

The use of reading strategies in English Medium of Instruction Physical Sciences classrooms in the FET phase

S.M. Swart

 orcid.org/0000-0003-2664-6697

Thesis accepted for the degree *Masters in Education* in
Curriculum Studies at the North-West University

Supervisor: Prof. E.M. Reyneke

Co-supervisor: Dr S. Romylos

Assistant supervisor: Prof. W.D. Dudu

Graduation: 2021

Student number: 12773697

DECLARATION

I, Sonica Maria Swart, hereby declare that the work contained in this dissertation/thesis is my own intellectual property. The contents of this dissertation/thesis whether partially or in its entirety have not been submitted to any university for examination.

Signature:

A handwritten signature in black ink, appearing to read 'Sonica Maria Swart', written in a cursive style.

Date: 2 February 2021

PREFACE

Firstly, I would like to thank my Heavenly Father for walking with me and giving me the strength, I needed. I could not have done any of this without the inspiration and guidance I received from Him.

I would also like to dedicate my Masters to my father whom I miss more every day.

I would also like to thank Prof. Reyneke. I would never have come this far without your guidance. Thank you for always being there when things were tough, always giving words of encouragement when they were needed.

To Dr Romylos, your knowledge and valuable insight into education was of tremendous help to me during my study. You never failed to assist and encourage me and I am forever grateful to you.

To Prof. Dudu, thank you for your willingness to assist me with regard to the knowledge needed for Physical Sciences. Your insightful comments helped strengthen my study and were greatly appreciated.

Finally, to all my friends and family that were always there for me. Your support carried me through.

ABSTRACT

The South African education system has come under fire for the poor performance of learners compared to that of their global counterparts. The poor performance in Physical Sciences classrooms stems largely from the inability of learners to read with comprehension. Consequently, more emphasis is being placed on learners' abilities to read with comprehension.

In an effort to assist learners and teachers, the Department of Basic Education has attempted to alleviate the anxiety with regard to reading by offering guidelines to teach English language in content classrooms. However, this is still insufficient as reading comprehension can only be achieved if a text can be broken into pieces, with each piece being analysed and understood individually and eventually linked together. To this end, the use of reading strategies becomes important. Reading strategies allow learners to deconstruct a text into more manageable pieces in order to extract meaning and ultimately to achieve understanding. This study advocates the use of reading strategies in the Physical Sciences classroom.

In the Physical Sciences, learners are faced with a variety of texts like written, diagrams and chemical equations to name a few. Learners often struggle, as each text has different demands in terms of higher order thinking. Consequently, learners need to have strategies in place to assist them with the extraction of knowledge from the different texts found in the Physical Sciences. This study proposes the following reading strategies: vocabulary/word recognition, syntactical awareness, text recognition, questioning, prior knowledge, inferring, clarifying/monitoring, searching-selecting and visualising.

The study focusses on the use of these strategies to aid comprehension within the Physical Sciences classroom, which ultimately allows learners to assimilate knowledge more effectively. This study is qualitative in nature and it includes observations as well as interviews of participants who teach Physical Sciences in the FET phase through medium of English. In order to triangulate the study, a document analysis of the CAPS document for Physical Sciences in the FET phase, as well as the Manual for Teaching English Across the Curriculum, was done.

Key words: reading strategies, Physical Sciences, reading comprehension, language teaching.

OPSOMMING

Die Suid-Afrikaanse onderwysstelsel het sterk onder vuur gekom weens die swak prestasie van leerders vergeleke met dié van hul globale teenhangers. Die swak prestasie in Fisiese Wetenskap-klaskamers spruit hoofsaaklik voort uit leerders se onvermoë om met begrip te kan lees. Gevolglik word sterker klem geplaas op leerders se vermoë om dit te vermag.

In 'n poging om leerders en onderwysers by te staan het die Departement van Basiese Onderwys probeer om die angste met betrekking tot lees te verlig deur riglyne aan te dui rakende die onderrig in klaskamers van Engels Taal in konteks. Dit is egter steeds ontoereikend aangesien leesbegrip alleenlik bereik kan word as die teks in stukke opgebreek kan word, en elke stuk ontleed en individueel verstaan en eindelijk aanmekaar gekoppel kan word. Met hierdie doel voor oë raak leesstrategieë belangrik. Leesstrategieë stel leerders daartoe in staat om 'n teks in meer hanteerbare stukke te dekonstrueer om betekenis daaruit te trek en ten slotte begrip te verkry. Hierdie studie bepleit die toepas van leesstrategieë in die Fisiese Wetenskappe-klaskamer.

In die Fisiese Wetenskappe kom leerders te staan voor 'n verskeidenheid tekste soos geskrewe teks, diagramme en chemiese vergelykings, om slegs enkele voorbeelde te noem. Leerders worstel dikwels, aangesien elke teks verskillende eise stel met betrekking tot hoërdenke. Gevolglik moet leerders oor strategieë beskik om hulle te help met die onttrek van kennis uit die verskillende tekste wat in Fisiese Wetenskappe voorkom. Hierdie studie stel die volgende leesstrategieë voor: woordeskat-/woordherkenning, sintaktiese bewustheid, teksherkenning, bevraagtekening, aktivering van voorkennis, maak van afleidings, opheldering/monitering, soek-selektering en visualisering.

Die studie fokus op die toepas van genoemde strategieë om begrip in die Fisiese Wetenskappe-klaskamer te bevorder, wat die leerders uiteindelik daartoe in staat sal stel om kennis meer effektief te assimileer. Hierdie studie is kwalitatief van aard en sluit observasies in, asook onderhoude met deelnemers wat Fisiese Wetenskappe in die Verdere Onderwys- en Opleidingsfase (VOO-fase) deur medium van Engels onderrig. Om die studie te trianguleer is 'n dokument-analise uitgevoer op die CAPS-dokument vir Fisiese Wetenskappe in die VOO-fase, asook die *Manual for Teaching English Across the Curriculum*.

Sleutelwoorde: leesstrategieë, Fisiese Wetenskappe, leesbegrip, taalonderrig

TABLE OF CONTENTS

PREFACE	II
ABSTRACT	III
CHAPTER 1 INTRODUCTION	1
1.1 MOTIVATION AND GENERAL PROBLEM STATEMENT	1
1.2 MAIN RESEARCH QUESTION	5
1.2.1 Sub-research questions.....	5
1.3 PURPOSE OF THE RESEARCH	5
1.4 CLARIFICATION OF TERMINOLOGY	5
1.5 RESEARCH DESIGN AND METHODOLOGY	6
1.5.1 Research design.....	6
1.5.2 Methodology.....	7
1.5.3 Participant selection.....	7
1.5.4 Methods of data collection	7
1.5.5 Methods of data analysis	9
1.5.6 Ethical aspects of the research.....	Error! Bookmark not defined.9
1.6 CONTRIBUTION OF THE STUDY	9
1.6.1 To the subject area or discipline	9
1.7 POSITIONING OF RESEARCHER	10
1.8 CHAPTER DIVISION	10
1.9 CONCLUSION	11
CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK	12

2.1	INTRODUCTION	12
2.2	BACKGROUND TO POOR PERFORMANCE IN PHYSICAL SCIENCES	13
2.3	BICS and CALP	17
2.4	READING IN PHYSICAL SCIENCES CLASSROOMS	20
2.4.1	The negative effects of learning/reading difficulties and the impact on reading for meaning.....	21
2.4.2	Reading for enjoyment versus reading for academic purposes.....	22
2.4.3	Vocabulary and word recognition.....	25
2.4.4	Syntactical awareness.....	28
2.5	READING STRATEGIES	29
2.5.1	Text recognition.....	31
2.5.2	Questioning.....	34
2.5.3	Activating prior knowledge.....	36
2.5.4	Inferring.....	38
2.5.5	Summarising.....	39
2.5.6	Clarifying/monitoring.....	41
2.5.7	Searching-selecting.....	42
2.5.8	Visualising.....	43
2.6	THE PROBLEMS OF THE CONTENT CLASSROOM AND THE ROLE OF THE TEACHER	44
2.7	EXAMPLE OF THE USE OF READING STRATEGIES DURING A PHYSICAL SCIENCES LESSON.....	48
2.8	CONCLUSION	49

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN	51
3.1 INTRODUCTION.....	51
3.2 DESIGN.....	51
3.3 PARTICIPANT SELECTION	52
3.4 INSTRUMENTATION AND DATA COLLECTION.....	54
3.5 DATA ANALYSIS	56
3.6 ETHICAL CONSIDERATIONS.....	58
3.7 TRUSTWORTHINESS	59
3.8 CONCLUSION	60
CHAPTER 4: DATA PRESENTATION AND ANALYSIS	62
4.1 INTRODUCTION	62
4.2 FINDINGS BASED ON CLASSROOM OBSERVATIONS.....	62
4.2.1 Participant A’s implementation and teaching of reading strategies.....	62
4.2.2 Participant A’s teaching of language concepts and structures	66
4.2.3 Participant A’s proficiency in English as medium of instruction	67
4.2.4 Participant B’s implementation and teaching of reading strategies.....	67
4.2.5 Participant B’s teaching of language concepts and structures	70
4.2.6 Participant B’s proficiency in English as medium of instruction	70
4.2.7 Participant C’s implementation and teaching of reading strategies	71
4.2.8 Participant C’s teaching of language concepts and structures	73
4.2.9 Participant C’s proficiency in English as medium of instruction	74
4.2.10 Summary of observations	74
4.2.10.1 Implementation and teaching of reading strategies.....	74

4.2.10.2	Participants' teaching of language concepts and structures.....	77
4.2.10.3	Participants' proficiency in English as medium of instruction.....	77
4.3	FINDINGS BASED ON THE INTERVIEWS.....	78
4.3.1	Participant A's view on language and reading strategies	78
4.3.2	Participant A's view on the role of the content teacher as a language teacher	80
4.3.3	Participant A's training and confidence in using English as the medium of instruction	80
4.3.4	Participant B's view on language and reading strategies	81
4.3.5	Participant B's view on the role of the content teacher as a language teacher	82
4.3.6	Participant B's training and confidence in using English as the medium of instruction	83
4.3.7	Participant C's view on language and reading strategies	84
4.3.8	Participant C's view on the role of the content teacher as a language teacher	84
4.3.9	Participant C's training and confidence in using English as the medium of instruction	85
4.3.10	Participants' composite views on language and reading strategies.....	86
4.3.11	Participants' composite views on the role of the content teacher as a language teacher.....	86
4.3.12	Participants' training and confidence in using English as the medium of instruction	87
4.4	FINDINGS BASED ON THE ANALYSES OF THE LESSON PLANS	87
4.5	FINDINGS BASED ON THE ANALYSES OF THE CAPS AND THE MANUAL FOR TEACHING ENGLISH ACROSS THE CURRICULUM	91

4.5.1	CAPS document	91
4.5.2	Manual for Teaching English Across the Curriculum.....	98
4.6	SUMMARY	99
CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS		101
5.1	INTRODUCTION	101
5.2	LITERATURE REVIEW	101
5.2.1	EMPIRICAL STUDY	102
5.3	DISCUSSION	103
5.4	LIMITATIONS OF STUDY	105
5.5	RECOMMENDATIONS	106
5.6	CONCLUSION	108
BIBLIOGRAPHY		110
ANNEXURES		11023

LIST OF TABLES

Table 2-1: Benchmark descriptors and Grade 4 scores.....	14
Table2.5: Strategies for effective reading.....	31
Table 2-2: Text structure (Meyer & Ray, 2017:129).....	33
Table 3.1: Illustration of the diversity of participants with regard to the above-mentioned categories.	54
Table 4-1: Adaptation of Physical Sciences CAPS document for Grade 10.....	93
Table 4-2: Adaptation of Physical Sciences CAPS document for Grade 11.....	95

LIST OF FIGURES

Figure 2-1: Distribution of languages in South African population.....	15
Figure 2-2: Cummins's framework of language skills.....	18
Figure 2-3: Revised Bloom's Taxonomy.....	20
Figure 2-4: The relationship between learner questioning and areas of critical thinking.....	35
Figure 2-5: Presenting breakdown of classroom instruction.....	46
Figure 2-6: Electrical diagram of resistors in series.	49
Figure 4-1: Graph of the implementation and teaching of reading strategies.	63
Figure 4-2: Graph of the implementation and teaching of reading strategies	68
Figure 4-3: Distance triangle.	69
Figure 4-4: Graph of the implementation and teaching of reading strategies	71
Figure 4-5: Initialism of concept.....	73
Figure 4-6: Graph of the implementation of reading strategies in observation lessons.	74
Figure 4-7: Graph of the implementation of reading strategies in observation lessons.	76
Figure 4-8: Findings of interviews.....	78
Figure 4-9: Lesson development	88
Figure 4-10: CAPS and the Manual for Teaching English Across the Curriculum	91

CHAPTER 1 INTRODUCTION

1.1 MOTIVATION AND GENERAL PROBLEM STATEMENT

The poor performance of South African learners in academically demanding subjects such as Physical Sciences and Mathematics has come under the spotlight, particularly since the country started participating in the Trends in International Mathematics and Science Study (TIMSS). At least 57 countries take part in TIMSS every four years and, since 1995 when TIMSS was administered for the first time, the performance of South African learners has been described as 'very low' (in 1995, 1999, 2003) to 'low' (in 2011, 2015) (Reddy, 2018). This low level of performance is confirmed by another report, "The Global Information Technology Report 2016", published by the World Economic Forum (Baller, Dutta & Lanvin, 2016). The Global Information Technology Report evaluated the education systems of 139 participating countries in terms of learner performance in Science and Mathematics. Alarming, this report ranks South Africa in the very last position (Baller *et al.*, 2016:232; 233). Extensive research has been carried out over recent years (Howie *et al.*, 2017) to try and establish what the reasons may be for the country's dismal performance, as the impact is clear: i.e. no access to jobs that require proficiency in Science and Mathematics (Reddy, 2018:1). Consequently, the incorporation of language in the Physical Sciences classroom becomes important to assist learners in acquiring a high level of proficiency in reading and comprehension (Mogofe, 2016:1). A number of researchers (Horning, 2014:1; Bharuthram, 2012:211) agree that South African learners' poor academic performance may be attributed to the fact that teachers across the curriculum do not teach learners to read with comprehension.

A number of researchers (Msimanga *et al.*, 2017; Plüddemann, 2015; Milligan & Tikly, 2016) identify language as a barrier to teaching and learning. Msimanga *et al.* (2017:245) point out that English is the preferred medium of instruction in most schools while the majority of South African teachers and learners use English as an additional language (after their mother tongue). Likewise, in her foreword to the Manual for Teaching English across the Curriculum, the Minister of Basic Education, Angie Motshekga, writes that English, the language of learning and teaching (LoLT) in the majority of South African schools, is "a barrier for learning and thus of learner attainment" (DBE, 2013:2). This perception of the LoLT as a major barrier is supported by the fact that the majority of South African learners cannot read for meaning. This is proven by the learners' consistent poor performance in the Progress in International Reading and Literary Study (PIRLS) (Howie *et al.*, 2017).

PIRLS is an international assessment of the reading comprehension of Grade 4 learners. This assessment has been conducted in countries such as Singapore, Malta, Norway, Egypt and Finland every five years since its inception in 2001 (Mullis *et al.*, 2016). As the title suggests, the PIRLS reports on the reading performance of participating countries and also indicates the top-performing countries. Two aspects of reading are tested: reading for literary experience and reading to acquire and use information (Mullis *et al.*, 2016). Howie *et al.* (2017) report that South African learners traditionally perform poorly in the PIRLS even though the country subjected its Grade 5 learners to the assessment, while most other countries tested their Grade 4 learners (Howie *et al.*, 2017). In the 2016 PIRLS, like in the case with The Global Information Technology Report, South Africa was ranked last out of 50 participating countries (Howie *et al.*, 2017). More disconcerting is the fact that South African learners managed an average score of only 320, a score significantly lower than the PIRLS centre point of 500. Howie *et al.* (2017) note that a score below 400 indicates that the learner is unable to read for meaning or to retrieve basic information from the text to answer basic questions. Even more alarming is the fact that the report showed that 78% of South African learners were unable to reach the lowest international benchmark of 400 whereas, internationally, only 4% of learners did not reach the lowest benchmark (Howie *et al.*, 2017). It can be concluded that the PIRLS results continue to highlight huge gaps in South African learners' ability to read for meaning, not only in their home languages (also tested by PIRLS) but also in English, which in turn affects performance in all subject areas, given that English is the LoLT in most schools (Evans & Cleghorn, 2012: xvii).

Consequently, attending to language in the Physical Sciences classroom becomes important as a means to assist learners in acquiring a high level of proficiency in reading and comprehension (Mogofe, 2016:1; Msimanga *et al.*, 2017:2530). Researchers (Horning, 2014:1; Bharuthram, 2012:211) agree that South African learners' poor academic performance may be attributed to the fact that teachers across the curriculum do not teach learners to read with comprehension. A thorough knowledge of reading strategies – and the skill to effectively apply these strategies in order to make meaning of academic texts – are of paramount importance in educational contexts, more so for learners who are challenged to study through medium of English as a second (and in some cases in South Africa, even a third or fourth) language (Bharutharam & Clarence, 2015:43). According to Mogofe (2016:1), “language is an important vehicle for the teaching and learning of Science”. Consequently, learners who struggle to understand English, as it might not be their mother tongue, will also struggle with academically demanding texts in subjects like Physical Sciences (Mogofe, 2016:2). The Curriculum and Assessment Policy Statement (CAPS) document for Physical Sciences in the Further Education and Training (FET) phases also states the importance of reading for academic success (DBE, 2011:10). This is due to the exposure to a variety of texts found within Physical Sciences. The document states that learners should be

afforded the opportunity “to read scientific text” (DBE, 2011:10). However, the reading of scientific texts is not limited to formal assessment tasks, but also includes informal tasks and settings (DBE 2011:10). Therefore, learners must be able to engage in meaningful reading in order to understand scientific texts. Unfortunately, as highlighted above, learners struggle to read with understanding.

