANSWER THE FOLLOWING QUESTIONS:

1. What question are you investigating? Write a hypothesis for your investigation.

_____

_____ (2)

2. Make a prediction: Which candle do you think will stop burning first? Which candle do you think will burn the longest?
   _____ (2)
3. How did the size of the jar affect the time the candle burned?
   _____ (1)
4. What do you think caused the candle to stop burning, once you put the glass jar over the candle?
   _____ (1)
5. a) What is the independent variable?
   _____

   b) What is the dependent variable?

   _____ (2)
6. Is this a fair test? If not state why.
   _____ (1)

[15 marks]

MARKS	LEVELS	DESCRIPTION	PERCENTAGE
12 – 15	7	OUTSTANDING ACHIEVEMENT	80 – 100%
11	6	MERITORIOUS ACHIEVEMENT	70 -79%
9 – 10	5	SUBSTANTIAL ACHIEVEMENT	60 – 69%
8	4	ADEQUATE ACHIEVEMENT	50 – 59%
6 – 7	3	MODERATE ACHIEVEMENT	40 – 49%
5	2	ELEMENTARY ACHIEVEMENT	30 – 39%
1 – 4	1	NOT ACHIEVED	0 – 29%

FORMAL ASSESSMENT TASK – MEMORANDIUM

Answers:

- The recording time for each class will differ. Teacher will need to record the accurate time for the learners. Accuracy (3)
- Learners will need to draw a bar graph (time taken for the candle to die out for each jar size). Accuracy (3)

8. Learners answers will vary slightly, but must reflect the following: A candle will burn longer if it has more oxygen. (2)
9. **Note:** A prediction is when you determine the outcome/ results of the investigation before conducting the experiment.
   The candle covered by the smallest glass jar will burn for the shortest amount of time and the candle that is not covered by a jar will burn the longest. (2)
10. The candle that was not covered burned the longest because it had an unlimited supply of oxygen. (1)
11. The lack of oxygen in the glass containers caused the candles to stop burning. (1)

    Note: Independent variable – This is the thing that you are changing in the investigation. You are in control of the independent variable.

    Dependent variable – The dependent variable is the thing that you observe in an investigation. You do not change it. The dependent variable will change depending on the independent variable.

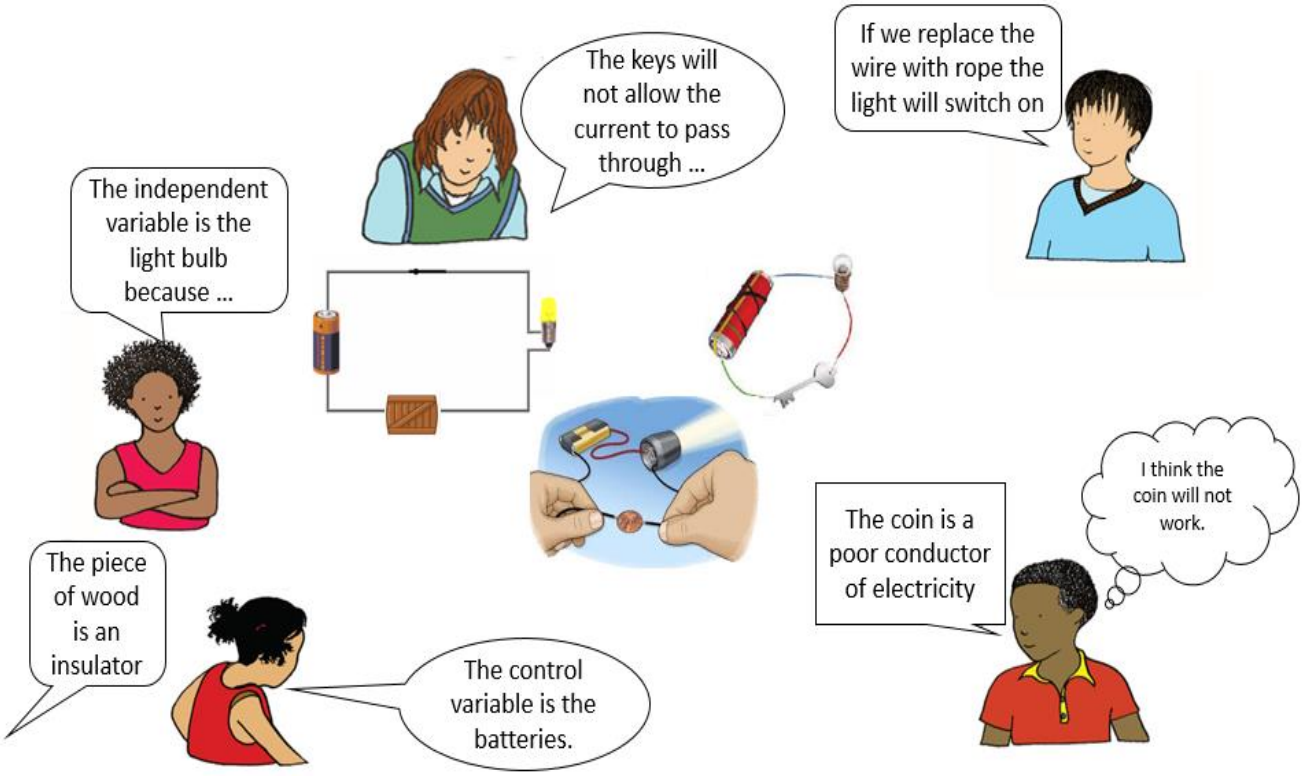
12. Independent variable – glass jar (changing the different size of the glass jar) (1)
    Dependent variable – lit candle (time taken for the candle to burn) (1)
13. Learner's answers will differ according to their observation and understanding. The cartoon graphics shows an unfair test, because the second candle has a glass jar over it. All the variables are not the same therefore it is an unfair test. (1)