Nel, Dreyer and Klopper (2004:95) state that learners who have never learnt to read in order to truly make sense of academic texts, find it difficult to obtain information from sources and, consequently, they find it hard to learn. A large number of learners who complete basic education in South Africa and wish to pursue tertiary studies prove to be ill-equipped for academic study because of their inability to make sense of most texts. Dreyer and Nel (2003:349), who did extensive research on the reading ability of first-year university students, report on their lack of reading skills. They describe how students with low literacy levels soon become alienated within the teaching and learning environment because of their inability to fully comprehend and interpret academic texts in order to complete assignments and pass tests and examinations.

Assignments, tests and examinations can only be completed successfully once a learner is able to read any given academic text with comprehension, i.e. such a learner is able to fully assimilate the new knowledge. No meaning can be extracted from a text if the learner is unable to read and comprehend. Klapwijk (2015:1) explains that “comprehension is a strategic process in which readers use cues from the text, in conjunction with their existing knowledge, to make predictions, monitor predictions, and construct meaning from the text”. Mills (2008:1) emphasises the importance of reading with comprehension in order for learners to move on to higher-order thinking skills, such as being able to critically analyse and evaluate texts, or to synthesise information from various sources. She further states that metacognition (one’s awareness and control of thinking processes) is critical for successful reading comprehension.

In light of the above, reading proficiency has come to the foreground in recent years, as it seeks to explain the lack of comprehension seen in learners who struggle academically. As learners progress through various grades in basic education, the complexity of texts increases, making it more important to effectively implement reading strategies (Le Cordeur, 2010:80). Learners who lack the skill to implement effective strategies will therefore experience greater academic pressure as they move to higher grades and eventually move into the highly competitive labour market or enter tertiary education. Implementation, however, can only follow once reading strategies have been taught.

Researchers (Prado & Plourde, 2011; Pretorius & Klapwijk, 2016) agree that reading strategies should be taught explicitly. Without explicit teaching, followed by practice, learners will not be

equipped to extract meaning from texts – simply because they will be unaware of the role these strategies play in the comprehension of texts. Even when learners have managed to acquire reading strategies by themselves, they might not be able to use these self-acquired strategies effectively because they would never have been taught how to correctly apply any of these strategies (Dreyer & Nel, 2003:350). Prado and Plourde (2011:33) emphasise that the responsibility of teaching reading strategies lies with the teacher. It is within formal instruction across the curriculum that learners learn to correctly apply reading strategies in order to construct meaning from given texts (Prado & Plourde, 2011:33). Ideally, learners should start implementing these strategies automatically.

Any teacher who wishes to teach reading strategies successfully and create opportunities for their application, needs thorough knowledge of such strategies, as well as the pedagogical skills needed for effective teaching and practice. If teachers had never been trained or made aware of reading strategies, they would not be able to teach these to learners. According to De Koning (2013:262), “teachers are still unsure about how to teach reading comprehension strategies”. This could be as a result of their personal lack of understanding. Pretorius and Klapwijk (2016) agree that the approach to teaching reading strategies can be linked to a teacher’s own perspective on reading. A lack of curriculum knowledge on the part of the teacher could also have an adverse effect on the effective teaching of reading strategies (Pretorius and Klapwijk, 2016:6). Pretorius and Klapwijk add that the training that teachers receive at tertiary institutions is often lacking as the DBE do not prepare them adequately to teach and assess reading comprehension. Mogofe (2016:13) states that “teachers are trained for ideal situations and Science teachers think their job is only to teach the Science content even if this does not make sense to the learners”. This suggests that teachers often neglect language while teaching their subject content, which negatively affects the performance of students. Ultimately, there needs to be an adaptation of science teaching to incorporate language in order to assist learners with comprehension, as the science teacher becomes a guide to learners in the acquisition of knowledge by making use of language as a medium for learning (Mogofe, 2016:14).

It is clear from this discussion that learners’ effective application of reading strategies relies heavily on teachers’ knowledge of reading strategies as well as their pedagogical skills in teaching how these strategies should be applied. Should a teacher fail to formally instruct learners on reading strategies and how to implement these strategies to fully comprehend any given text, many learners will not be able to read with comprehension.

1.2 MAIN RESEARCH QUESTION

To what extent do Physical Sciences teachers in the FET phase, who teach their subject through medium of English, implement reading strategies to aid comprehension?

1.2.1 Sub-research questions

- How equipped do Physical Sciences teachers feel to teach reading strategies in their classrooms?
- To what extent are reading strategies explicitly taught in Physical Sciences classrooms?

1.3 PURPOSE OF THE RESEARCH

The primary aim of the study is to establish:

- whether English Medium of Instruction (EMol) Physical Sciences teachers in the FET phase are aware of reading strategies and, if so, whether they focus on the implementation of these strategies in teaching and learning.

The secondary aims are to:

- establish how equipped Physical Sciences teachers feel to teach reading strategies in their classrooms.
- establish the extent to which reading strategies are explicitly taught to learners,
- provide an in-depth analysis through qualitative research, as to the application of these strategies or the lack thereof in the Physical Sciences EMol classroom in the FET phase, and to provide recommendations in order to improve reading.

1.4 CLARIFICATION OF TERMINOLOGY

- **Reading strategies** within the context of this study can be defined as the active choice of reading processes to derive meaning from a text (Zhang & Wu, 2009:39). It also includes a reader's metacognitive awareness in order to use the most appropriate strategy in pursuit of a specific purpose (Zhang & Wu, 2009:40).
- **FET** refers to Further Education and Training within the South African schooling system. The FET phase includes Grade 10-12 learners.

- **CAPS** refer to the Curriculum and Assessment Policy Statement, published by the Department of Basic Education (DBE) in South Africa. A CAPS document is available for each subject in each learning phase. The South African Department of Basic Education (DBE) (2020) describes the CAPS document as: "...a single, comprehensive, and concise policy document, which has replaced the Subject and Learning Area Statements, Learning Programme Guidelines and Subject Assessment Guidelines for all subjects listed in the National Curriculum Statement Grades R-12" (DBE, 2018).
- **Cognitive Academic Language Proficiency (CALP)** refers to "the dimension of language proficiency which is strongly related to overall cognitive and academic skills" (Cummings, 1979:198).
- **Basic Interpersonal Communication Skills (BICS)** refers to "conversational fluency in a language" (Cummings, 2008:487). These skills are "acquired regardless of IQ or academic aptitude" (Cummings, 1979:198). BICS refers to the everyday ability to converse with peers and not to academic interaction.
- In this study, **academic literacy** can be seen as the ability to utilise vocabulary to interpret and analyse relationships among various texts and sequences to construct meaning from academic texts (Wiedeman, 2003:61). There are various definitions for academic literacy by various research scholars but, for purposes of this study, I used the definition of Calvo *et al.*, (2020:2) who describe academic literacy as the ability to communicate proficiently in an academically focused environment, with a focus on reading and writing in an academic subject area. My focus for this study is, however, on reading and not writing.
- **English Medium of Instruction (EMol)** is, "The use of the English language to teach academic subjects in countries or jurisdictions where the first language (L1) of the majority of the population is not English" (Dearden, 2014:2).

1.5 RESEARCH DESIGN AND METHODOLOGY

1.5.1 Research design

According to Creswell (2008:13), a case study can be defined as "a strategy of inquiry in which the researcher explores in depth a program, event, activity, process, or one or more individuals." According to Creswell, data collection occurs over a sustained period of time using various collection instruments. A single case study was conducted, as the focus was on one high school, more specifically three Physical Sciences teachers who teach through medium of English as an additional language in the FET phase.

The study sought to create an understanding of the teaching methodology of these teachers, specifically with regard to teaching reading strategies and subject-specific vocabulary. According to Mouton (2011:150), the strengths of case-study research can help construct high validity insight. In order to create high validity as indicated by Mouton, the mode of data collection included observations, interviews and document analyses. These data-collection methods sought to create a triangulation in the study in order to provide deeper insight and higher validity.

1.5.2 Methodology

This study made use of a qualitative research methodology. Qualitative research aims at understanding rather than explaining the phenomenon and utilises naturalistic observation rather than controlled measurement, with the “subjective exploration of reality from the perspective of an insider” (De Vos *et al.*, 2011:307). The major approach or perspective that was used is interpretivist; that is, seeking to understand and interpret reality through the meaning that participants in this study give to their daily lives (De Vos *et al.*, 2011:310). Data were gathered by means of participant observation, document analyses and interviewing three participants. The focus was on EMol Physical Sciences FET teachers’ knowledge of reading strategies, as well as their perception of their ability to teach these strategies and to create opportunities for their learners to practise and implement them. Since the study was conducted at one particular school in the Gauteng province, it is regarded as a case study, which can be explained as “a way of conceptualizing human behaviour or merely as a way of encapsulating it,” (Schram, 2006:107). Schram (2006:107) explains that the strategic value of a case lies in its ability to draw attention to what can be learned from a single case.

1.5.3 Participant selection

For the purpose of this study, a purposive sampling technique was used. Teddlie and Yu (2007:80) define purposive sampling as “non-probability sampling or purposeful sampling”. The purposeful selection of EMol Physical Sciences teachers in the FET phase sought to provide insight as to the extent to which reading strategies are taught in the subject. The participants for the study were selected from a school within the Gauteng province in the Johannesburg West district. The medium of instruction at the school is English, which is the mother tongue of approximately 33% of the learners attending the school.

1.5.4 Methods of data collection

Regarding this study, the following data-collection instruments were used:

Semi-structured interviews.

During the course of this study, I conducted semi-structured interviews with three EMol Physical Sciences teachers in the FET phase after I had observed their lessons. According to Englander (2012:34), interviewing can be seen as “a specific mode of data gathering that is integrally related to the research process as a whole”. An advantage of interviews is that “the answers of the interviewee are more spontaneous” (Opdenakker, 2006:3). The purpose of each interview was to determine each particular teacher’s knowledge of reading strategies. It further sought to provide clarity with regard to the extent that these strategies are taught, if at all. The interviews also sought to establish what the participants felt their role was in teaching language in the content classroom.

Observations

According to Kawulich (2005:2), observation can be seen as “the process enabling researchers to learn about the activities of the people under study in the natural setting”. A possible disadvantage of observation could be researcher bias. This could cause a distorted view of the research subject that impedes the achievement of research goals (Kawulich, 2005:8). In order to avoid research bias, one can make use of a “variety of methods for knowledge production” (Kawulich, 2005:8). For the purpose of this study, a focussed observation was used. Each teacher teaching Physical Sciences through medium of English, where only 33% of learners are English home language speakers in the FET phase, were observed for a minimum of five lessons. Data were collected by making notes and by reflecting on these notes afterwards. Observation was focused on the teaching and implementation of reading strategies, which also included the teaching of subject-specific vocabulary to make meaning of a variety of texts which are found within Physical Sciences, like sketches, graphs, tables, etc. I also sought to establish whether these strategies were taught explicitly during lessons.

Document analysis

A document analysis can be defined as “a systematic procedure for reviewing or evaluating documents” (Bowen, 2009:27). The use of a document analysis in this study also acted as a triangulation method to create validity in the study. Bowen (2009:28) states that “document analysis is often used in combination with other qualitative research methods as means of triangulation”. For this study, I analysed the Physical Sciences FET CAPS document and lesson planners, as well as the Manual for Teaching English Across the Curriculum. The purpose of the document analysis was to identify whether Physical Sciences teachers incorporate reading strategies into their lesson plans, as well as whether the CAPS document makes provision for the teaching of reading strategies. An advantage of document analysis is that it is “unaffected by the research process” (Bowen, 2009:31). However, document analysis can also negatively impact the research process as it does not provide enough information relating to the research question

(Bowen, 2009:32). In order to bridge the potential gap, observation of teachers teaching Physical Sciences in the FET phase was done.

1.5.5 Methods of data analysis

Data analysis was completed after all the information from the various research instruments had been collected. The data were then interpreted in order to present findings. Mouton (2011:109) defines interpretations as “relating one’s results and findings to existing theoretical frameworks or models showing whether these are supported or falsified”. I will elaborate on my data analysis methods in Chapter 3.

1.5.6 Ethical aspects of the research

I asked an independent person to approach the prospective participants and to explain the nature of the research, their involvement and issues concerning consent. This person also distributed the consent forms to the participants. I was available to answer any additional questions only after the participants had consented to take part in the research. The consent forms clearly state: the nature of the study, aims, purposes of the study, benefits for participating, and guarantee of confidentiality (Creswell, 2008:89). Consent to conduct the study was granted by the Gauteng Department of Education. Consent letters were also sent to the principal of the chosen school, as well as the governing body. The parents of learners who were in class during the observations were also asked to complete consent forms, which stated the nature of the study and informed them that their child was not the subject of the study. The learners also completed an assent form which informed them of the study, the reason for the researcher’s presence in their classroom, and that they were not the subject of the research study. Names of the teachers and the school were kept confidential. The aim of the study was to research the identified problem in a manner that caused the least disruption and discomfort to the participants and the learners in their classrooms. Ethical clearance was also obtained from the EMELTEN-REC Ethics Committee of the North-West University. I also completed ethical training in order to ensure that the study adhered to the rules and regulations for conducting research.

1.6 CONTRIBUTION OF THE STUDY

1.6.1 To the subject area or discipline

Reading strategies significantly improve reading comprehension. This study may aid in creating awareness of reading strategies, in the hope that all subject teachers in the FET phase, especially those who teach through medium of English as an additional language, will realise the importance of the explicit teaching of reading strategies.

1.7 POSITIONING OF RESEARCHER

I obtained my B.Ed. Honours specialising in Curriculum Studies in 2007. After the completion of my studies, I started teaching at an English Home Language school in Gauteng. During the course of my 13-year teaching career, the decline of the learners' performance in English became evident. The reading ability of learners played a major role in the poor scores for English, as they are unable to read with comprehension. This lack of reading comprehension is seen in the answering of questions as well as assignments, such as literature essays. Consequently, I decided to investigate reading in the Physical Sciences classroom, as I saw that learners were not performing well compared to their international counterparts. I decided to look at reading strategies as a means to assist teachers in supporting learners to read with comprehension. I felt that, by improving the ability of learners with regard to reading with comprehension, learners would be able to perform better in the Physical Sciences classroom.

The need to assist learners and teachers in subjects other than English has always been important to me. I have a great passion for English, especially poetry that demands a deeper understanding of not just the text, but also oneself. English language is not just confined to the English classroom, but also plays a major role in the other classrooms. That is why I feel that all content teachers should pay attention to language. I also subscribe to the notion of being a lifelong learner as I feel that, as a teacher, I need to be able to change and adapt to the ever-changing educational milieu.

1.8 CHAPTER DIVISION

Chapter 1: Chapter 1 outlines the rationale behind the study as well as gives a brief overview of the problem statement which leads to the research question. The chosen methods for data collection and analysis are also discussed, as well as the ethical implications of the study. A clarification of terminology is also provided to guide readers with regard to definitions and concepts used in the study.

Chapter 2: This chapter explores the poor reading performance of South African learners, as contained in various reports. The various factors that influence comprehension, e.g. higher-order thinking, are discussed. The focus of this chapter is on the use of a variety of reading strategies in order to aid comprehension and knowledge accumulation. Lastly, the chapter focuses on the role that the Physical Sciences teacher plays with regard to reading and the teaching of reading strategies.

Chapter 3: This chapter gives an in-depth view on the research design and methodology of this study. The selection of a qualitative case study is discussed in detail and it is explained how this impacted on the manner in which the research was conducted.

The selection of the relevant school and participants is discussed. In this chapter, the use of the data-collection tool, namely document analysis, observation, and interviews are explained. Furthermore, it outlines how the collected data were analysed in order to extract relevant information. The ethical application of each of the data-collection tools is discussed, together with the reliability of the study.

Chapter 4: The focus of this chapter is on the data that were collected during the document analysis, observations, and interviews. A document analysis of the Physical Sciences CAPS document, lesson plans, as well as the “Manual for Teaching English Across the Curriculum” was conducted to establish how Physical Sciences teachers are assisted in teaching reading in their classes. The results of the different observations are shared, and a summary of the observations is provided with regard to the use of reading strategies. Similarly, the interviews are discussed individually and then together to show the similarities and differences in the participants’ responses to the different questions.

Chapter 5: Chapter 5 offers a conclusion of the study and recommendations based on the data that were collected. It also shows the limitations of this study with regard to participant selection and sample size. Lastly, it shows the benefit of the study and how future studies could be conducted, based on the findings of the current study.

1.9 CONCLUSION

This chapter sought to outline the motivation for this study, as the basis for this study is seated in the poor performance of South African learners in academically demanding subjects such as Physical Sciences. It provided an overview of the different research questions and how they relate to the central idea, namely: “The importance of reading strategies in ensuring academic progress in English Medium of Instruction Physical Sciences classrooms in the FET phase.” The different sections in this chapter sought to provide the reader with a clear view of this study and how the research design was chosen in alignment with the problem statement. The next chapter will focus on theories and concepts related to the importance of reading.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter sketches the theoretical framework of the study. The literature review focuses on South African Grade 10-12 high school learners' poor performance in Physical Sciences and aims to explore possible reasons for this. South African learners struggle to read with comprehension. The performance of learners in the Physical Sciences classroom is poor because learners struggle to read for meaning and are faced with expository texts which are more challenging than narrative text (Andrianatos, 2018:135). South African learners' performance in Physical Sciences is discussed, paying specific attention to the 2015 Trends in International Mathematics and Science Study (TIMSS) document as well as the 2016 Progress in International Reading Literacy Study (PIRLS) document. The study reviews research on Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP), explores what is meant by active reading for academic purposes and engagement with texts, and suggests strategies to promote active engagement in order to enhance comprehension. The importance of reading for meaning in the content classroom is explored, followed by an in-depth discussion of the concept of reading. Factors that negatively affect reading are also discussed, as well as reading for enjoyment versus reading for academic purposes. The literature review furthermore examines the role that the learner's mother tongue plays in language acquisition. This influences the CALP of a learner (Ntuli & Pretorius, 2005:93). This chapter also discusses the relationship between poor reading comprehension and vocabulary knowledge. The role of syntax and semantics in reading comprehension is also explored. The use of reading strategies in the content classroom is elaborated on, as well as the fact that learners are unaware of these strategies and how these can assist with comprehension. The strategies include knowledge of vocabulary and word recognition skills, inferring, text recognition, questioning, activation of prior knowledge, summarising, clarifying, searching and selecting, and visualising. I also stress the role of the content teacher in teaching reading strategies, and reservations that might exist when teaching language in the content classroom. In addition, I highlight the challenges of academic reading before focussing on the needs of subject teachers regarding the effective teaching of English academic language skills in specific content areas. The next section elaborates on the poor performance of learners in Physical Sciences and the possible reasons for this. The study also provides an example of how reading strategies can be incorporated in the Physical Sciences classroom.