Appendix 6: Grade 6 Concept Cartoon

NATURAL SCIENCES & TECHNOLOGY GRADE 6:

FAT 1 – INVESTIGATIONS TERM 3

INVESTIGATE DIFFERENT MATERIALS THAT CONDUCTS ELECTRICITY



You will need: two torch cells (size AA); one torch bulb; three connecting wires; objects to test.

Answer the following questions:

1. Write down a hypothesis. Which materials do you think will conduct electricity?

_____ (2)

2. Conduct your investigation
   Use the equipment in the list to build a circuit. Follow the circuit diagram alongside as a guide.

a) Connect both the open-ended wires to each of the objects, one by one.
b) Observe what happens to the light bulb.

3. Record your observations

Copy the table and record your observations. (5)

Testing materials to see if they can conduct electricity		
Object / type of materials	Did the light bulb produce light?	Was the light bright or dim?

4. Draw conclusions

a) Which materials could the electricity current pass through? List the materials that are conductors of electricity.

_____ (2)

b) Which materials could the electricity current not pass through?

_____ (1)

c) Identify one property that is the same for all electrical insulators.

_____ (2)

d) Is it correct to say that only metals can conduct electricity? Give a reason for your answer.

_____ (2)

e) What is the dependent variable?

_____ (1)

[15 marks]

MARKS	LEVELS	DESCRIPTION	PERCENTAGE
12 – 15	7	OUTSTANDING ACHIEVEMENT	80 – 100%
11	6	MERITORIOUS ACHIEVEMENT	70 -79%
9 – 10	5	SUBSTANTIAL ACHIEVEMENT	60 – 69%
8	4	ADEQUATE ACHIEVEMENT	50 – 59%
6 – 7	3	MODERATE ACHIEVEMENT	40 – 49%
5	2	ELEMENTARY ACHIEVEMENT	30 – 39%
1 – 4	1	NOT ACHIEVED	0 – 29%

FORMAL ASSESSMENT TASK – MEMORANDIUM

Answers:

1. **Note:** A prediction is when you determine the outcome/ results of the investigation before conducting the experiment.
Ability to make a hypothesis.
Learners made a prediction about which materials they think will conduct electricity. (2)
2. Learners test different materials.
3. Learners record their observation in the table. (5)
4. **a)** According to their observations recorded on their record table, learners correctly identified materials that are electrical conductors. (2)
b) According to their observations recorded on their record table, learners correctly identified materials that are electrical insulators. (1)
c) Correctly identified the property 'can conduct electricity' that is the same for all electrical insulators. (2)
d) Gave a correct reason why it is not correct to say that only metals can conduct electricity, for example: It is not correct to say that only metals can conduct electricity, because water can conduct electricity too. (2)
e) Note: Independent variable – This is the thing that you are changing in the investigation. You are in control of the independent variable.
Dependent variable – The dependent variable is the thing that you observe in an investigation. You do not change it. The dependent variable will change depending on the independent variable.

The light bulb is the dependent variable. The light will switch on depending on the independent variable (changing of the wires; inserting rope to test; inserting a coin).