2.2 BACKGROUND TO POOR PERFORMANCE IN PHYSICAL SCIENCES

In recent years, the poor performance of learners in Physical Sciences has come to the foreground. According to the TIMSS conducted in 2011 and in 2015, South African learners have performed poorly in Physical Sciences in comparison to the international community (Edwards, 2010:572). The 2015 TIMSS study measured the performance of Grade 8 learners in Physical Sciences. The results are cause for concern, as South Africa came last out of the 39 participating countries. Equally concerning is the fact that the average achievement of South African learners in Physical Sciences was lower than the international benchmark. Reddy (2018) points out that South African learners' performance in Physical Sciences improved from the previous TIMSS in 2011, but warns that improvement is happening too slowly, as South Africa is falling increasingly behind the international community with regard to Physical Sciences competence. Baller *et al.* (2016:233) share Reddy's concern about South African learners lagging behind the rest of the world in terms of performance in Physical Sciences as they observe the statistics captured in another international report, the 2016 Global Information Technology Report. Following the release of this report, the South African schooling system was subjected to widespread criticism. Reddy (2018:1), who laments the poor performance of South African learners in Physical Sciences, opines that learner performance in this subject, traditionally seen as challenging, reflects the effectiveness or ineffectiveness of any education system. Reddy (2018:1) furthermore argues that instruction in Physical Sciences should assist learners in the development of their ability to engage with content and progress to a level of knowledge application. In other words, learners need to be guided in order to develop their ability to adapt the different challenges faced when trying to assimilate content. This does seem to be the case, as poor performance in the subject signals learners' inability to engage with subject content.

Taylor (2016:15) notes that South African learners do not meet international standards and he identifies reading skills as problematical. The author used the following table to illustrate South African learners' poor performance, as highlighted in the PIRLS 2016 report. It is evident that the South African learners who were assessed seriously lacked in reading proficiency. Only a small percentage of learners achieved above the score of 474, the lowest benchmark, while the majority were unable to use basic reading skills to respond to the given text. It furthermore transpired that those who could do basic inferences could not integrate these inferences to construct meaning.

Table 2-1: Benchmark descriptors and Grade 4 scores

PIRLS Benchmark	Score	Reading Skills	International median	South African median
Advanced	625+	Advanced readers: Learners are able to integrate information across relatively challenging texts and can provide full text-based support in their answers. Learners are able to make interpretations and can demonstrate that they understand the function of organisational features in texts.	7%	1%
High	550-625	Competent readers: Learners exhibit the ability to retrieve significant details embedded across the text, to provide text-based support for inferences, and to recognise main ideas, some textual features and elements and are able to begin to integrate ideas and information across texts.	41%	3%
Intermediate	475-549	Some reading proficiency: With regard to reading stories, learners are able to understand the plot at a literal level and to make some inferences and connections across texts.	76%	7%
Low	400-474	Basic reading skills: Learners are able to recognise, locate and reproduce information that is explicitly stated in texts, and make straightforward inferences.	94%	13%

(Taylor 2016:16)

The lack of reading skills as reflected by the PIRLS report highlights the shortcomings and the need to re-think the ways in which we teach in South Africa. When one links the PIRLS report to the 2016 Global Information Technology Report, it becomes clear that urgent attention should be given specifically to the teaching of Physical Sciences with a view to ensuring active learner engagement. Mogofe (2016:30) acknowledges that the study of Physical Sciences calls for a high level of cognitive engagement and adds that the medium of instruction in public schooling in South Africa poses a particular challenge. The fact that the majority of learners attending public schools in South Africa have to learn through medium of English (which is not their mother tongue and, in some cases, only a third or fourth language) definitely affects learners' level of engagement with subject content and their academic performance (Rollnick, 2000:100). Based on the statistics

gathered in a language census in 2011, a mere 10% of South Africans use English as a home language (Howie *et al.*, 2017:19). In 2019, BusinessTech reported a figure of only 8.1% (BusinessTech, 2019). The figure below illustrates the 2011 figures on learners' home language distribution.

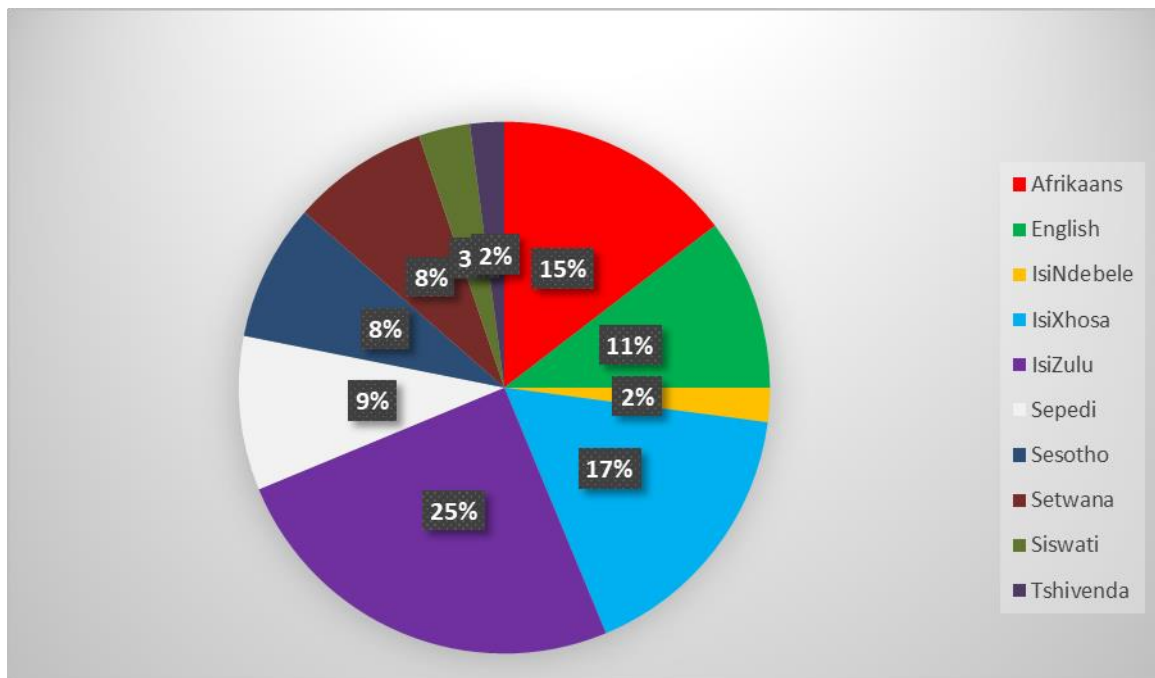


Figure 2-1: Distribution of languages in South African population

(Howie *et al.*, 2017:19)

The reality is that the majority of South African learners who attend public schools are challenged by using English as the language of learning, which may be a first, second or even a third additional language for some. The Department of Basic Education (DBE) acknowledged the fact that content teachers face a double challenge: teaching their subjects and having to teach the language of the subject in order to promote learner engagement and understanding. What followed was the publication of a document entitled “Manual for Teaching English Across the Curriculum 2013” (DBE, 2013).

The manual emphasises the need for language to be taught by all content teachers, explicitly stating that “all teachers are English teachers” (DBE, 2013:2). The DBE thus expects all teachers at public schools where English is the LoLT, to promote awareness of language and to actively employ techniques to teach subject-specific vocabulary, concepts, and linguistic structures in order to assist learners in their active engagement with subject content as they learn to read for meaning. The DBE (2018:11) explicitly encourages reading, stating that learners must use “strategies for becoming independent readers in any context.” The fact that content teachers are

expected to teach linguistic skills, such as reading as a receptive skill, may be seen as problematic, as not all content teachers are equipped with the necessary linguistic knowledge and skills that would enable them to effectively integrate language teaching with subject content teaching (Tan, 2011:339). Instead of trying to fill any knowledge and skills gap with regard to language teaching in the content classroom, the manual briefly addresses the linguistic skills of listening, speaking, reading, and writing before sharing random examples of linguistic aspects that content teachers might address in promoting understanding in specific subjects e.g. comparing verb and noun forms of words for example: associate / association; dilute / dilution (DBE, 2013:16-38). It seems to be assumed by the DBE that content teachers have knowledge of linguistic aspects such as morphology that allows the teacher to explain the use of prefixes and suffixes in unpacking the meaning of subject terminology. For example, it allows the teacher to break up the word 'hydrochloric' into the prefix 'hydro' which means water and 'chloric' which means 'relating to or obtained from chlorine'. In doing so, the teacher is able to simplify the word in order to assist with the comprehension of the concept. The manual states that learners should compile a list of all the prefixes and suffixes commonly used in the subject. This poses a problem as learners need knowledge of root words, prefixes and suffixes in order to understand the structure of the word. In other words, the content teacher needs to understand the composition of words and how these may change parts of speech and therefore meaning, when adding affixes. These assumptions that teachers are knowledgeable of morphology and other linguistic aspects may lead to the ineffective use of the teachers' manual, as teachers may not understand the given examples.

Another document that expresses the need for content teachers to use language across the curriculum, is the Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences in Grades 10-12 (DBE, 2018). The document states that, 'Teachers of Physical Sciences should be aware that they are also engaged in teaching language across the curriculum' (DBE, 2018:10). Consequently, Physical Sciences teachers need to be able to assist learners with subject-specific linguistic aspects in the content classroom. This may place Physical Sciences teachers in an unfamiliar position, as they are expected to incorporate language teaching in their lessons without having sufficient knowledge and skills to do that.

Like the DBE manual for teaching English across the curriculum, the CAPS document does not include sustainable strategies to equip teachers, but there seems to be an assumption that all teachers of Physical Sciences in Grades 10-12 are knowledgeable of linguistic aspects such as phonology, morphology, syntax, semantics and pragmatics. It is also assumed that teachers have the skill to effectively plan for and implement language teaching to promote learner engagement with, and understanding of, content. What is interesting to note is that the examples for language

teaching that are set out in the CAPS for Physical Sciences Grades 10-12 (DBE, 2018a) are similar to examples in the CAPS for English Home Language Grades 10-12 (DBE, 2018b). This confirms the validity of the statement made earlier that the Department of Basic Education assumes that content teachers are equipped with the necessary linguistic knowledge. Both these CAPS documents provide examples for teaching of prefixes and suffixes based on the assumption that teachers are able to use these components together with root words in order to develop learners' linguistic knowledge and reading skills. The problem is that content teachers have not been formally trained to address the linguistic aspects of the English language in their teaching. Formal training is crucial since one needs to understand the challenge of developing learners' CALP. Learners may be able to use English for social purposes, but learning through medium of English as an additional, or in some cases as a foreign language, can seriously hamper academic performance.

2.3 BICS and CALP

The distinction between BICS and CALP plays an important role in the acquisition of language skills, as it is the interaction between the two that creates comprehension (Cummins, 2017:73). Both these concepts need to be enforced separately in order to create full comprehension. A study by Cummins (2000:55) shows that learners who mastered fluency in English, but did not develop their CALP, often struggled with academic assignments. Communicative skills often develop before and faster than cognitive academic skills and teachers need to take that into account during reading activities. Cummins (2017:61) argues that BICS is something that develops naturally through conversational interactions which shows the ability to use a language for communicative purposes. This differs from CALP, which requires learners to use a language that is decontextualised in order to express themselves in an academic manner, demanding a deeper understanding of a language. In other words, students need both BICS and CALP for their language skills to develop successfully (Prince, 2017:52). The illustration below shows the interaction between BICS and CALP, as well as the cognitive demand of each of the aspects of the skills.

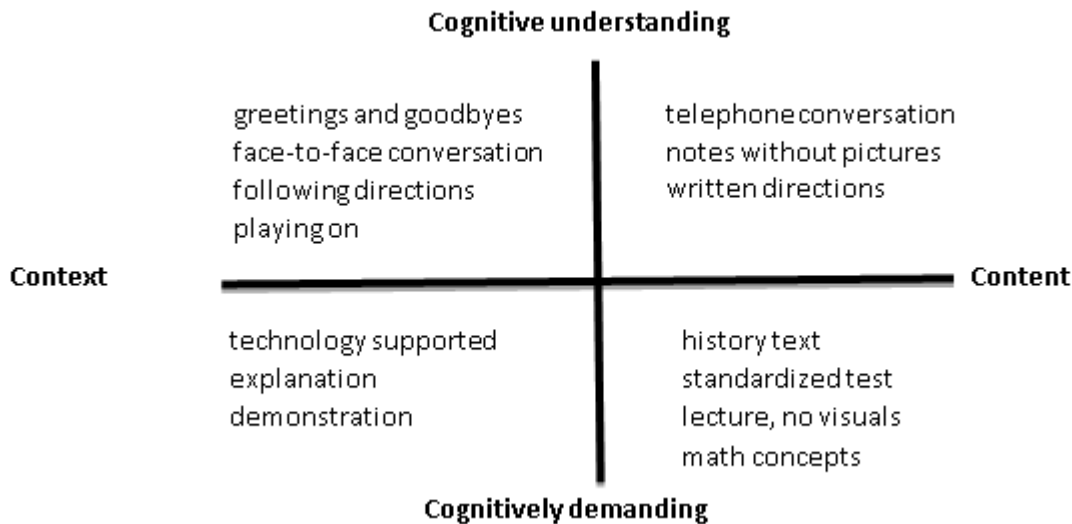


Figure 2-2: Cummins's framework of language skills

(Prince, 2017:52)

With reference to the figure above, the first two quadrants at the top speak to the use of BICS which makes a lower cognitive demand on learners. These include activities such as greetings and telephone conversations. Although these are not cognitively challenging, they are influenced by the context in which they appear. The second quadrant shows activities that are still communicative, but more formal. The lower part of the figure speaks to the use of CALP which makes a higher cognitive demand on learners. Tests and formal instruction form part of the context but are limited to a specific activity. CALP is embedded when learners need to apply knowledge, for example when doing experiments. It may be further contended that the communicative abilities of a learner are not fully reliant on cognitive abilities, but rather on contextual cues (Cummins, 2000:57). These include external ones like visual or audio cues from other people. In contrast, cognitive academic abilities react to very few cues. It is knowledge of linguistic aspects of language that allows learners to derive meaning. Deriving meaning is an essential part of academic proficiency as it allows for the construction of complex meanings (Cummins, 2000:57). Consequently, the progression through grades brings about a greater cognitive demand that is only met by the effective manipulation of language. This manipulation creates comprehension and it is quite different from normal conversational manipulation. CALP therefore requires higher order thinking skills like “hypothesizing, evaluating, inferring, generalizing, predicting or classifying” (Gibbons, 1991:3). Considering the demands of academic texts, learners need to display progress in higher-order thinking. An inability to apply these skills has a negative effect on learners' academic performance.

Within Physical Sciences, higher order thinking skills and CALP become crucial. Hlabane, (2014:44) comments that the subject Physical Sciences requires higher-order cognitive skills as well as high-level academic language skills. The relationship between higher order thinking and CALP is therefore of cardinal importance, as a deficiency in cognitive abilities has a negative impact on academic performance due to the inadequate development of CALP (Hlabane, 2014:44). For learners to be successful academically, they need to develop a high level of CALP in order to not only understand but also to respond on higher cognitive levels. Grosser and Nel (2013:3) concur with the notion that learners must be able to use CALP not only for understanding but also for academic communication, such as sharing their views during discussions or expressing their understanding in writing. They argue that learners must be able to not only comprehend a text, but also to interpret it. The ability to communicate the interpretation of a given text, for example by sketching a diagram based on information from a text, requires a high level of CALP as well as critical thinking.

Higher-order thinking is needed when readers make complex inferences based on a specific text (Afflebach *et al.*, 2015:204) and can be seen as the most important element for critical thinking (Chinedu *et al.*, 2015:2). Vieira and Vieira (2014:659) argue that critical thinking is a key component when it comes to education in the science classroom as it assists with scientific literacy. Chinedu *et al.* (2015:2) define higher order thinking skills as the ability to analyse “information to determine the problem, evaluate the problem and create new workable solutions”.

This implies that learners need to be able to identify a problem and by using various inputs e.g. prior knowledge of a given text, construct meaning in order to solve the identified problem. In the Physical Sciences classroom learners might be asked to balance a chemical equation. Learners will have to draw on their knowledge of balancing equations, as well as using the periodic table of elements to find the molecular value of each element. Ultimately, learners will be able to combine what they know to balance the equation. Saido *et al.*, (2018:13) feel that a “central goal of science education is to help students develop their higher-order thinking skills.” The authors argue that the use of Bloom’s taxonomy is important for the cognitive development of learners. Forehand (2010:2) defines Bloom’s Taxonomy as “a multi-tiered model of classifying thinking according to six cognitive levels of complexity”. These levels indicate the cognitive thinking required for complete comprehension of a given text. Bloom’s Taxonomy includes the following cognitive levels: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, 1956). His criteria were revised by Anderson and Krathwohl (2001), as seen in the image below.