Appendix 7: Information converted to data

RESEARCH FINDINGS – GRADE 4 NATURAL SCIENCES TEACHERS

How has this scientific experiment helped you as a teacher, to benefit your understanding of scientific jargon in investigations?			FINDINGS
4A • It was a learning experience for me and my learners. • It was refreshing and new, teaching materials which enhanced my understanding of the content and improved my science knowledge. • Also a new method to teach my learners science terms.	4B • Jargon investigations helped the learners to think out of the box, it stimulated learners understanding of concepts and got learners thinking in different ways.	4C • It helped me identify both common and uncommon misconceptions the learners had relating to scientific jargon. Once we were able to identify it, it became easier to teach and move on to the next topic.	Teacher resource as teachers has gained knowledge from exercising this teaching material. Teachers identified errors and misconceptions.
Did the curriculum material, Concept Cartoons (characters, speech bubbles) encourage scientific talk amongst the learners?			FINDINGS
4A • If definitely encourage talking amongst the learners. • It was refreshing and new, teaching materials which enhanced my understanding of the content and improved my science knowledge, also a new method to teach my learners science terms.	4B • Learner's attention was on the cartoon and speech bubbles. • It immediately grabbed their attention. • They found it much easier to read the cartoons and relate their thinking by responding to the cartoon/ speech bubbles.	4C • Definitely they tried to imitate the characters in the cartoon.	New teacher agrees this definitely helped her understanding of scientific jargon, it also improved her teaching methods of teaching science investigations.
Did the learners understand the scientific terminology used in the cartoon?			FINDINGS
4A • The terminology was a bit foreign to them. • They asked me teacher what is constant variable, I had to explain it to them on their level for them to understand.	4B • I had to explain the word control variables.	4C • They did struggle a bit because it is not Grade 4 requirement, to understand the type of scientific jargon, so it was new to them.	Learners did not meet the criteria of this investigation, because the scientific terminology was above their level of learning science vocabulary.
Did the learners understand the speech bubbles, and what each character was saying?			FINDINGS
4A • The speech bubbles were easy, the learners were able to read and understand. • What through the learners off was they assumed all the statements in the	4B • Yes learners could relate, I had to explain certain words but they enjoyed the cartoon and could connect the speech bubbles to Natural Sciences.	4C • Yes they did they could relate each character, and they understood what they were saying however certain words they did not understand the meaning, for example independent	

Cartoon, was correct they were naïve. • I had to inform learners these are just opinions they are not necessary correct.		variable and control variable.	
Has Concept Cartoons improved the understanding of scientific jargon in Natural sciences investigations in your classroom?			FINDINGS
4A • I had to explain the terms input and output, which was a prior lesson as well. • I have seen an improvement in their marks, when we did the practical investigation using Concept Cartoons.	4B • Yes it was much easier to explain science concepts in this way.	4C • I feel like the activity might have been just jumped to a conclusion too quickly, maybe one or two introductory activities to warm them up to the idea to allow them to get comfortable with this 'new' way of working.	
Has this teaching material improved the understanding of scientific jargon in Natural Sciences investigations for second language learners?			FINDINGS
• Yes it has, the learners see these cartoon characters as being on their level, they can relate to the characters. • They also connected prior knowledge to the lesson, which helped with certain scientific words.	• Yes it also helped with reading and critical thinking.	• No they did not understand the terms as it is not on their level yet.	
What is your opinion of this curriculum material, Concept Cartoons?			FINDINGS
• I would love to include Concept Cartoons in all my learning areas, I found it makes my job easier as the learners relate to the characters and speech bubbles. • It was less explaining and more engaging and discussing. • If there could be more content in this form it would be easier to teach Natural Sciences to learners and benefit us as teachers.	• This is new, it is different and great for teaching concepts and to enhance critical thinking.	• Definitely believe it can work and I believe it is the next best thing for scientific exploration.	
How can the researcher improve this curriculum material for further investigating within the subject Natural Sciences?			FINDINGS
• It is my first time using this teaching material, therefore I do not have anything to fall back on,	• I think the researcher can make more cartoon investigations, similar to this one.	• By breaking it up more into sections. • Allow more activities to make learners	

and for me I think it is perfect the way it is.		comfortable with the idea.	
What have you learnt by implementing the teachings of Concept Cartoons in the subject Natural Sciences?			FINDINGS
• It definitely improved teaching as a whole for myself. • I have observed that the learners participate more, their understanding is much better, than what it would have been if there was not Concept Cartoons. • It stimulated the learners thinking. • I only used this material as my practical investigation, and I loved it.	• It definitely changed the way I taught scientific investigations and I tried to implement this in my way of teaching.	• Learners relate to it more. • It was a more relaxing and fun approach to learning science investigations, also the learners are able to look at different approaches, identify it and relate to it.	
Will you continue to use this teaching material, when conducting science investigations?			FINDINGS
• Definitely it has only benefited me in my teaching of Natural Sciences investigations.	• Yes it was something new, and I will try a d use it in other investigations.	• Yes, I would also try to see how I could improve it to accommodate my teaching of science investigations.	