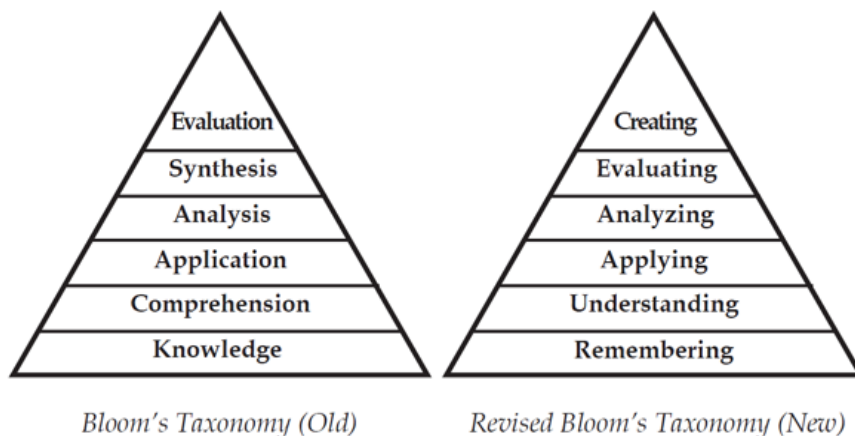


Figure 2-3: Revised Bloom's Taxonomy

(Anderson & Krathwohl, 2001)

Teachers need to be mindful of structuring assignments and assessments so that they address all the levels in order to assist learners in the use of all the levels (Forehand, 2010:5). In doing so, teachers assist learners in developing their cognitive thinking skills. Saido *et al.* (2018:14) state that the first three levels of Bloom's taxonomy focus on basic understanding and are not as cognitively demanding as the last three levels. Higher order thinking skills are developed when learners have to analyse, evaluate and create. However, these skills can only be developed if learners are able to use basic skills. During their study, Saido *et al.* (2018:17) found that the majority of their participants were able to answer questions on the lower cognitive levels. They argued that the lack of analysing, evaluating and creating skills negatively impacts on a student's creativity in science (Saido *et al.*, 2018:17). In order to assist learners in using the more cognitively demanding levels of Bloom's taxonomy, teachers need to use the curriculum to not only develop basic understanding of concepts, but also to encourage learners to display a deeper understanding and application of knowledge (Saido *et al.*, 2018:17). For learners to progress from lower to higher levels of cognition, their ability to read for meaning becomes increasingly important.

2.4 READING IN PHYSICAL SCIENCES CLASSROOMS

Reading literacy has become of utmost importance, not only in an academic environment but in all spheres of society. Reading literacy can be defined as "the ability to understand and use those written-language forms required by society and/or valued by the individual" (Mullis *et al.*, 2016:11). The ability to read with comprehension is especially important not just within a schooling environment but also in the broader community. Unfortunately, learners often struggle to read with comprehension, especially in content classrooms where texts are often more demanding

(Fang, 2017:494). As stated above, Taylor (2016:15) identifies a lack of reading literacy as one of the main reasons for South African learners' poor performance in international assessments. It can never be just assumed that learners, especially those in the Further Education and Training (FET) phase, are able to read texts in different content areas for meaning. Subject-specific aspects of text, such as vocabulary and concepts that are the building blocks of texts, should explicitly be taught to them so that they can use existing knowledge to manipulate the language in order to facilitate comprehension. Specifically, in the Physical Sciences classroom, learners are bombarded with a variety of complex texts that demand a high level of cognitive engagement and comprehension. The next section focuses on the negative effects of learning and reading difficulties and the impact on reading for meaning.

2.4.1 The negative effects of learning/reading difficulties and the impact on reading for meaning.

Learners' inability to read for meaning is often reflected in their poor performance in high-level academic assessments. Poor academic performance often results in a lack of motivation, a negative attitude towards academic studies and resistance to read any subject content (Mogofe, 2016:16).

The fact that assignments and assessments in higher academic levels, for example Grades 10-12, progressively demand the application of higher-order cognitive skills, may cause increasing levels of stress and anxiety for learners. High levels of stress and anxiety, which may for example be caused by the complexity of a reading task, have a direct influence on cognitive processes (Rai *et al.*, 2015:348). Once learners are emotionally stressed, they will find it extremely difficult to engage effectively with subject content and to read for meaning (Rai *et al.*, 2015:3). Krashen (1985) refers to the affective filter. The affective filter can be seen as the emotional distraction that learners face when trying to understand the content of a given text (Lin, 2008:115). The higher the level of emotional distraction, the more information and understanding will be lost. In an academic context, reading anxiety hampers comprehension. Javanbakht and Hadian (2014: 776) define reading anxiety as "the anxiety provoked during the process of reading text". Furthermore, test anxiety may also be linked to reading anxiety which in turn impedes the academic performance of learners (Rai *et.al.*, 2015:3). This will also affect the learners' ability to perform and demonstrate the acquired knowledge within an examination environment (Javanbakht & Hadin, 2014). Anxiety associated with reading and comprehension can be alleviated if learners are familiar with reading strategies and have been trained to implement such strategies. On the other hand, learners' failure to comprehend leads to them experiencing negative feelings about their work in general.

Bharuthram and Clarence (2015:43) argue that learners who lack the ability to interpret a given text will also be unable to perform satisfactorily in assessment tasks. This incapability will also affect learner participation, which leads to a failure to form initial connections with texts. This may leave the learner feeling alienated within the learning environment. Wilkinson and Silliman (2014:2) highlight the importance of classroom activities and argue that learners who struggle with comprehension will not actively take part in class activities. This in turn also impacts on their academic achievement, as there is no active engagement. The authors further argue that activities such as reading “determines access to learning” (Wilkinson & Silliman, 2014:3). The reading process and the pressure on learners often result in undue stress that hampers the assimilation of knowledge.

A learner with a proactive attitude towards reading will be able to reflect on the text that he/she reads. According to Warner and Fay (2017:3), proactive means “anticipating and acting towards future problems instead of waiting for problems to arise”. This anticipation helps learners to develop planning and problem-solving skills. Furthermore, learners who act proactively are able to use strategies like scanning the text, forming hypotheses, anticipating complications and adopting the correct approach to reading the text in order to aid comprehension (Warner & Fay 2017:3). There are various factors that may aid comprehension and the next section elaborates on these.

2.4.2 Reading for enjoyment versus reading for academic purposes

Reading for enjoyment has long been linked to academic success. A study conducted by Whitten *et al.* (2019:48), found that students who read for enjoyment “averaged higher grades in English, Mathematics, Science and History than their non-reading peers”. In other words, learners who read for pleasure achieve better academically than learners who only get exposed to reading in an academic setting. The implications of reading for pleasure and the benefits these have for Physical Sciences can be seen in the influence on reading comprehension, vocabulary and prior knowledge (Whitten *et al.*,2019:50). Learners who read for pleasure have a better-developed vocabulary and background knowledge, which allow them to activate knowledge better by using reading strategies, such as activation of prior knowledge. This allows for better reading comprehension as learners who read for pleasure have already been exposed to a variety of texts (Whitten *et al.*, 2019:51).

Reading strategies are developed not only within an academic environment but also while reading for enjoyment. Likewise, meaningful interaction is developed through both types of reading. It is important to note that reading for enjoyment can assist with academic progress as the knowledge obtained while reading for enjoyment can be used as a departure point when reading for academic

purposes (Clark & Rumbold, 2016:6). Januaryy (2018:271) states that reading for enjoyment develops a natural reading ability, as learners become aware of sentence structure and vocabulary. Clark and Rumbold (2006:6) suggest that reading for pleasure could raise educational standards. They argue that people who read recreationally become better readers, obtain a large vocabulary, develop the ability to understand and use complex grammatical constructions, develop good writing style, and become good at spelling (Clark & Rumbold, 2006:6). Gallik (1999:481) concurs with Clark and Rumbold (2006) by stating that "recreational reading has been found to improve reading comprehension, writing, vocabulary, spelling and grammatical development".

Januaryy (2018:267) feels that learners who are interested in what they read will be more motivated to read, especially if they see the benefit of reading, such as an improvement in their vocabulary. The author makes a distinction between Extensive Reading (ER) and Intensive Reading (IR). IR is linked to reading for academic purposes, while ER represents reading for enjoyment (Januaryy, 2018:267). The author argues that IR and ER should be utilised within a classroom in order to foster enjoyment of reading in learners (Januaryy, 2018:267).

Reading for pleasure therefore alludes to the fact that readers perform tasks of their own free will, without being prompted to do so, in order to derive satisfaction from the reading (Clark & Rumbold, 2006:6). Thus, meaningful interaction creates reading literacy, which plays an important role in the holistic proficiency of a reader. Clark and Rumbold (2006:6) further argue that reading literacy can therefore be seen as the ability to understand language in the various written forms in order to construct meaning from any text. It is also seen as a form of escapism which aids the connection with the text and is important in facilitating comprehension. Correspondingly, it can be argued that reading for pleasure improves reading comprehension as it ultimately impacts academic reading when learners use the same strategies to assimilate knowledge (Gallik, 1999:481). Subsequently, the reading of books for enjoyment has an underlying effect regarding language, which could aid learners in their academic endeavours.

However, the purpose of reading differs in reading for enjoyment or reading for learning. Knutson (1998:2) maintains: "Pleasure reading is most frequently associated with narrative and, in particular, popular fiction. It is commonly perceived to be the antithesis of academic or serious reading. By contrast, reading to learn is pursued to gain insight or information." It is therefore the lack of insight that leads to learners not fully understanding academic content. The distinction between reading for enjoyment and reading for academic purposes is made, because the attitude and the aim of the reading differ. In the case of reading for pleasure, the learners may be more motivated, as the sole purpose of this task is enjoyment. In contrast, reading for academic purposes does not always cause enjoyment and the task demands gaining specific content

knowledge. Reading in an academic context is more demanding on learners as they are expected to not only comprehend a text but to critically engage and respond to the information in a given text (Shih, 1992:290). The author argues that, due to the high demand placed on learners' reading in the content classroom, it is vital to train them to use reading strategies to develop their ability to interact with a text – and in doing so, to assist with the understanding of that text (Shih, 1992:291). However, the promotion of reading for enjoyment does not happen in the Physical Sciences classroom, but rather in the language classroom. Therefore, collaboration between language teachers and Physical Sciences teachers could prove beneficial, for instance, by using a similar text in order to promote reading for pleasure. The attitude of the Physical Sciences teacher plays a role in the motivation of learners in reading for pleasure. The attitude of the teacher may become apparent during informal discussions where they motivate learners to read not only for academic purposes but also for pleasure.

Another factor that may impact on reading comprehension is that of the mother tongue. South Africa has a variety of indigenous languages, with 11 languages being recognised as official languages. This diversity in home languages impacts on teaching and learning where English is the LoLT. According to the latest statistics, only 8.1% of children in South Africa use English as a home language (BusinessTech, 2019). Consequently, the majority of learners who attend schools where the medium of instruction is English, are not English native speakers, and this creates a barrier to learning. This is because a “key concept of language development is learning the words of a language” (Makoni, 2016:19). The implications of this are that learners face considerable challenges when learning vocabulary, if the language that they use for learning differs from their mother tongue (Makoni 2016:19).

A learner's mother tongue can be defined as the language “that is learnt before any other language” (Makoni, 2016:20). Makoni (2016:20) also argues that the mother tongue is formed by ancestral heritage or the use of the language by parents or caregivers. In other words, mother tongue refers to the language that a person is exposed to first and more frequently. However, the South African schooling system allows for learners to be schooled in their mother tongue until Grade 3. After Grade 3, most learners are schooled in English (Makoni, 2016:21). Consequently, non-English speakers must learn a new language not only for communicative purposes but also for academic purposes. Ultimately, first additional and third additional language learners are at a disadvantage compared to home-language speakers who already possess BICS and can start developing CALP – as opposed to second-language learners who first need to develop BICS before they can start building CALP (Makoni, 2016:22).

Within the Physical Sciences classroom, learners are faced not only with the difficulty of learning a first additional language, for example English, but also scientific language. Scientific language

“tends to be complex, abstract and very specialised” (Mavuru & Ramnarain, 2019:4). The complexity of a scientific text is seen in the dependence on clarifying scientific words, formulae and calculations (Ramnarain 2012:112). Consequently, learners are faced with the daunting task of learning and expressing scientific concepts in a language that they are still acquiring. In order to bridge the barrier between home language and specifically English, teachers need to guide learners in order to develop understanding. Teachers need to provide instruction, as the language that learners use outside a classroom setting differs from the academic language used within a classroom (Mavuru & Ramnarain, 2019:17). The factors that affect reading comprehension are explored in the next section.

2.4.3 Vocabulary and word recognition

Learners with limited vocabulary skills often struggle to comprehend a text, as the basic meaning of words is unknown to them. This results in them losing the meaning of a sentence. Unfortunately, the instruction of vocabulary skills is often neglected because teachers regard it “as difficult to teach and tedious to learn” (Le Cordeur, 2010:84). Both language and content teachers therefore often seem to neglect the instruction of vocabulary skills. Ilter (2017) also states that content teachers mostly feel that there is no need to teach language in the content classroom as it takes up too much time. Content teachers may assume that the learners have acquired vocabulary naturally (Ilter, 2017:1138). This assumption makes it difficult for learners with weak vocabulary skills to engage meaningfully with any given text. Furthermore, instruction should be aligned with the purpose of the text. An example in this case is the explicit teaching of biological terms in order to formulate a definition. Learners will be able to apply the definition in order to create meaning from the text. Martens (2014:33) highlights the existence of a clear relationship between vocabulary and reading comprehension. Ardasheva *et al.* (2017:666) maintain that limited vocabulary knowledge has a negative effect on reading comprehension. Moreover, the authors feel that in order for a learner to understand the content, they need to be *au fait* with science-specific vocabulary (Ardasheva *et al.*, 2017:669). The complex nature of science-specific vocabulary makes the instruction of vocabulary extremely important as teachers assist learners to familiarise themselves with the specific vocabulary.

The importance of vocabulary in content classrooms, specifically Physical Sciences classrooms, cannot be overstated as it is integral to the academic and reading level of a learner. Unfortunately, the instruction of vocabulary is sometimes less desirable for both learners and teachers (Le Cordeur, 2010:84). This is because of the time constraints faced by teachers, and the fact that learners might lack understanding of basic words and concepts. Le Cordeur further argues that vocabulary teaching should be structured in such a way that learners are actively involved in the formulation of definitions. If the content teacher does not attend to vocabulary that might be

unfamiliar to learners, there will surely be gaps in understanding. Nergis (2013) maintains that the recognition of vocabulary helps to facilitate the interpretation of a text. This is due to the cognitive effort that is directed towards deciphering information. The ability to read accurately and fluently affects a learner's ability to decipher a text, especially if that text contains extensive vocabulary (Johnson & Zabrocky, 2017:20). Martens (2014:4) argues that difficulties in comprehension are due to unfamiliarity with the vocabulary used in a text. Learners will avoid reading because they will not be able to manipulate the meaning of the words in order to absorb the knowledge contained in the text. Another aspect to take into consideration is a learner's exposure to vocabulary. Consequently, good vocabulary skills are greatly influenced by the variety of home languages that exist specifically in South Africa, due to the diversity of cultures. Many learners in South African schools come from an English first additional background, and only receive exposure to English in classrooms (formal) and on social media platforms (informal). When focusing on vocabulary, one can make the distinction between breadth and depth of vocabulary as suggested by Li and Kerby (2015).

Breadth of vocabulary refers to the number of words known. However, although a word may be known, the deeper meaning may not be understood (Li & Kerby, 2015:1). This is seen as basic understanding of vocabulary. Depth of vocabulary refers to a deeper understanding of words (Li & Kerby, 2015:1). Depth of vocabulary refers to the ability to use vocabulary to construct meaning by showing awareness of the structure of a word (Li & Kerby, 2015:1). Learners that have both a good breadth and depth of vocabulary are able to better comprehend a given text, as they are able to combine breadth and depth to derive meaning. Furthermore, the benefit of having an extensive vocabulary results in learners having a "larger database from which to guess the meaning of unknown words" (Qian, 2002:51.7). Learners without good general reading ability are limited when it comes to the deep and broad understanding of scientific knowledge that they can derive from the text (Johnson & Zabrocky, 2017:27). In contrast, learners with good vocabulary skills, are able to use their own knowledge to derive meaning from the new text and, as a result, to link it to their prior knowledge.

Swanson *et.al* (2016:202) maintain that vocabulary should be expanded through explicit teaching, repeated exposure to the newly acquired word, and teaching strategies to derive the meaning of the new word. The authors feel that through the active teaching of strategies such as the activation of prior knowledge, prediction, summarising, questioning and organising, inferring and clarifying, learners will be able to improve their comprehension across a variety of texts. Moreover, the various content subjects have various texts with regard to subject-specific vocabulary that needs to be understood in order to obtain the knowledge needed to understand concepts (Wexler, Mitchell, Clancy & Silverman, 2016:3). This means that the teacher should assist learners when

it comes to subject-specific vocabulary, by incorporating language teaching into their lessons. In an attempt to assist teachers with the teaching of vocabulary, textbooks that are aligned to the Curriculum Assessment Policy Statement (CAPS) offer some scaffolding for the teaching of vocabulary. Unfortunately, the scaffolding is limited and does not always assist learners in the comprehension of complicated terms e.g. "Insulators are materials that impede the free flow of electrons from atom to atom and molecule to molecule" (The Physical Sciences classroom 2020).