RESEARCH FINDINGS – GRADE 5 NATURAL SCIENCES TEACHERS

How has this scientific experiment helped you as a teacher, to benefit your understanding of scientific jargon in investigations?			FINDINGS
5A • Learners communicated in a way that was more simplistic. • (Some of the words that was in the Cartoon I had to break it down for them). • The words are big words for them (learners).	5B • I introduced new concepts in a fun way. • (I find some concepts difficult to teach because of the language barrier).	5C • I hardly use scientific jargon, because it is confusing for the learners to understand, I use simple terminology to explain concepts. • This experiment helped me to have a better understanding of scientific jargon. • It made me realize the importance of teaching scientific jargon.	Most teachers prefer to avoid scientific terminology, even though most school sciences classes are taught in English, reason for this is 'partly because it is difficult to translate English scientific terms' (Cobbing, 2011). Therefore teachers avoid using scientific terminology.
Did the curriculum material, Concept Cartoons (characters, speech bubbles) encourage scientific talk amongst the learners?			FINDINGS
5A • They did not really use the scientific words that	5B • The learners were interested in reading the	5C • The characters and speech bubbles helped	As stated by Webb (2009), 'Language in science is not

were given e.g. variables. • The understood words that was taught to them before e.g. control variables they could identify this.	cartoon and identifying the difficult concepts. • They struggled to understand variables. • I think they saw this as an English lesson because I teach English to them as well. This task dealt with explaining words which is done in my English class.	to make the experiment more interesting to the learners. • It did not encourage much scientific talk. Amongst the learners. • It was the first introduction of Concept Cartoons and scientific jargon.	only an issue for second-language learners and teachers', (Webb, 2009, p. 314). Teachers prefer teaching the basics and avoid teaching difficult concepts as it confuses learners. "In science where so much of the work is concerned with describing observations, this becomes a special handicap. The language barrier would seem to be a very obvious source of difficulty since science is hostile with unfamiliar technical words", (Setati, 2011, p. 1). As stated by Setati, 2011 "The use of language is one of the situational factors that need careful consideration by the educators",
Did the learners understand the scientific terminology used in the cartoon?			FINDINGS
5A • Second language learners found it easier, than those whose home language is English. • Second language learners put more effort into understanding the content, and show more interest, especially when it came to understanding scientific terminology. • Learners who speak English struggled with this activity because they do not use these words in their normal day to day vocabulary, and they do not understand the meaning of these words.	5B • I had to prompt them by asking certain questions thus leading them in their group discussions to understand scientific words.	5C • Yes, I explained it as we came across the scientific terminology in the cartoon.	'Second language speakers of English the great majority of South Africans, are disadvantaged when faced with bewildering, jargon-rich English in its various forms and must divert extra time and energy to learning it', (Cobbing, 2011). After the teachers guided the learners were they able to complete most of the activities. 'It should also be borne in mind that language problems in Science are not confined to second language learners only', (Setati, 2011, p. 3).
Did the learners understand the speech bubbles, and what each character was saying?			FINDINGS
5A • Yes they understood the speech bubbles	5B • They understood the speech bubbles	5C • Yes they enjoyed the characters and what they	The Concept Cartoon intrigued learner's interest and they were learning