Furthermore, vocabulary skills can be improved when learners are taught how to derive the meaning of the word using the context. The benefit of this is not only the expansion of a learner's vocabulary, but also the development of "strategies needed for monitoring reading comprehension and vocabulary development" (Ilter, 2017:1136). Ironically, no content can be taught without language, yet language teaching may not be seen as important in content classrooms (Tan, 2011:339). An argument can therefore be made that vocabulary teaching in a science classroom can be beneficial without taking away from content instruction (Ilter, 2017:1136). Subsequently, criticism of science texts stems from the texts being "inaccessible because they introduce the reader to many unfamiliar words yet fail to explain them in ways that connect with students' experiences" (Arya *et al.*, 2017:1080). Therefore, teachers should devote more of "their in-class time to improving students' reading skills and vocabulary" (Ilter, 2017:1136). Consequently, learners will be able to use the vocabulary learnt independently to derive meaning. Thus, an argument can be made that teaching reading skills and concept learning should happen in the content classroom as it will assist learners in gaining content knowledge (Ilter, 2017:1136).

Reading comprehension is also dependent on decoding and knowledge of words (Botsas, 2017:139). What this implies is that learners should be able to decode a given text as well as recognise the words that are unique to the text and subject. Botsas (2017:140) indicates that reading comprehension strategies are genre specific. The genre within an academic setting refers to the various content subjects. Learners should be aware of the subject-specific jargon that appears within a given text. Ardasheva *et al.* (2017:665) argue that, in order for learners to be successful in the Physical Sciences classroom, they need to master general academic vocabulary as well as science-specific vocabulary. The reliance on definitions for terms used in Physical Sciences means that learners will struggle if they do not have vocabulary knowledge. Ardasheva *et al.* (2017:665) find that poor vocabulary knowledge is detrimental to reading comprehension. The ability to decode words within a text is important when learners need to relay what they have learned. In relaying what has been learnt, learners often make use of BICS. Razak and Yunus (2018:3) contend that BICS and CALP are interchangeable in a classroom. They feel that BICS can be used by both learners and teachers as it allows for discourse among learners, and between learners and the teacher (Razak & Yunus, 2018:4).

The recognition of specific words, for example in scientific texts, plays an important role in comprehension; however, it is not enough as learners should be able to use words in various contexts which influence the meaning of any given word. Nergis (2013:2) states that it is not only knowledge of vocabulary that translates into meaning, but also contextualisation. Also, making sense of the wider context, i.e. developing extensive vocabulary, facilitates comprehension. Furthermore, Hirsch (2003) argues that, “to make constructive use of vocabulary, the reader also needs a threshold level of knowledge about the topic being discussed”. This will allow learners to use vocabulary in various combinations as well as selecting the correct context in which the word is used. This allows learners to derive meaning based on the context in which a word appears within a sentence. Syntactical awareness also affects reading comprehension.

2.4.4 Syntactical awareness

Apart from vocabulary, learners need to be aware of syntax in order to comprehend texts. Syntactical awareness aids reading comprehension as it is within the syntax that meaning is constructed (Brimo *et al.*, 2017:60). Syntax creates meaning and shows the relationship between words and grammatical structures which plays an important role in textual comprehension (Nergis, 2013). Brimo *et al.* (2017:58) define syntax as “the rule system that governs how words are combined into larger meaningful units, such as phrases, clauses and sentences”. Deacon and Kieffer (2018:72) feel that syntactical awareness is the manipulation of word order within a sentence to find meaning. This links to Brimo *et al.*'s (2017) argument, as Deacon and Kieffer (2018:73) state that a sentence that is broken up into clauses is easier to understand. Consequently, syntactical awareness becomes important with regard to reading comprehension, as learners must be able to break sentences up in order to extract the needed knowledge for comprehension and ultimately manipulate sentence construction to respond to the given text (Deacon & Kieffer, 2018:72). An example is a sentence from a question in a Physical Sciences exam set by the Department of Basic Education which reads: “Initially a girl on roller skates is at rest on a smooth horizontal pavement” (DBE, 2018:9). The sentence can be broken up into two parts, as follows:

Part 1

Initially a girl on roller skates is at rest
(clause)

Part 2

on a smooth horizontal pavement.
(phrase)

In Part 1, learners need to understand the concept “at rest”, meaning there is no movement, in other words no momentum. The second part speaks to the fact that the surface is flat (horizontal) and the smooth pavement indicates that there is no resistance from the surface. If learners break up the sentence as seen above, they will be able to understand each concept separately and respond to any changes – for example, should the girl start moving forward. Consequently, they will be able to manipulate the word order to respond to a question based on their initial understanding of the sentence that they broke up into phrases and clauses. As learners progress through the grades, they are faced with increasingly complex texts which make comprehension difficult, especially when there is more than one main and sub-ordinate clause as well as phrases in a sentence, e.g. “you have to be careful when adding chemicals together, because they could react violently”. By utilizing syntactical awareness to simplify the text, learners will be able to derive meaning from a given text by breaking it up into smaller pieces to aid understanding (Deacon & Kieffer, 2018:82).

A study conducted by Mokhtari and Thompson (2006) focussed on the relationship between reading comprehension and syntactical awareness. The authors state that reading with comprehension is challenging for a number of learners as they lack the needed syntactical awareness to decode a text (Mokhtari & Thompson, 2006:74). This was seen in the results of their study, as they found that “students who showed deficits in syntactical awareness performed poorly on measures of reading comprehension” (Mokhtari & Thompson, 2006:87). Consequently, learners with poor syntactical awareness will not have the ability to fully understand a text, which means that they will not be able to effectively engage with or respond to the text. Syntactical awareness becomes important when learners are faced with a variety of texts as it assists them with text recognition. An in-depth discussion on text recognition will be offered in section 2.4.5.1 in this chapter. I now attend to the reading strategies that may be employed in the Physical Sciences classroom.

2.5 READING STRATEGIES

Reading strategies are designed to assist learners in extracting the needed knowledge as they engage with various texts. These include the relationship between vocabulary and word recognition, text recognition, inference, monitoring, visualising, activation of prior knowledge,

selecting, summarising and questioning. The following discussion aims to shed light on what these strategies entail.

Defining reading strategies has been a difficult task for scholars, as there is no agreement on what reading strategies are (Andrianatos, 218:34). However, for the purpose of this study, reading strategies are seen as, “the extraction and construction of meaning from text by teachers and students ... through the skilful and situational use of a repertoire of cognitive strategies” (McEwan, 2004:3). Various authors offer their own views on which reading strategies must be used in order to aid reading comprehension. Wexler *et al.* (2016:3) identify the elements that should be included in teaching to improve comprehension. These are prior knowledge, knowledge of vocabulary, questioning, and constructing meaning through summarising. On the other hand, Brown (1980) cited by Van Kraayennoord (2010) argues that the most important reading strategies include clarifying, identification of main concepts, monitoring, self-questioning and recovery strategies (Van Kraayennoord, 2010:285). All the above authors identify different strategies that aid reading comprehension, although they have differing views on which strategies are important for reading comprehension.

Another author, Cekiso (2007), opines that reading strategies should be implemented at different phases of the reading process. These phases include the pre-, during-, and post reading phases. He argues that different strategies need to be used during each of these phases in order to ensure comprehension. An example of a reading strategy that is used in the during-reading phase, is inference. Cekiso (2007:16) argues that inference is essential for the during-reading phase, as it allows learners to create links between different parts of a given text. In his study, Cekiso (2007) identifies a variety of strategies that are used in the various phases of reading. These include prediction, inferences, deriving the meaning of a word from the context, identifying main ideas and summarising. Some of the strategies identified by Cekiso overlap with other authors; however, there is a clear difference as Cekiso argues that different strategies should be used during different phases. The implication of this is that each of the strategies needs to be taught during the correct phase in order to assist learners with comprehension. This is aligned with what is suggested in the CAPS documents for English First Additional Language and English Home Language (DBE, 2011a; DBE, 2011b).

Although a variety of authors offered their examples of reading strategies, this study focusses on the reading strategies as set out by McEwan (2007). In addition to McEwan’s strategies, text recognition is also discussed, as it plays an important role in comprehension.

McEwan (2007:3) identifies the following seven strategies of most effective readers:

Table: 2.5: Strategies for effective reading

Activating	Making use of prior knowledge and experiences to construct meaning from text.
Inferring	Bringing together different parts of the text in order to contrive meaning.
Clarifying	Monitoring reading techniques during and after reading to determine comprehension of the text.
Questioning	Engaging with the text through a variety of questions to derive meaning from the text.
Selecting	Using different sources and selecting relevant information to clarify misunderstandings, solve problems or gather information.
Summarising	Restating the meaning of the text in your own words that differs from the original text.
Visualising	Constructing a mental image of the text in order to extract and construct meaning.

(McEwan, 2007:3)

McEwan (2007) believes that the implementation of these steps will ensure active engagement and meaningful interaction with textual content so that comprehension and critical thinking may take place. The knowledge of these and other reading strategies, for example text recognition and word recognition, is important for reading comprehension. Knowledge of reading strategies can therefore be seen as “knowledge about what reading strategies can be applied, how strategies can be used and under which conditions” (Warner *et al.*, 2017:4). Awareness and knowledge of reading strategies will enable teachers to develop learners into effective readers. As mentioned before, text recognition, in addition to the strategies suggested by McEwan (2007), is discussed.

2.5.1 Text recognition

In order to gain content knowledge, learners need to be able to understand and interpret an assortment of texts. Roehling *et al.* (2017:71) define text structure as, "the way information is organised in a text". However, learners can also use their knowledge of text structures to meet the demands of the content classroom. Text recognition becomes an important strategy that aids reading comprehension. According to Meyer and Ray (2017), good readers build sound mental representations of what they read by understanding different text structures. They argue that, when learners are taught the structure of texts, they are supported to think logically since they learn to organise their thoughts and get to use parallel processes to improve learning (Meyer & Ray, 2017:128). Once learners are able to organise their thoughts, based on the format and structure of a text, it becomes easier for them to make connections and to recall existing information. Thus, by understanding how the texts are organised/constructed, learners will be

able to organise/construct their own meaning, which leads to comprehension (Meyer & Ray, 2017:128).

Meyer and Ray (2017:128) state that there is an increased demand on learners to be able to engage with expository texts in science classrooms. In the Physical Sciences classroom, learners are exposed not only to written text in the form of paragraphs but also to diagrams and experiments. Each of these texts has its own format that needs to be understood in order to extract meaning. In the science classroom, for example, we often find reports on experiments. These reports follow a certain structure. If learners do not understand the concept of sequence and the fact that each step of the experiment needs to happen at a certain time, they will: a) not get the desired outcome when physically doing the experiment, and b) not be able to understand why a certain result is achieved. When learners acquire the skill to examine the structure of a text, they will be able to spot relationships such as sequence, comparison, causation or problem and solution (Meyer & Ray, 2017:128). The recognition of science texts becomes especially important, as expository texts that are used in the content classes are often more difficult than typical narrative texts (Meyer & Ray, 2017:127).

Another challenge to comprehension is the way that science textbooks are organised (Wexler *et al.*, 2016:4). These textbooks often "do not incorporate essential information to support comprehension of the text" (Wexler *et al.*, 2016:4), which makes it difficult for already struggling learners. Consequently, teachers need to develop ways to assist learners in understanding the text as presented in the textbook. The use of reading strategies will allow teachers to assist learners who might struggle with the given text, whether in writing or in diagram form. Therefore, teachers need to be mindful of the challenges that the various texts pose to learners and play an active role in assisting them to assimilate the knowledge.

According to the researchers, text structures are divided into six categories, namely "comparison, problem-and-solution, causation, sequence, collection and description" (Meyer & Ray, 2017:127). They argue that each of these categories has its own structural organisation which needs to be identified before a text can be comprehended. The authors identified key terms that aid the recognition of the text structure. Each of these structures has specific terms which learners should be familiar with in order to understand the categories of text structures. The table below indicates the categories and terms used in Physical sciences classrooms according to Meyer and Ray (2017).

Table 2-2: Text structure (Meyer & Ray, 2017:129)

Category	Identifying terms
<p>COMPARISON – relates ideas by differences and/or similarities, complexity can be increased by the number and detail of issues compared. The main ideas are organized to provide a comparison, contrast, or alternative view (e.g., political speech).</p>	<p>The following words could identify a comparison: instead, but, however, alternatively, whereas, on the other hand, while compare, in comparison, in contrast, in opposition, not everyone, all but, have in common, similarities, share, resemble, the same as, just as, more than, longer than, less than, act like, look like, despite, although, difference, differentiate, different ...</p>
<p>PROBLEM and SOLUTION – relates responding ideas; complexity can be increased by the identification of causes of the problems and ways to reduce them. The main ideas are organized in two parts: the problem (or question) part and the solution (or answer) part (e.g., popular science articles, medical information).</p>	<p>Problem: problem, trouble, difficulty, hazard, need to prevent, threat, danger, puzzle, can hurt, not good, bad ...</p> <p>Solution: to satisfy the problem, ways to reduce the problem, so solve these problems, protection from the problem, solution, in response, recommend, suggest, reply...</p>
<p>CAUSE and EFFECT (causation) – relates ideas casually; complexity can be increased by embedded cause-and-effect paths and causal chains and reduced by similarity to familiar narratives. The main ideas are organized into cause-and-effect parts (e.g., directions, explanations, economic or science texts).</p>	<p>cause, led to, bring about, originate, produce, make possible, owing to, by means of, accomplish by, since, due to, because, in order to, reasons, why, if/then, on account of, in explanation, effect, affects, so, as a result, consequence, thus, therefore, accordingly, for the purpose of...</p>
<p>SEQUENCE (time-ordered collection of events, ideas) – relates ideas via time. The main ideas are the steps or history presented (e.g., recipe steps, history books, biographies).</p>	<p>later, afterwards, after, then, subsequently, as time passed, following, continuing on, to end, finally, year(s) ago, at the start of, primarily, early, before, to begin with, more recently, again, finally, the former, the latter, not long after, soon, now, today, after a short while, meanwhile, steps, stages ...</p>
<p>COLLECTION – relates ideas simply by grouping them together; sometime the grouping is made explicit with enumeration. The main idea is the grouped list (e.g., “to do list,” botany). For example, groups of solutions or causes are often presented together.</p>	<p>and, in addition, also, include, moreover, besides, first, second, third, etc., subsequent, furthermore, at the same time, another, and so forth...</p>
<p>DESCRIPTION – relates ideas by elaboration of attributes, specifics, or setting information. The main ideas are that aspects of a topic are presented (e.g., newspaper article)</p>	<p>attributes of, characteristics are, for example, for instance, in describing, marks of, namely, properties of, qualities are, specifically, such as, that is...</p>

Considering the categories, as seen in the previous table, the following examples illustrate the application of these categories in the Physical Sciences classroom. The **Cause-and-Effect** category can be seen when learners have to calculate displacement. Displacement indicates that

an object moved from point A to B. In order for movement to happen, there needs to be a force that causes an object to move from its resting position. The effect of this is displacement, as the object is no longer in its original position. Another example found in the Physical Sciences classroom speaks to the **Sequence** category. This is a crucial category within Physical Sciences, as the subject makes use of a variety of experiments to prove and explain concepts. The sequential layout of an experiment needs to be followed in order for the experiment to be successful. An example of the sequence of an experiment is found within chemistry. The combination of chemicals needs to be done in the correct sequence as it will influence the reaction that takes place, for example the adding of potassium to water. When this is done, the potassium moves to the surface and explodes. By taking text structure into account, learners will also be able to self-question, as they are able to create the links between structure and knowledge.

2.5.2 Questioning

Another strategy, related to text recognition, is questioning. Questioning plays an integral part in comprehension as it leads to higher order thinking and allows learners to gauge to what extent they understand the content and also how their understanding impacts the world around them. Joseph *et al.* (2016:153) maintain that self-questioning increases the focus on the important details of a text. This focus on critical details helps learners to ensure that the fundamental concepts of the text are understood, for example, the structure of a Physical Sciences experiment. Küçükoğlu (2003:711) defines the questioning process as the process whereby readers construct meaning by asking questions to “enhance understanding, find answers, solve problems, find information and discover new information”. Therefore, an argument can be made that a relationship between learning, comprehension and questioning exists. Thus, the ability to apply deep-level reasoning in order to stimulate cognisance of a given text will, in turn, promote the comprehension of a set text (Craig *et al.*, 2006:576). In other words, learners who are unable to apply high-level questioning could struggle to stimulate their cognisance, leading to a lack of textual understanding. As a result, the learner will lack the ability to think critically about what he/she has read. Dovoudi and Sadeghi (2015:81) make use of the following diagram to show the relationship between questioning and critical thinking:

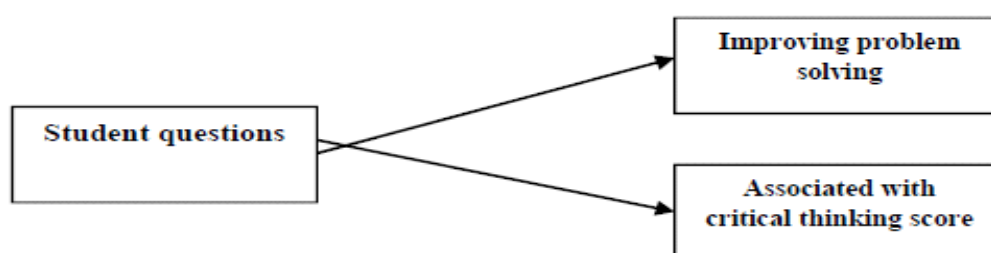


Figure 2-4: The relationship between learner questioning and areas of critical thinking.

(Dovoudi & Sadeghi, 2015:81)

As seen above, learners apply the questioning process, and subsequently develop the skills to solve problems. This is possible only by increasing the critical thinking process. Dovoudi and Sadeghi (2015:86) state that “self-questioning improves reading comprehension and contributes to active reading”. Therefore, self-questioning becomes vitally important for critical-thinking abilities. Joseph and Ross (2018:277) agree that self-questioning is important for reading comprehension, as it allows learners to pause and generate their own questions to check their understanding. The authors further state that self-questioning is effective when learners are faced with expository text often found in the science classroom (Joseph & Ross, 2018:277). Furthermore, self-questioning allows learners to use prior knowledge, identify facts, make inferences, identify sequences and make predictions (Joseph & Ross, 2048:277). As a result, self-questioning allows learners to employ a variety of strategies in order to answer their own questions, and in doing so aid comprehension.