and enjoyed the characters. • I had to guide them through the activity, If I do not they will struggle.	although they struggled to grasp the word variables.	were saying in the speech bubbles.	something at the same time as interpreting science information.
Has Concept Cartoons improved the understanding of scientific jargon in Natural sciences investigations in your classroom?			FINDINGS
5A • Yes the cartoon itself helped with learners understanding of how to do this type of investigation. • Also they had prior knowledge of certain words.	5B • I think Concept Cartoons has improved their understanding. • They found the cartoons a fun way to learn. • Most of the learners could relate.	5C • Yes after I explained the words and we read the cartoon again, they then understood.	Part of this study was to using a teaching tool Concept Cartoons to enhance the learning scientific vocabulary, learners were introduced to activities and teaching materials aimed at promoting discussion, the aim of this study was to introduce techniques ' to promote discussion, writing and argumentation in science classes', (Webb, Towards an Integrated Learning Strategies Approach To Promoting Scientific Literacy in the South African Context, 2009, p. 316)
Has this teaching material improved the understanding of scientific jargon in Natural Sciences investigations for second language learners?			FINDINGS
5A • The characters with the words helps and the visuals itself. • The words were difficult, I had to explain it to the learners. • When it comes into character in the cartoon it made more sense for them.	5B • This was a fun activity, however it could have been introduced in stages then it would definitely help with the understanding of scientific jargon.	5C • It did however, I had to explain the words to them which helped.	The learners are being spoon fed, and their true potential has not been unlocked, the teachers are trying but it seems difficult to teach concepts when the learners lack more than just science knowledge. Even though, 'language is being explored for its role in facilitating and assessing learning, and in understanding complex interactions related to Science teaching and learning', (Setati, 2011).
What is your opinion of this curriculum material, Concept Cartoons?			FINDINGS
5A • It caters for visual learners. • Learners struggle to interpret or to put	5B • It is a fun way to integrate the English language and science	5C • Useful tool to help learners understand scientific jargon. With more use over time, I think it will encourage	'When these learners arrive in the classroom underprepared for learning secondary school Science, they are regarded as

things in their own words, whereas this gives a picture, it gives you an idea it gives a guide. All that needs to be done is to discuss the content. • It is a good starting point.		learners to participate in scientific talk	having two problems. They appear to have weak scientific knowledge, and more seriously, they are regarded as lacking the necessary linguistic tools to construct advanced Science concepts', (Setati, 2011, p. 2). It is important to expose learners to scientific literacy, If learners struggle with language, we as teachers cannot assume the will perform badly in other learning areas.
How can the researcher improve this curriculum material for further investigating within the subject Natural Sciences?			FINDINGS
5A • It would be nice if this could be implemented in the food chain, where the learners could maybe add their own information. • Add in empty speech bubbles for examples	5B • Add extra lessons for the learners to be exposed to this type of teachings • In this investigation all the speech bubbles did not have characters, add characters (people) for all the • .	5C • speech bubbles.	Researcher note the following recommendations
What have you learnt by implementing the teachings of Concept Cartoons in the subject Natural Sciences?			. FINDINGS
5A • It was a different way of explaining science investigations to my learners. • I liked how some of the speech bubbles was incorrect, it made them think; and it manipulated the situation to stimulate the learners thinking and reasoning. • This method tested their ability of understanding.	5B • It caused excitement among the learners. • They were eager to read the speech bubbles and to discuss the comments. • The cartoons made it learner friendly.	5C • I have learnt that the Concept Cartoon made the learners interested in the investigation. • The learners enjoyed the investigation.	Teacher resource. 'The assumption is that low-level English language skills affect learning in a manner similar to low basic skills, (Setati, 2011) I have also learnt that I should not underestimate the learners. If I explain the scientific jargon clearly they will understand
Will you continue to use this teaching material, when conducting science investigations? it.			FINDINGS
5A • I would definitely use it in the future as the response I got from my learners was good. • I would first explain the content and then do the investigation using the Concept Cartoons	5B • This was helpful especially when we do group work. • The learners with the learning barriers will be encouraged to learn in a playful manner.		•

	• They could even role play the material in the speech bubbles. • I would include an opportunity for dictionary work which will allow them to read up on the difficult concepts.		

RESEARCH FINDINGS – GRADE 6 NATURAL SCIENCES TEACHERS

How has this scientific experiment helped you as a teacher, to benefit your understanding of scientific jargon in investigations?			FINDINGS
6A • Was something new? • Created talk, learners were afraid to answer but eventually spoke when they realized their peers disagreed with the characters.	6B • First time I used cartoons to teach science investigation, using cartoons. • It helped, brought about talk amongst the learners, created positive interaction.	6C • Assisted a lot learners were able to answer questions regarding hypothesis – key word in science investigations. • Debates took place amongst learners. • After this activity they understood scientific words.	This teaching material created classroom talk. – 'Using a Concept Cartoon to promote discussion and explore children's ideas, (Constantinou, 2016, p. 12) Viewed as a teaching material - Educative Curriculum Material, as stated by Beyer & Davis, "materials designed to help novice teachers learn how to engage in productive curricular planning", (Bey15).
Did the curriculum material, Concept Cartoons (characters, speech bubbles) encourage scientific talk amongst the learners?			FINDINGS
6A • Most of the learners understood the speech bubbles and could relate to the characters when they were incorrect with information, they discussed this.	6B • There was a lot of interaction taking place amongst the learners, they were discussing the characters and what the characters were saying. • Scientific talk was encouraged.	6C • Yes especially the new words variables and non-variables.	'the children were at the center of their own learning, discussing and debating scientific concepts with their peers and learning from each other', (Constantinou, 2016, p. 12).
Did the learners understand the scientific terminology used in the cartoon?			FINDINGS
6A • Yes • The speech bubbles helped the learners understand the scientific words, after I explained them. • Learners identified false information from the speech bubbles, and responded well to false	6B • Yes • It was a learning cycle the learners kept on referring back to what the characters said. • There were differences and agreements amongst learners because of the speech bubbles.	6C • Yes • After I explained the meaning of some words.	Stated by Webb, Williams & Meiring, Concept Cartoons are designed to provoke discussions and stimulate thinking, It consist of simple drawings and minimal text which show characters arguing about everyday situations', (Webb, Williams, & Meiring, Concept cartoons and

requests from the speech bubbles.			Writing frames: Developing argumentation in South African science classrooms?, 2013)
Did the learners understand the speech bubbles, and what each character was saying?			FINDINGS
6A • Yes they did understand	6B • Yes learners could pick up when some of the characters were not making sense.	6C • Yes they understood the speech bubbles	Speech bubbles include common misconceptions – characteristic of Concept Cartoons (Naylor & Keogh, Concept Cartoons in Science Education, 2000)
Has Concept Cartoons improved the understanding of scientific jargon in Natural sciences investigations in your classroom?			FINDINGS
6A • Some words were not taught to learners therefore they did not understand certain words in the characters	6B • I started off teaching them the meaning of these words, it was big words it, is just about getting the learners to understand the terms. Confusing words in science it is called hypothesis, in Technology it is called prediction.	6C • Yes learners understood the words, used in this investigation.	I have concluded the teachers are teaching scientific terminology in Grade 6 to learners, the do not want to overload the learners with new information, therefore they introduce certain work of Grade 6 Natural Sciences to learners in stages. In the long run Concept Cartoons will assist learners with scientific terminology.
Has this teaching material improved the understanding of scientific jargon in Natural Sciences investigations for second language learners?			FINDINGS
6A • It has help the learners • What helped was the visuals, characters interacting with each other • Most learners prefer visual tasks	6B • Yes it helped the slow learners, the related the cartoon characters to what they see on T.V. • Every cartoon as message which gets carried over. • This was beneficial for learners with learning barriers. It would improve their knowledge concerning specific science topics and investigations/ science jargon.	6C • It was explained in such a way that it made it easy for second language learners to understand.	Concept Cartoons uses visuals which are intriguing for learners and they remember what they have saw from the characters therefore they remember the content taught. An educative curriculum material enhances teacher learning. 'Curriculum materials including textbooks, teacher guides and technology-based materials, whether supplied by publishers or researchers, have traditionally been designed with student learning as the goal', (Schneider & Krajcik, 2002, p. 222). Therefore Concept Cartoons is viewed as an educative curriculum material as teachers use it in the

			classrooms to support and enhance their own learning.
Quote – Teacher 6B – There's a saying first impressions last, so when second language learners see the pictures, they will be attracted to it, the nitty gritty will fall into place later on. So I can see their imagination is triggered and there interest are triggered, they will want to know what is going on, once they see the Concept Cartoons, and then hereafter you can start teaching science concepts.			Concept Cartoons are viewed as an educative curriculum material as it is evident from the above findings this teaching mechanism has intrigued the imagination of learners via their teachers guidance, and has impacted on the learning in the science classrooms.
What is your opinion of this curriculum material, Concept Cartoons?			FINDINGS
6A • It is an easy way for learners to study	6B • Created more interaction amongst learners. • Concept Cartoons allowed learners to be proactive. • Clearly learner centered. • The cartoon captured the learner's interest. • Learner's referred back to the cartoon when in doubt. • The cartoon was on the learner's level of understanding.	6C • Concept Cartoons makes it easy for learners to understand the investigation and the experiment, learners could visualize this happening and not just read it.	Learner centered What teachers are saying here are a few of the characteristics of Concept Cartoons: The cartoons are aligned with the scientific point; Based on everyday situations; relatable for students understanding; plausible alternatives that are based on research evidence about students ideas at different stages; drawings and texts makes them accessible to learners who are not fluent informal language and science terminology, (Naylor & Keogh, Concept Cartoons in Science Education, 2000)
How can the researcher improve this curriculum material for further investigating within the subject Natural Sciences?			FINDINGS
6A • Draw up another practical to compare the results. • This could be an introductory.	6B • I liked the idea of falsifying some of the speech bubbles is was a good brain teaser for myself and the learners, this allowed for critical thinking. • This activity gave my learners space to think outside the box.	6C • This activity worked well for my learners	Do a pre and post activity for future reference.
What have you learnt by implementing the teachings of Concept Cartoons in the subject Natural Sciences?			FINDINGS
6A • It was fun and different for myself and my learners compare to	6B • To try and make lessons interesting for my learners.	6C • I learnt that by using Concept Cartoons learners will be able to	Teachers enjoyed this teaching tool.