In order for self-questioning to be effective, learners should be able to challenge themselves by framing questions that are cognitively demanding so as to assess their level of understanding (Dovoudi & Sadeghi, 2015:82). When they ask only lower-order questions in self-assessment, they will limit their own engagement with the content and not acquire skills for deeper analysis reflection (Davoudi & Sadeghi, 2015:82). Overall, a case can be made for the use of questioning as a catalyst for critical thinking to facilitate the acquisition of knowledge. De Brook *et al.* (2017:261) state that, “Questioning is an effective way to help readers construct a coherent representation of a text because it directs readers’ attention to making essential connections.” The role of the teacher regarding questioning can be seen in the assistance that they offer learners in order to generate questions that are specific to the content and text. In other words, the questions that learners ask should be “factual and inferential type questions” (Joseph *et al.*, 2016:168). In assisting learners to ask the correct questions, the teacher is able to facilitate the learning process by guiding learners in problem-solving and in critical thinking. This can only be accomplished if the questioning technique is modelled by the teacher and learners later automatically engage in metacognition. The use of metacognition aids learners in problem solving as it is seen as constructing meaning through one’s own understanding and experiences (Soto *et al.*, 2019:2). Learners make use of their own experiences in order to decode a text to find meaning. The ability to decode a given text is seen as **metacognition** (McNamera & Magliano, 2009:32). Landine and Stewart (1998) defines metacognition as “knowledge concerning one’s own cognitive processes and the active monitoring and regulation of these processes” During their research, McNamera and Magliano (2009) found that learners with poor metacognition struggled with

decoding as well as repair strategies (McNamera & Magliano, 2009:32). Effectively, learners who are unable to monitor their own understanding and learning will be unable to apply questioning in order to facilitate with the comprehension of a text. An example of a metacognitive question within Physical Sciences is: Why does fizzing occur in some chemical reactions? Learners must then be able to draw on what they know about reactions in order to answer the question. Another skill that learners need in order to comprehend a text is meta-comprehension.

Meta-comprehension can be seen as the understanding of the text being read (Soto *et al.*, 2019:2). According to Halamish and Elbaz (2020:20), reading comprehension focuses on the reader and the text, whereas meta-comprehension shows to what extent a reader is able to monitor their own understanding of a text. Meta-comprehension is seen as the ability to answer questions that test comprehension after reading a text (Wiley *et al.*, 2016:393). In other words, the higher the meta-comprehension skill of a learner, the better the understanding of the text. “When readers have an accurate understanding of their knowledge about a text, their meta-comprehension accuracy is said to be high. In cases of poor meta-comprehension accuracy, however, readers are less able to appropriately regulate their efforts” (Soto *et al.*, 2019:3). Therefore, meta-comprehension allows for deeper engagement with a text as it assists with the regulation of comprehension of a given text. Meta-comprehension questions are utilised in order to make connections between different parts of a text (Wiley *et al.*, 2016:296). In other words, learners must use questions to make inferences in order to fully comprehend a text or concept. An example of a meta-comprehension question is: What would happen to the pH level of water if hydrochloric acid were added? In order to answer this question, learners must draw on their knowledge of pH levels as well as the effect that acid and basis have on the pH level of a liquid.

2.5.3 Activating prior knowledge

Before a learner can fully engage with the new content, the learner needs to learn how to establish a link between the knowledge he/she already possesses and the knowledge he/she is attempting to gain. Prior knowledge is therefore seen as one of the fundamental predictors of reading comprehension. According to Tarchi (2015:4), prior knowledge can be seen as, “the whole of a person’s actual knowledge, available before a certain learning task”. By activating prior knowledge, learners can improve their comprehension of a variety of texts, both printed and multimodal. The ability to activate prior knowledge often has nothing to do with cognitive abilities, but rather the experiences and knowledge that the learner has interacted with, for instance: the knowledge of the topic, genre and the vocabulary of the given text (Mills, 2008:4). Accordingly, the importance of knowledge integration is seen when learners activate prior knowledge by moving away from the mere memorisation of information to establishing connections between different elements of prior knowledge. Gonzalez (2017:191) agrees that prior knowledge is

important, as learners that are able to link new information with previous knowledge are better readers, since they do not rely on memorising new facts but actually understand these. An argument can therefore be made that without the proper activation of prior knowledge, new content cannot be properly assimilated. However, the problem remains that certain learners may not have sufficient prior knowledge due to impoverished environments and little exposure to the world. No learner is a *tabula rasa*, but there are huge differences between those who have been exposed to the world and those who have not. This reminds of the Matthew effect in reading (Stanovich, 1986). This means that those who start with a foundation, tend to continue to do so, while those who do not have any experience with reading from a young age, are unlikely to catch up. Not only do they not catch up, according to Stanovich (1986), but there will also be an increased gap between the slow starters and fast starters as their school careers continue. The gap between learners is often seen in their ability to predict outcomes based on knowledge that they have already acquired. Küçükoğlu (2013:710) states that predicting “helps the reader set a purpose for their reading”; without prediction the comprehension of a text becomes meaningless. Thus, the importance of knowledge activation is seen in the integration of prior knowledge, as well as the ability to construct purpose from the text through prediction in order to aid understanding. Prior knowledge can be seen as multidimensional as it may be seen in terms of breadth and depth (Tarchi, 2015:4). The implication of this is that learners need to understand the nature of their knowledge and how it aids comprehension. According to Tarchi (2015:4), the depth of prior knowledge is linked to knowledge on a specific topic. In the context of a Physical Sciences classroom, it could refer to the learners’ knowledge of the different types of energy. Before learners can calculate the energy that is expended, they must first be able to tell the difference between kinetic energy and potential energy. Energy that is already in motion is referred to as kinetic energy and potential energy is energy that is stationary. To activate prior knowledge, the teacher can ask the learners to provide their own examples of each of the types of energy, as well as explaining in their own words what the difference is between kinetic and potential energy.

As discussed earlier in this chapter, a differentiation needs to be made between the breadth and depth of vocabulary. Apart from the distinction between breadth and depth of vocabulary, a differentiation between the breadth and depth of knowledge is also seen. The difference between the breadth and depth of knowledge is seen in the specific nature of the knowledge. Unlike depth of knowledge, breadth of knowledge refers to the knowledge of the discipline, e.g. Physical Sciences (Tarchi, 2015:4). Therefore, learners who possess knowledge of the subject might not have topic-specific knowledge for example learners might understand the word “rest” as relaxing, where in Physical Sciences it refers to no movement/energy used. Thus, the teacher needs to act as a bridge between what the learner already knows and the new content. In other words, prior knowledge should be used to aid comprehension by acting as a departure point for acquiring new

knowledge. Learners will therefore be able to use prior knowledge as a starting point to acquire new knowledge, which in turn helps comprehension. This is done when prior knowledge is used as the starting point, for example when inferences need to be made, as these require learners to establish links between different concepts within a text. An example of prior-knowledge activation is if the science teacher asks learners what happens if they push someone on a swing. Learners may answer that the person starts moving back and forth; this allows the teacher to start explaining the concept of kinetic energy and movement.

2.5.4 Inferring

Prior knowledge enables learners to make certain inferences when they are confronted with an unfamiliar text. Based on what they already know regarding any particular topic, learners can infer, i.e. connect various parts of the text to existing knowledge in the process of constructing meaning. Hall and Barns (2018:281) reiterate the importance of prior knowledge for making inferences, as prior knowledge and information from a given text intertwine when inferences are made. Learners that are unable to make inferences while reading have poor comprehension of a given text, as they are unable to establish links (Hall & Barns, 2018:280). Knowledge constructed through inference happens when a learner is required to incorporate information from different parts of a text, as well as information that is found outside the text (Tarchi, 2015:5). McNamara, Ozuru and Floyd (2017:232) argue that a text should provide cues or clues to assist learners with linking the content to prior knowledge. Learners with a limited prior knowledge experience a deficit; they could struggle to construct meaning from the new text, as they have nothing to link it to. Apart from being able to link a text to prior knowledge, learners must be able to link knowledge within a text. Prior knowledge becomes particularly important in this regard, because if readers “do not possess sufficient knowledge, inferences are likely to be unsuccessful” (McNamara *et al.*, 2017:246). In other words, prior knowledge acts as a vehicle for knowledge, which in turn assists with inferences within a text. Thus, by linking various parts of the given text together, meaning can be derived. Learners who struggle with comprehension often lack the ability to make constructive inferences that require creating links in the given text (Tarchi, 2015:5). Furthermore, inferring is combining what is written and unwritten within a text while incorporating prior knowledge in order to construct textual meaning. The connections made through inference also include connections made to personal experiences. Küçükoğlu (2003:710) comments that learners make the following connections: “Text-to-text, Text-to-self, and Text-to-world.” Text-to-text relates to a learner’s ability to find connections and similarities between different texts. An example of this is when learners are able to connect recurring words or ideas to a text, e.g. the idea of distance to an article regarding movement from points A to B. Text-to-self refers to the learner’s ability to connect the text to something they create, based on their own experience. An

example of this is when a learner has to draw a graph about displacement by using the route, they take to school every day. Finally, text-to-world speaks to the ability of a learner to connect a text (an experiment, for instance) to everyday life. Using the example of zinc-and-hydrochloric acid reaction again, learners must be able to link the salt that was formed as a result of the reaction to a practical use in the world. An example of this is when the salts that formed are used in deodorants. Consequently, these connections become particularly important for comprehension, as they establish meaning of what is read. Thus, the connection of text gives purpose and meaning to reading, which in turn aids textual comprehension.

The ability to create inferences indicates the understanding of how various events influence one another and also illustrates the main concepts contained within a set of arguments (Mullis *et al.*, 2016:20). Reading comprehension requires that inferences take place lexically and semantically. Lexical refers to “the meaning of a term within a sentence” (Tarchi, 2015:5), whereas the ability to understand the composition of a sentence, as well as the ability to manipulate it to derive meaning, is seen as syntactical awareness. For learners to be able to make lexical inferences, they need to be able to take things like sentence length and vocabulary difficulty into consideration (Arya *et al.*, 2017:210). Knowledge of vocabulary will also greatly influence lexical inference. Teachers need to aid learners when it comes to sentence construction, as the length of the sentence impacts understanding. A correlation between sentence length and sentence complexity is seen as, “the longer the sentence, the greater the likelihood that multiple discrete ideas, called propositions, are embedded in it” (Arya *et al.*, 2017:109). Consequently, the role of the teacher is to ensure that he/she bridges the gap that might occur when a sentence becomes too complex for the reader (learner), due to his/her limited reading experience (Arya *et al.*, 2017:10). In contrast to lexical inferences, semantic inferences can be seen as “a wider knowledge of the world” (Tarchi, 2015:5). The knowledge of the world enables learners to use a wider frame of reference in order to make inferences. Inferences become more dependable when semantic associations are used with regard to a specific text (van den Broek & Yeari, 2015:1194). The authors further argue that stronger semantic associations result in increased inferences. Overall, inference implies the connection of knowledge to various contexts in order to facilitate comprehension and, ultimately, the assimilation of knowledge. The ability of learners to be able to establish links between a variety of contexts also aids in summarising, which is the ability to condense work in order to extract important information.

2.5.5 Summarising

With regard to summarising as a reading strategy, it is important to note that this involves the simplification of the text to derive knowledge. According to Semtin and Maniom (2015:55), the use of summarising or the listing of key points plays an important role to gain a clear

understanding of the text. This can be seen when learners condense work into smaller pieces in order to identify the important elements within the text. In other words, learners must be able to determine which ideas are important and combine them in order to extract meaning from the text. In a Physical Sciences classroom, learners should be able to summarise an experiment in order to communicate the findings. Cekiso (2007:22) indicates that it is important for learners to paraphrase while summarising, as this shows that they understand the text and are able to put it into their own words. In this regard, the importance of distinguishing between relevant and irrelevant knowledge in the summary process is of utmost importance to improve the understanding of a text (Küçükoğlu, 2003:711). Summarising can therefore be a way for learners to organise ideas throughout the text in order to fully comprehend it. It can be said that summarising means making the text one's own.

Marzec-Stawiarska (2016:90) argues that, "reading to summarise involves deliberate active operations aiming at formation of the gist of the text." The ability to understand the core meaning of a text will therefore aid learners in comprehending the text. Consequently, relevant information is summarised to eliminate redundant information. According to Marzec-Stawiarska (2016:91), summarising consists of three strategies, namely deletion, generalisation and construction. Each of these strategies aids in the extraction of the relevant information to summarise a text. Deletion could be seen as the ability to eliminate "unimportant and redundant information" (Marzec-Stawiarska, 2016:91). By eliminating irrelevant information, a learner is able to summarise information relevant to what he/she is trying to understand. Generalisation refers to the ability to generalise information from the text. Construction involves the "inferencing ...which in practice means either identifying or generating the main idea of one or more paragraphs" (Marzec-Stawiarska, 2016:91). The explicit teaching of summarising becomes particularly important as learners with a lack of vocabulary knowledge might struggle to effectively summarise. Summarising should therefore be used once terminology has been explained, as unfamiliarity of terminology or text will make it difficult for learners to summarise a given text.

Summarising within the Physical Sciences classroom also contributes to comprehension. During their investigation, León and Escudero (2015:77) asked participants to read an extract of maximum 500 words from an encyclopaedia and write a summary afterwards to show their understanding. The evaluation of these summaries was done by taking into account the content of the summary, as well as the ability of the learners to paraphrase. During their study, the authors found that learners at school level struggle to summarise using their own words and that this skill was only seen at university level (León & Escudero, 2015:78). The authors identified the reason for this gap in skills as the inability of learners at school level to show a deeper understanding of summary structure, as well as the inability of learners to synthesise information and present it in

a coherent way (León & Escudero, 2015:78). The ability to present information in a coherent manner makes clarifying easier, as it shows where knowledge of a given text is lacking.

2.5.6 Clarifying/monitoring

In the content classroom, the ability of learners to monitor or clarify what they are reading lies in their ability to think about the text while reading, and retrospectively. It is this ability that enables learners to clear up any misunderstandings that might have arisen in a lesson. Furthermore, it is the ability to combine various aspects in order to clarify any misunderstandings surrounding concepts and facilitate comprehension. Hassan (2017:16) states that monitoring is important as “it helps readers verify their reading strategies so that the necessary adjustments can be made if meaning is not obtained.” This creates a sense of reflection in the reader as they try and establish cohesion between what they already know and what they have just read. Accordingly, the ability to use this reflective process as a means to organise and use relevant information (Cekiso, 2007:21) replaces the construction of meaning with a critical consideration of the text. Consequently, the application of this strategy expects learners to learn to search for the deeper meaning of the text in order to form a judgement that is justified. In order for learners to monitor text comprehension, they need to evaluate the structure and language of the text. Mullis, Martin and Sainsbury (2016:21) argue that during the evaluation of text, “readers draw upon their knowledge of language usage, presentation features and general or genre-specific features of texts”. Thus, the implication for learners trying to assimilate new academic knowledge includes the need to understand the jargon and genre-specific features of the text in order to fully comprehend it. Therefore, learners who are able to reflect on the general or genre-specific features would be able to actively engage with the text more effectively, thus leading to a better knowledge of the academic text.

The utilisation of monitoring allows for a deep level of understanding of a text. Wassenburg *et al.* (2015:48) argue that there needs to be a deep-level text comprehension to fully assimilate knowledge. The authors maintain that, “skilled readers who evaluate their comprehension constantly ask themselves if what they are reading makes sense” (Wasseburg *et al.*, 2015:49). By doing this, learners are constantly monitoring/clarifying if they understand the text – and if there are elements that they do not understand, they can go back to the text and seek clarity. However, the given text does not always clarify understanding, thus learners must be able to make use of prior knowledge as well as inferences to clear up misunderstanding (Wassenburg *et al.*, 205:50). During their study, the authors found that there are a few fix-up strategies that learners can utilise in order to monitor/clarify their understanding. These include skipping over a text until clarity is found, filling the gaps as they read, guessing the meaning or finding an external source to assist with meaning. According to Wassenburg *e.al.* (2015) the explicit teaching of

monitoring/clarifying as a strategy improved the comprehension of learners. Therefore, learners need to be trained to use monitoring/clarifying by selecting information to ensure comprehension of a given text. Consequently, the use of monitoring makes learners aware of other reading strategies. This enables them to monitor the use of other strategies such as searching/selecting in order to repair comprehension (Hassan, 2017:29).

2.5.7 Searching-selecting

Teaching learners to analyse work in a selective manner will enable them to utilise a variety of sources. Selecting or searching enables learners to be able to evaluate and monitor the information given to them. This action takes place when learners can utilise a variety of sources in order to select the necessary information to construct meaning. The skill to differentiate between useful and irrelevant information is of paramount importance today, as learners are bombarded with a plethora of knowledge, especially on the Internet. This includes information needed to answer questions, to construct definitions, and to clarify and solve problems that might have arisen from reading the given text. Within an academic environment, reading is seen as being task-orientated because it has a specific goal. In other words, learners need to read for a specific purpose. Task-specific reading requires learners to search, select and process information to show comprehension (Cerdán *et al.*, 2011:201). The authors highlight that readers need to be able to identify cues linking to the information that they wish to extract. Cerdán *et al.* (2011:201) distinguish between two types of cues, namely superficial and deeper semantic cues. Superficial cues refer to keywords found in the question as well as the given text. This makes searching and selecting easier as there is an overlap between the question and the text, which creates a better understanding and coherent mental representation from the given text (Cerdán *et al.*, 2011:201). An example of this is if learners are given the periodic table of elements and asked to write down the position of a specific element on the table, for example H.

However, superficial cues do not allow for a deeper engagement and understanding of a given text, as these do not facilitate the use of inferences to extract meaning from the text (Cerdán *et al.*, 2011:202). Consequently, learners must be able to use deeper semantic cues, which involves combining different ideas that were selected from the text in order to aid comprehension (Cerdán *et al.*, 2011:201). The ability to use deeper semantic cues is not evident in less-skilled learners, as they struggle to search and select information and link it together to aid understanding (Cerdán *et al.*, 2011:201). In other words, learners who are relying on only similar words and not similar ideas will not be able to select concepts and group them together to derive meaning from a given text.

Therefore, the proper application of this skill will enable learners to isolate important information within the text in order to aid comprehension. Textual monitoring becomes important, as it allows learners to use a sequential process to find relevant information and select what is needed to construct meaning. Thus, through constant monitoring, learners can ensure their understanding of the text as they search for the relevant information (Park *et al.*, 2014:159). A further argument is made, namely that by critically evaluating the text, learners can determine the accuracy of the information gathered from different sources. Consequently, the use of multiple resources means that learners end up broadening their scope of information, and therefore broadening their knowledge on the subject.

2.5.8 Visualising

The selection of information aids learners in visualising the content of a given text in order to derive meaning. Visualising can be defined as the ability to describe events in a text that are crucial in order to form a coherent visio-spatial representation (De Koning & van der Schoot, 2013:261). This draws on the reader's ability to take what is read and mentally manipulate the information to construct meaning from the text. De Koning and van der Schoot (2013:263) maintain that the ability of a learner to visualise textual content for themselves influences the proficiency of the reader. Mills (2008:6) agrees that visualising assists with comprehension and states that, by visualising, a reader "anchors new ideas" (Mills, 2008:6). Furthermore, Mills believes the use of visualisation can help create a mental picture which in turn helps with difficulties that the reader might face with a text (Mills, 2008:6). Leopold and Leutner (2012:4) agree with Mills when they state that, "To develop an understanding of the text's content, the reader is required to form a mental representation of the objects and relations that are described by the text." In other words, learners need to use the information contained within a given text to visualise the content, in order to derive meaning and ultimately comprehend the text.

Unfortunately, in a classroom setting, learners are often provided with images instead of being tasked with creating their own (De Koning & van der Schoot, 2013:263). This can be problematic as learners might not relate to the image that is provided. It is also easier to comprehend new information if you can visually link it to prior knowledge. De Koning and van der Schoot (2013:267) distinguish between internal and external visualisation. Internal visualisation refers to mental images that are created by interpreting a given text and that cannot be seen. By contrast, external visualising refers to a text that is physically represented and can be seen, for example a graph. Internal and external visualisations do not happen in isolation but are interlocked (De Koning & van der Schoot, 2013:267). An example of this is when information from a written text is first organised in a specific order before it is visually represented. When a learner needs to draw a graph, he/she should first organise the variables internally in order to give a coherent visual

representation of them. The ability to visualise a text both internally and externally becomes very important and the role that the teacher plays in this regard also influences the manner in which learners are able to visualise. In the Physical Sciences classroom, internal visualisation can be prompted by asking learners to “picture the route you take to school”; this usually results in learners mentally visualising the route. The mental visualisation can be used as a starting point for an external visualisation, as learners could be asked to draw the route from their home to school.

During research conducted by Leopald and Lautner (2012:4), the researchers found that readers who employed visualisation showed a better understanding of expository texts. In their study, they divided participants into two groups. Group one drew a visual representation of the text in order to show their understanding, while group two used only the text to gain understanding (Leopald & Leutner, 2012:5). The authors found that the group that drew a visual representation of the information given in the text was able to manipulate the content of the text more effectively, resulting in a deeper comprehension of the text (Leopald & Lautner, 2012:5). Therefore, teachers need to encourage learners to make use of visualisation – that is, to create an image of the content of a given text – as this will assist them with comprehension.

2.6 THE PROBLEMS OF THE CONTENT CLASSROOM AND THE ROLE OF THE TEACHER

The growing concern about poor reading comprehension in content classrooms has brought the role of the content teacher to the foreground. The role of the teacher is to motivate learners to interact meaningfully with the given text through reading. The deliberate instruction of reading strategies by the content teacher helps alleviate the feeling of alienation that a lack of comprehension can cause. Ness (2016:60) states that teachers who make use of single or multiple comprehension strategies when teaching, while guiding learners in the implementation of these strategies, help learners to improve reading comprehension. In order to comprehend a text fully, the teacher needs to assist learners in using their cognitive abilities. Unfortunately, the assumption is made that learners acquire reading strategies and reading comprehension naturally, like the skill of speaking, which is not the case. Klapwijk (2015:2) describes reading strategies as tactics that can help learners to bridge the gap between decoding (reading) a text and comprehending a text, while Anderson (1991:460) sees strategies as “deliberate cognitive steps that learners can take to assist in acquiring, storing and retrieving new information”. These cognitive steps towards decoding a text assists learners with comprehension, as these allow them to assimilate the knowledge within a variety of texts. Leppänen *et al.* (2004:75) feel that learners who struggle to read from Grade 1 until the end of primary school will carry over the disadvantages of not being able to read with comprehension into secondary school and beyond. It is during the

primary- school phase that skills and strategies need to be developed in order to act as vehicles for future knowledge acquisition. Therefore, teachers need to make a concerted effort to teach reading strategies explicitly in their classrooms.

Reading strategies largely determine the ultimate understanding of content and should be explicitly taught to students. Unfortunately, the explicit teaching of reading strategies in a Physical Sciences classroom is not common practice (Ness, 2016:72). During her research, Ness (2016:72) also found that teachers are often unaware of these strategies and are therefore unable to assist learners when they struggle to comprehend lessons. Consequently, some learners fail to fully assimilate the knowledge and are not provided with any strategies to help them understand.

Traditionally, the role of text and literature instruction has not been accentuated enough within the Physical Sciences classroom. Mitchell *et al.* (2016:2) define scientific literacy as “an understanding of the content of science, its applications, and its use in problem solving and the ability to think critically about it”. Thus, the need to help students become scientifically literate is not prioritised (Wexler *et al.*, 2016:2). The consequence of language not being prioritised is that learners fail to understand a given text and therefore fail to gain knowledge. Teachers must therefore be mindful of the fact that not all learners are scientifically literate, which causes barriers to learning. Wexler *et al.* (2016:2) further argue that the literacy acquired early on in schooling does not translate into proficiency when it comes to a given text. Therefore, integration of secondary-content teaching becomes essential. In other words, Physical Sciences teachers need to combine language and content teaching to ensure that learners understand the subject matter. As mentioned before, this is not standard practice, as many content teachers still believe that language teaching is solely the responsibility of the language teacher. In order to combine language and content teaching, Physical Sciences teachers need to be aware of – and need to teach – reading strategies to assist learners in becoming scientifically literate.

Content teachers need to be mindful of the fact that the transfer of reading strategies from the language to the content area is not automatic. Hence, the role of the content teacher is to model the transfer of reading strategies from language to content area (Colombo & Furbush, 2008:97). Colombo and Furbush (2008:97) agree with Negris (2013) that a lack of vocabulary and shortcomings in syntactical awareness will create barriers to learning. The solution they offer is that content teachers should support learners by focusing on subject-specific academic vocabulary and syntax as well as specific content-area reading strategies (Colombo & Furbush, 2008:97). For teachers to be able to assist learners with syntax and reading strategies, teachers need to be able to use syntax and reading strategies themselves. Teachers not trained in these skills might not teach syntax or reading strategies, as they do not feel confident in doing so.

As mentioned earlier, the transfer of reading strategies from the language classroom to the content classroom is important, as learners need these skills in order to read with comprehension. The reading strategies used in English-language classrooms differ from those used in content classrooms, in the sense that a greater focus is placed on syntax and the different components of linguistics, such as phonetics, phonology, morphology, pragmatics and semantics. The additional pressure on content teachers to incorporate language instruction into their lessons may lead to the exclusion of language altogether, as content teachers lack the confidence to teach facets of language. This is confirmed by Ness (2016:61), who says the content teacher feels that teaching language specifically is impossible, due to the pressures of covering the content in a limited time. Consequently, teachers in content classrooms, such as Physical Sciences, choose to focus on the content rather than language, as they feel that the content that needs to be covered is more important.

Furthermore, Ness (2016:59) explored teachers' perceptions with regard to the instruction of reading comprehension. She found that teachers not only felt unqualified to explicitly teach language in their content classrooms, but they also refused to take responsibility for doing so, as they saw language teaching as the responsibility of the language teacher (Ness, 2016:59). Content teachers consequently spent only 3% of the total instruction time on reading-comprehension instruction. Her findings are illustrated in the figure below.

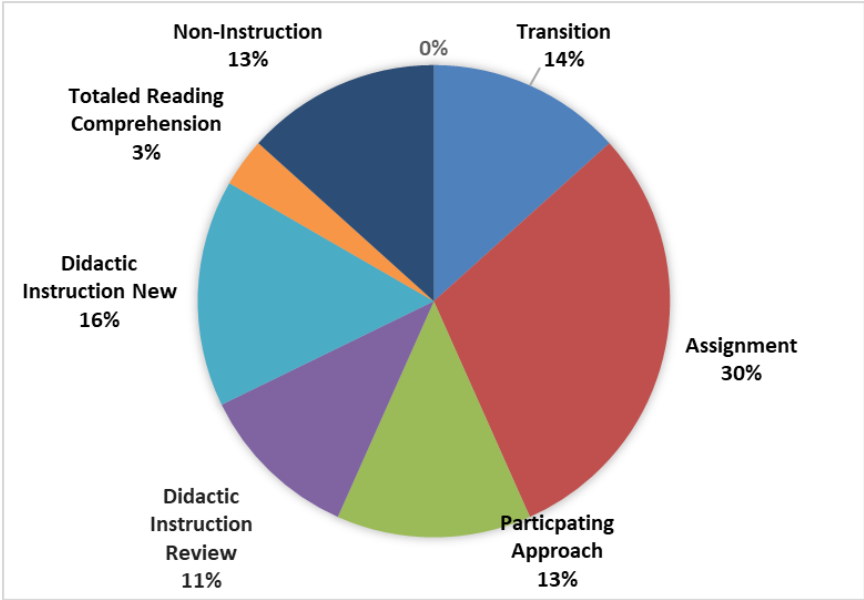


Figure 2-5: Presenting Breakdown of Classroom Instruction.

(Ness, 2016:62)

The figure illustrates lack of attention given to reading comprehension. The implication of this is that learners are unable to understand content texts. These texts are expository in nature and

place a higher demand on comprehension. Time needs to be allocated to teaching reading strategies that aid comprehension if this skill is to be enhanced. The development of reading strategies takes place when learners practise reading strategies and actively participate in the learning process (Warner *et al.*, 2017:4). Learners need to understand the role that each strategy plays in the ultimate comprehension of a given text. Moreover, an inability to apply these reading strategies ultimately results in understanding of the text being lost and incomplete assimilation of new content (Klapwijk, 2015:1).

The consequence of the neglect of reading skills at school level is that students find it difficult to make academic progress at tertiary level, where both the volume and level of difficulty of texts increase dramatically (Bharutharam, 2012:205). Without the use of strategies, learners might not be able to comprehend what they read, which in turn hinders their ability to analyse, critique, evaluate and synthesize various sources necessary to assimilate knowledge (Bharutharam, 2012:205). Mills (2008:11) further argues that in order to be competent readers, learners must have “learned to monitor their comprehension by becoming aware of what they understand, recognising when they do not comprehend, and using appropriate strategies to restore comprehension”. Similarly, learners who experience problems reading any given text will ultimately also encounter difficulty extracting the relevant information from the text; this in turn leads to learning difficulties. Consequently, the inability of learners to interpret texts will ultimately lead to knowledge not being acquired.

Creating awareness of these strategies is important within the content classroom. Therefore, an adaptation in teaching methodology is needed (Vázquez & Ellison, 2013:67). This means that the content teacher should adapt his/her perspective regarding the role of language teaching to aid comprehension of his/her subject content. However, as mentioned earlier, content teachers often lack relevant linguistic knowledge, which causes them to feel uncomfortable when having to teach language in the content classroom (Vázquez & Ellison, 2013:70). As a result, content teachers often look to language teachers to teach the required language skills. It is also noted that content teachers often feel ill-equipped to deal with the language demands of their subjects: “many content area teachers report additional concerns including feeling unprepared to help their struggling readers because they do not have the time, training or support, and may feel that teaching reading skills is not their responsibility” (Wexler *et al.*, 2016:4).

According to Wexler *et al.* (2016) there are various challenges that impede the implementation of content-area language instruction. The first is the reading capability of learners within mainstream educational classes (Wexler *et al.*, 2016:4). This places pressure on the Physical Sciences teachers to assist learners in managing the demands placed on them in the classroom. In education, reading for meaning is one of the fundamental skills learners should possess; yet, as

seen in the performance of South African learners, as set out by Baller *et al.* (2016), these learners are underperforming in Physical Sciences and in Mathematics due to gaps in comprehension. This effectively means that some of the learners in the Physical Sciences classroom are struggling to read for meaning.

2.7 EXAMPLE OF THE USE OF READING STRATEGIES DURING A PHYSICAL SCIENCES LESSON

The following example relates to the use of reading strategies during a specific unit of work within the Physical Sciences classroom. The unit on electricity and magnetism is found in the Grade 10 CAPS document. For the purpose of this example, the focus will be on resistance within an electrical current.

In order to activate prior knowledge, the teacher could ask learners whether they use more electricity at home during winter or summer. When learners respond that they use more in winter, a follow-up question could be why this may be the case? If learners respond that it is due to the use of heaters, the teacher can introduce the concept of resistors. Before the concept can be taught, the word needs to be simplified in order to assist learners that might not be familiar with the term. This could be done by asking learners if the word sounds familiar and if it reminds them of another word, or of the same word in another context e.g. resistance training. The teacher can explain the different parts of speech, e.g. resistor as a noun but resistance as an adjective in resistance training. Once the basic understanding of the word is there, the teacher could give the definition of a resistor in the scientific context. This could be defined as a component within an electric current that resists the electrical stream in the circuit. The learners can now be challenged to use the new word in sentences of their own.

The teacher could then give a visual representation of a resistor within a circuit, by making use of an electrical diagram, as well as a basic circuit board. The combination of the two visual elements will assist learners with the identification of the different components within an electrical diagram. A basic diagram of resistors connected in series can be drawn, as seen in the figure below. The word 'series' could then be explained in the context of Physical Sciences, as it is also used in other disciplines, like when referring to a collection of books that follow on each other or in a real-life context such as watching series on television.

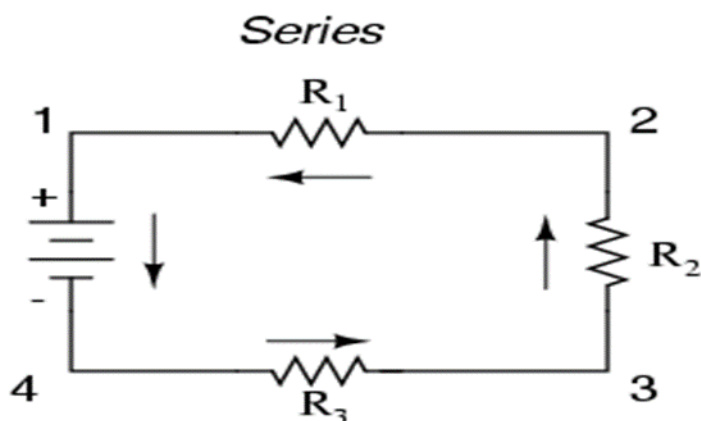


Figure 2-6: Electrical diagram of resistors in series.

(Source: https://www.ibiblio.org/kuphaldt/electricCircuits/DC/DC_5.html)

This diagram can then be built by using resistors, e.g. globes and batteries. Learners will be able to see the globes all light up as the electrical stream passes through them.

Once learners have a visual representation of the concept of resistors, the teacher can ask a variety of questions that assess the learners' ability to make inferences. This includes questions like: What will happen if one of the globes is removed? What will happen if there are too many globes in the stream?

Questions like the examples provided above will test the learners' ability to make logical inferences, as the stream will be broken and none of the globes will light up. The inference that learners therefore make is that, if a component within a series electrical connection breaks, the whole stream will break. Alternatively, if the resistance within a series connection is more than the power provided by the source (battery) the stream will also not function, as there is not enough energy.

The above example speaks to the use of some of the reading strategies within a Physical Sciences lesson. It is noteworthy that not all strategies will be utilised during all the lessons as it is dependent on the text and what is needed for comprehension. The use of the above reading strategies, namely prior knowledge, clarification of terms, visualisation and inference can then form the basis of comprehension with regard to this specific example.

2.8 CONCLUSION

As discussed in this chapter, there is concern about learners who struggle to read with comprehension in the Physical Sciences classroom. This problem is highlighted in various reports such as TIMMS and PIRLS, which show the poor reading and science performance of South

African students compared to their international counterparts. The chapter also showed the link between BICS, CALP and higher-order thinking. This link was shown in order to illustrate what is needed for comprehension, as well as factors that influence comprehension. The role of reading, whether for enjoyment or academic purposes, was also discussed in order to show how learners are exposed to reading and the demands made on them. This chapter explored the role of the mother tongue of a learner and how it is often a barrier to learning, as learners need to master a new language. Finally, a discussion on the various reading strategies, including vocabulary, was done to show how the implementation of reading strategies could improve reading comprehension.