route learning from textbooks. • I will try to implement my own Concept Cartoons in Natural Sciences lessons • Trying something new is exciting and cartoons can be educational as well.	• With this teaching tool, I have learnt it is not about me and how I perceive the learners to grasp these concepts, but if I use this technique in other practical's it will work, as my learners performed better. • I would like to implement this going forward, the aim is to master the basics and the concepts.	develop skills to make decisions and come to conclusions.	It completed a lesson for them knowing their learners understand the content and remember the materials used. Positive outcome.
Will you continue to use this teaching material, when conducting science investigations?			FINDINGS
6A • Yes I would have it displayed it is an amazing teaching tool.	6B • Yes I will try to create my own and continue to improve on it. • I will use it in other learning areas. • This teaching tool helps with limited resources and materials which is needed in science investigations, therefore it is beneficial for myself and my learners.	6C • Yes will continue to use it.	This teaching tool has assisted teachers with science investigations, by keeping learners interested and asking questions to each other. It has created talk amongst learners. However I have noticed not much was said about scientific talk teachers were honest and has admitted that it is difficult to build learners science vocabulary as learners struggle with scientific language at this stage. Teacher 6B has used scientific language it is used often in the classroom therefore teacher 6B and teacher 6C had positive responses to the learning tool. I have found teachers who has been teaching Natural Sciences for +9 years has had greater results in using this teaching materials. They understand their learners more and are able to guide them where necessary.

Appendix 8: Written information given to participants prior to participation

Contact person: Warda Abrahams (Master's Degree – Student)

ReferenceNo:H17-EDU-ERE-005

Dear participant

You are being asked to participate in a research study. I will provide the necessary information to assist you to understand the study and explain what would be expected of you as a participant. These guidelines would include the risks, benefits, and your rights as a study subject. Please feel free to ask the researcher to clarify anything that is not clear to you.

To participate you will need to provide a written consent that will include your signature, date and initials to verify that you understand and agree to the conditions.

You have the right to query concerns regarding the study at any time and immediately, report any new problems during the study, to the researcher. Telephone numbers of the researcher are provided:

Warda Abrahams: 073 912 5956 My supervisor: 083 459 2240 / office number: (041) 504 4044

Furthermore, it is important that you are aware of the fact that the ethical integrity of the study has been approved by the Research Ethics Committee (Human) of the university. Studies cannot be conducted without research approval. Queries with regards to your right as a research subject can be directed to the Research Ethics Committee (Human), Department of Research Capacity Development, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

Participation in research is completely voluntary. If you do partake, you have the right to withdraw at any given time, during the study without penalty or loss of benefits. However if you would like the training of implementing Concept Cartoons as a teaching tool in Natural Sciences investigations, you may attend the workshops offered by the researcher.

Although your identity will at all times remain confidential:

- You will be requested to complete a biographical sheet before conducting semi-structured interviews.
- Audio recording tape will be used during semi-structured interviews.
- Attend workshops of implementing Concept Cartoons in Natural Sciences investigative lessons

Yours sincerely

Warda Abrahams

PRINCIPAL INVESTIGATOR.

Appendix 9: Biographical Questionnaire

Please complete this biographical sheet, to help the researcher have an understanding of you as the participant.

Biographical questionnaire:

a) Name of participant:

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b) What is your teaching qualification?

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c) What Grade are you currently teaching?

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d) What is your experience in teaching Natural Sciences in Intermediate Primary Phase?

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e) Do you think your qualification is sufficient enough to teach Natural Sciences?

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f) Do you think your qualification is sufficient enough to teach scientific terminology?

g) What is it that you like about teaching Natural Sciences?

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h) Tell me about an experience in teaching Natural Sciences that you enjoyed and why?

Look at the science concepts in the table below.

Independent variable / dependent variable / controlled variable	Hypothesis / prediction
Dissolve / insolvent / soluble / solvent	Renewable / non-renewable energy
Conduction / convection / radiation	Insulator / Isolator

i) If you could choose one of these science concepts which one would you choose to teach to your learners and why?

---

j)) Which of these sciences concepts would you not choose to teach to your learners, why is this?

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k) Which of the above terms do you find difficult to explain to your learners, why?

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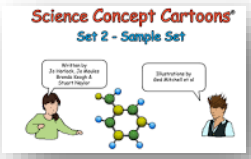
l) Have you heard of Concept Cartoons before? If yes what are your thoughts of Concept Cartoons?



I thank you

Appendix 10: Introductory workshop provided to participants

The potential for Concept Cartoons to assist Natural Sciences teachers with developing scientific jargon for Primary School learners.

By

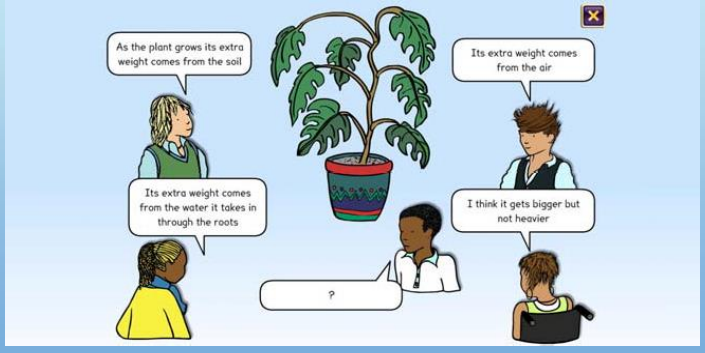
PURPOSE OF MY

- THE PURPOSE OF THIS STUDY IS TO EXPLORE HOW CONCEPT CARTOONS AS AN EDUCATIVE CURRICULUM MATERIAL, CAN PROMOTE THE UNDERSTANDING OF
- BENEFITS OF THIS STUDY:
  - HELPS UNDERSTAND SCIENTIFIC TERMINOLOGY, GAIN CONFIDENCE FROM ADAPTING SCIENCE METHODS OF TEACHING.
  - LEARNERS GAIN BETTER UNDERSTANDING OF SCIENCE CONCEPTS IN INVESTIGATIONS.
  - USES CHARACTERS AND SPEECH BUBBLES THAT ARE INTERESTING.
  - IT INTRIGUES LEARNERS, AND HELPS THEM TO CONNECT THE CARTOON STYLE CHARACTERS TO RELATABLE SITUATIONS.

INTRODUCTION OF CONCEPT CARTOONS

- THE CARTOON STYLE CHARACTERS INTRIGUES LEARNERS INTO DISCUSSIONS WITH PEERS, AND THE SPEECH BUBBLES USES SCIENTIFIC TERMINOLOGY WHICH ENABLES LEARNERS TO THINK SCIENTIFICALLY AND UNDERSTAND THE WORDS BEING USED BY RELATING IT TO A SCENARIO.
- THE SCENARIOS ARE EVERYDAY SITUATIONS WHICH LEARNERS CAN RELATE TO, IT IS ALSO SUITABLE FOR ALL AGE GROUPS
- (NAYLOR & KEOGH, 2000)

ANOTHER EXAMPLE CONCEPT



(Naylor &

AN EXAMPLE OF CONCEPT

(Naylor & Keogh, 2000.

What does my research entail? What will you have to do

- WHAT DOES MY RESEARCH ENTAIL? WHAT WILL YOU HAVE TO DO AS A PARTICIPANT
  - ANSWER A QUESTIONNAIRE (PARTICIPANT INFORMATION)
  - WORKSHOP ON HOW TO IMPLEMENT CONCEPT CARTOONS IN CLASSROOM
  - TEACH CURRICULUM CONTENT USING CONCEPT CARTOONS, AND OBSERVE LEARNERS RESPONSE
  - HEREAFTER SEMI- STRUCTURED

- REFERENCES

NAYLOR, S., & KEOGH, B. (2000). CONCEPT CARTOONS IN SCIENCE EDUCATION. IN S. NAYLOR, & B. KEOGH, CONCEPT CARTOONS IN SCIENCE EDUCATION (PP. 37-102). GREAT BRITAIN: MILLGATE HOUSE PUBLISHERS. RETRIEVED JULY 17, 2017