Based on the given information, an inference can be made namely that strategies to promote reading for meaning must be explicitly taught by the teacher, whether in the content classroom or language classroom, to promote reading comprehension. Cekiso (2007:13) maintains that, “there is a growing consensus that reading comprehension improves when there is a greater awareness of reading strategies”. The role of the content teacher, in the case of this study, the Physical Sciences teacher, cannot be emphasised enough, as it is through the teacher that the learners become acquainted with the various strategies. According to Swanson *et al.* (2016:219), “teachers must maximize opportunities for text reading, vocabulary building, and improving comprehension in the core content areas in which text with varying structures and purposes for learning may be utilized”. It is with the guidance of the teacher that learners can practise and employ the different strategies to facilitate comprehension. The researcher acknowledges the fact that teachers cannot constantly teach reading strategies, as such an endeavour is time-consuming. However, a thorough and explicit introduction to such strategies and application at the beginning of the year, followed by constant modelling by the teacher, may prove to be successful in improving comprehension of texts in the Physical Sciences classroom. Learners may, after a period of induction and thorough modelling, start automatically employing these strategies.

The next chapter focuses on the methodology that was followed when conducting this research.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

This chapter seeks to outline the research design used during this study. It focuses on aspects such as participant selection, instrumentation and data analysis, as well as ethical considerations. These aspects are discussed in depth to provide a clear understanding of the research process.

3.2 DESIGN

This study aimed to research the utilisation of reading strategies by teachers of Physical Sciences in the FET phase (Grades 10-12). A qualitative approach was chosen because the researcher had come across a specific phenomenon, namely the use of reading strategies that promote reading with understanding in the Physical Sciences classroom, at a specific school. The aforementioned phenomenon was also researched by Martens (2014) and Cekiso (2007). Both authors found that the use of reading strategies could aid with the understanding of a given text. Their findings tie in with those of Klapwijk (2015), who advocates using reading strategies to aid learners with comprehension.

The study was qualitative in nature and focused on a single case in its natural setting. According to Baxter and Jack (2005:544), a qualitative case study is “an approach to research that facilitates exploration of a phenomenon within its context using a variety of sources”. Creswell and Poth (2017) add that a qualitative study involves the study of things in a natural setting and tries to interpret these to establish their meaning in the world. Yin (2002) agrees that a case study can be seen as an occurrence in a real-life setting. Hodkinson and Hodkinson (2001:3), who conducted an analysis of the strengths and weaknesses of a case study, argue that a case study creates a simplified space for the phenomenon to be investigated as a definite strength. They add that the weakness of a case study might be that limited data can be extracted, and that findings emanating from the analysis of data cannot be generalised. Since this study does not aim to generalise the findings, this weakness is not applicable. This study allowed for a more intimate interaction with participants during individual interviews and observations during lessons in their natural setting, namely the Physical Sciences school classroom.

This study focussed on reading strategies that might aid comprehension of subject-specific content in the Physical Sciences classroom. The design of this study was a single case study focusing on one school in the Gauteng province. It sought to observe teachers in the natural setting of the school classroom where learners are expected to make meaning of a variety of texts such as diagrams, sketches, and written text. I wished to establish whether the teacher

participants in the study paid any attention to equipping their learners with reading strategies for meaningful engagement with subject content and, if so, how they did this. Furthermore, I wished to gain understanding of the classroom setting and conditions. The research was conducted by following “logical sequences that connect the empirical data to a study’s initial research question and ultimately the conclusion” (Yarzan, 2015:144). By following this sequence, the validity of the data collection was increased due to the systematic gathering and evaluation process.

This study is underpinned by a social-constructivist world view. Social constructivism can be seen as an environment where the researcher seeks “understanding of the world in which he/she lives and works” (Creswell & Poth, 2017:327). This view relies heavily on the participants’ perspectives of the situation. For this study, the participants offered insight into the use, or the lack thereof, of reading strategies in the Physical Sciences classroom. The research tools were structured in such a way that insight could be gained into the real-life struggles of participants in ensuring the meaningful engagement of learners with subject content. Challenges and complexities, that might not have been identified by the participants, could be observed by the researcher during lesson observations. Furthermore, an interpretivist paradigm was followed.

An interpretivist paradigm involves seeking methods of research that enable the researcher to gain an in-depth understanding of the relationship between humans and their surroundings (Thanh & Thanh, 2015:26). With regard to this study, I sought to explore the extent to which Physical Sciences teachers employed/did not employ reading strategies when teaching, and whether learners were taught these strategies.

3.3 PARTICIPANT SELECTION

The participants were selected from one school in the Gauteng province in South Africa. The teachers all teach Physical Sciences in the FET (Grades 10-12) phase. This school was chosen because of the concern shared by the Physical Sciences teachers regarding learners’ lack of reading skills and poor performance in the subject. The teachers indicated that poor results had been obtained in Physical Sciences in the FET phase, at the end of the previous school year. They ascribed this to learners’ inability to read for meaning. Participant selection was also done based on the different topics that was identified and the limited time allowed by the school to complete the research.

Chapter 2 explored the fact that teachers and learners do not employ reading strategies. This highlighted the need for a better understanding and utilisation of reading strategies. The focus on Physical Sciences classrooms stemmed from the poor performance of South African learners in this subject, as pointed out by Baller *et al.* (2016) in their analysis of the South African basic

education system and how it compared internationally. The report entitled “The Global Information Technology”, compared the South African education system, and specifically the teaching of Mathematics and Science, with education systems across the globe. The report compared various aspects, such as performance in Mathematics and Science, as well as the quality of the education system as a whole. The South African education system was placed 137th out of 139 countries in terms of overall quality. Furthermore, South Africa was placed last when it came to the quality of Mathematics and Science teaching. Based on South African learners’ poor performance in international assessments, such as the global study referred to above and also the Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading and Literary Study (PIRLS), the Department of Basic Education identified the need to improve reading for meaning, especially in content classrooms where English as an additional language is used as the LoLT. In an effort to aid educators, the Manual for Teaching English Across the Curriculum (DBE, 2013), was published. The aim was to improve the quality of teaching.

The selection of participants included teachers who teach Physical Sciences in the FET phase. Devlin (2017:292) raises the concern that, if a study has only a small number of participants, this could result in the problem not being solved. The aim of the study, however, was not to solve the problem but rather to highlight it and provide recommendations which might be conducive to a better understanding of the problem in the long run. The current study was limited to one school in the Gauteng province. Therefore, findings from the study cannot be generalised to include all Physical Sciences classes, as the study was limited to a certain geographical area and did not include teachers with varied qualifications and years of experience. However, generalisation of a case study does not speak to a universal generalisation but rather to a theoretical one (Yin, 2009:15). In other words, by investigating a case study intensively using a variety of data-collection tools, a theoretical generalisation was done for this study. No attention was given to different levels of teacher qualifications or years of experience. The limitations of this single case study could be overcome should further studies expand the geographical area and include teachers with varied qualifications and years of experience, among other variables which could have an influence on the findings.

Devlin (2017:292) defines a subject pool as “individuals who have agreed to serve as participants for research”. The participants of this study were chosen based on one criterion: whether they taught Physical Sciences in the FET phase. Three participants teaching Physical Sciences at the same school were selected for this study. These teachers were also the only ones teaching Physical Sciences at this specific school. The participants were recruited by making use of a third party who acted as a mediator between the researcher and potential participants. The participants were made aware of the aims of the study, which would focus on reading strategies in the Physical

Sciences classroom. The only exclusion criterion was that the study would only involve teachers who taught Physical Sciences through medium of English in the FET phase at the specific school. Although age, gender, years of teaching and linguistic ability were not part of the inclusion criteria, it could be of interest to include these biographical details in the study, as these add context. As seen in the table below, the participants vary in years of teaching experience, gender, age, and linguistic ability

Table 3.1: Illustration of the diversity of participants with regard to the above-mentioned categories.

Participant	Age	Gender	Years teaching experience	Linguistic ability (As per participant)	Linguistic ability (As per observation)
A	29	F	6	Very Good	Good
B	51	F	17	Good	Good
C	43	M	12	Good	Good

3.4 INSTRUMENTATION AND DATA COLLECTION

This study made use of interviews, document analysis, and observations as instruments for data collection. Each of these instruments was used to triangulate the findings of the study and therefore add to the validity of the results.

Firstly, five lessons of each participating Physical Sciences teacher were observed. Observation is “a form of data gathering in which the observer(s) collect(s) information through the senses, primarily visual” (Devlin, 2017:197). These primarily visual observations allowed the researcher, aligned with Maxwell’s (2012:76) statement, to make inferences regarding different perspectives of the participants and to obtain information regarding behaviour and events that occurred in the natural classroom setting. Devlin (2017:197) refers to the observation of participants in their natural environment as “naturalistic observation”, and he further asserts that observation comprises of stimulus as well as prior experiences of the researcher. Since these prior experiences could lead to bias, I needed to be mindful of any preconceived notions during observations. It was important to remain mindful of what was to be observed; in this case whether any reading strategies were taught and/or implemented by the teacher – and, if so, how it was done. A baseline observation sheet was used. This sheet was designed to focus on reading strategies and language teaching across the curriculum. Selecting the most suitable lessons for observation was also important, as active teaching does not necessarily happen in all instances. The unpredictability of schools in terms of changes in timetables or lessons also needed to be

taken into consideration. Due to this, the initial time period allocated for lesson observations had to be extended to ensure that useful data could be collected.

Secondly, document analyses were done of the following documents: The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences in the Further Education and Training (FET) phase (Grades 10-12), two lesson plans for Gr 10 provided to teachers who teach Physical Sciences in the FET phase, as well as the DBE's Manual for Teaching English Across the Curriculum. According to Bowen (2009), document analysis can be defined as "a systematic procedure for reviewing or evaluating documents". This systematic evaluation enables the researcher to examine a document to derive meaning and therefore gain empirical knowledge (Bowen, 2009:27). Document analysis involves the evaluation of texts and figures that cannot be influenced or altered by the researcher. One of the roles of document analysis in qualitative research is to triangulate the study. The analysis of the Physical Sciences FET CAPS document, lesson plans, as well as the Manual for Teaching English across the Curriculum was done in order to ascertain to what extent teachers were guided and supported to assist learners with reading in the Physical Sciences classroom. Guidance and support offered by the Physical Sciences FET CAPS document and/or the Manual for Teaching English across the Curriculum could affect Physical Sciences teachers' perception of whether they felt equipped to plan for and teach reading strategies explicitly in their classrooms. An analysis of two lesson plans provided was done to establish to what extent the lessons are structured to allow for the teaching of language and reading strategies. It also showed the development of the lesson and what the main focus was of each phase. The lesson plan also provides insight into time allocation for teaching language and reading in the Physical Sciences classroom.

According to Bowen (2009), "Document analysis yields data – excerpts, quotations, or entire passages – that are then organised into major themes, categories and case examples." Yin (1994) also argues that a document analysis is characteristic of qualitative research, as it provides a great representation of information. The focus of the document analysis was to determine whether the CAPS for Physical Sciences in the FET phase dealt with the reading of subject content in any way; whether the Physical Sciences teachers planned for language teaching, specifically reading skills in the content area in their lesson plans — and whether the Manual for Teaching English across the Curriculum, issued by the DBE to assist content teachers to bridge possible language in teaching and learning, attended to reading strategies.

Thirdly, a semi-structured interview was used, as it is one of the most common techniques utilised for qualitative research and has the benefit of being flexible and versatile (Kallio *et al.*, 2016:2957). Devlin (2017:216) states that such interviews may be conducted successfully if they are set up in such a way that they allow for adaptation and follow-up questions. For this study, the interview

questions were set up to allow for adaptation and the framing of follow-up questions to suit each situation. One-on-one interviews were conducted to determine how equipped the teachers felt to teach reading strategies in their classrooms and to gain a deeper understanding of what happens naturally in each participant's Physical Sciences classroom. This was done to accommodate the participants and not inconvenience them by requiring them travel to another location. I did not opt for focus group interviews because the aim of gaining deeper understanding of each participant's unique situation might have been jeopardised in a group. A participant might not have had the confidence to give an answer that would be truly reflective of his/her opinion. Some participants might also have dominated the discussions. Each one-on-one interview was approximately 45 minutes long and was recorded on an audio recorder. I transcribed the recordings verbatim. The questions focused on the Physical Sciences teachers' knowledge of language structures as well as their use of language when teaching Physical Sciences through medium of English. I also endeavoured to establish to what extent Physical Sciences teachers were aware of reading strategies and how they used them in their classrooms. This study did not make use of questionnaires, as these are primarily used in quantitative research. Questionnaires can contain both open-ended and closed-ended questions. Due to the fact that questionnaires lend themselves primarily to closed-ended questions, these were not utilised. This study aimed to illicit a response from the participants that was more in-depth and not merely a "yes" or "no" response without qualifying why the participants answered in a specific manner.

3.5 DATA ANALYSIS

Creswell and Poth (2017:186) see data analysis as a process that "consists of preparing and organising data for analysis; then reducing the data into themes through a process of coding and condensing the codes; and finally representing data in figures, tables or a discussion". Themes such as the implementation of reading strategies and the use of vocabulary skills were identified (relating to reading strategies and the use of these strategies by Physical Sciences teachers). The data collected need to be managed and organised to aid effective analysis. The organisation of data ultimately needs to lead to the sorting and long-term storing of relevant data which will then be used to draw up conclusions (Creswell & Poth, 2017:186).

Data collection for this study was done by first observing the participants who taught Physical Sciences through medium of English in Grade 11, then followed by one-on-one interviews and, finally, analysing the documents. The reason for this was to keep the observations as neutral as possible so as not to taint the findings in the event that participants might change their approach based on questions asked during the interview. Each interview and observation were analysed separately, before combining the data in order to find similarities.

After data had been organised, extensive reading of the data took place. Creswell and Poth (2017) state that readers should immerse themselves in the data to gain knowledge. Note-taking was found to be an effective tool during both the observations and the one-on-one interviews, as it helped me to focus on what naturally happened in the classroom setting and on what participants shared during the interviews – and, in addition also helped to order thoughts on what was observed and heard. The observation sheet was designed in such a way that it allowed for additional notetaking to collect as much data as possible. These notes recorded observations, such as the teacher walking around in the class assisting learners with the various chemical equations. By reviewing these notes, I was able to describe and classify codes into themes, such as the language awareness shown by the teachers during the lessons. Coding and classification into themes are regarded as the essence of qualitative research. Creswell and Poth (2017:190) explain that “coding involves aggregating the text or visual data into small categories of information, seeking evidence for the code from different databases being used in a study and then assigning a label to the code”. Selective coding was used as “categories are organised around a central explanatory concept” (Blair, 2015:18). An example of data that were analysed in this study was the identification of reading strategies used during the observations.

The coding for this study could be done by the researcher, since the sample was small. Due to the fact that the researcher is not *au fait* with computerised coding, a more hands-on approach was opted for. Themes were identified and this allowed me to place the various data into groupings that had the same theme, e.g. language training that Physical Sciences teachers received. This allowed me to form a ‘central explanatory concept’ of reading in the Physical Sciences classroom (Blair, 2015:18). The central concept of reading focused on in this study can be explained as the use of reading strategies in the Physical Sciences classroom and how these were transferred to the learners (specifically reading strategies as mentioned in Chapter 2) and language teaching in the Physical Sciences classroom to aid learners’ meaningful engagement with subject content. Coding during the document analysis focussed on aspects of reading and language, such as prior knowledge and word recognition. This was carried through to the observations where the observations of each participant were analysed individually before compiling a composite report. The same steps were followed when the interviews were analysed. The common themes (e.g. vocabulary, visualising), relating to reading strategies were identified during the individual interviews and later summed up according to similarities and differences among the participants.

Coding was followed by the classification of information. This process involved sorting data into themes and categories (Creswell & Poth, 2017:194). The classification of information under

specific themes, which centred around reading strategies and content-specific language teaching in the Physical Sciences classroom, enabled the researcher to see patterns in the research.

Sorting data into themes and categories led to the interpretation of themes and information that had been gathered. According to Creswell and Poth (2017:195), one needs to make use of creative and critical faculties to make sense of information. Making sense of information also includes linking interpretations to the larger body of research already conducted by other researchers. As a result of creative and critical engagement with data and the existing body of research, information could be interpreted, and I was able to represent the results of the study in a variety of ways.

Data can be represented by using text, tables or figures. The combination of these representations leads to a better understanding of the findings. Consequently, I revisited the research question and the available data in order to choose the best combination to represent the findings (Creswell & Poth, 2017:197). In accordance with Creswell and Poth's (2017:197) suggestion that the text used to represent data should be revisited to verify whether or not the conclusions were valid, I engaged in revisiting. By reporting on the findings of this study, I wish to improve teachers' understanding of reading strategies in the Physical Sciences classroom and the importance of attending to subject-specific language teaching. Furthermore, it is hoped that this study could serve as a basis for further studies regarding content-specific reading strategies and language teaching to aid learners' meaningful engagement with subject content.

3.6 ETHICAL CONSIDERATIONS

The ethical aspects of research should be an important consideration for every researcher, as it is vital that participants are protected against harm. The involvement of other individuals calls for the researcher to act in a manner that will cause the least disruption or discomfort. Due to unethical research done in the past, the Nuremberg Code was developed. This code clearly states that participants should give their consent voluntarily, results must be beneficial to society, no unnecessary mental or physical harm must be done, and subjects have the right to withdraw from the study at any time (Devlin, 2017:107). To ensure that all ethical codes were adhered to, I familiarised myself with the ethical code of conduct of the North-West University. I also obtained ethical clearance to conduct the study from the NWU-EMELTEN-REC (Annexure A). With the Nuremberg Code in mind, I obtained informed consent from all participants through a third party. This independent person explained the research to the participants, after which I was available to clarify all additional questions from the participants. They were also informed that, should they choose to withdraw from the study, they would not need to provide any reasons for such a

decision, and it would not be held against them. I endeavoured to be as unobtrusive as possible so as not to cause any unnecessary discomfort.

As this study was conducted at a school in Gauteng, permission was sought from the relevant authorities, namely the Gauteng Department of Education (Annexure B). Even though the learners were not the focus of the study, they were present in the class in the peripheral. Thus, permission from the parents was sought (Annexure C). Learners were also given an assent letter (Annexure D), as they were present in class when the study was done, although not directly involved.

Research from other individuals and entities was used, as the study includes insights and findings from primary and secondary sources. These sources were credited in the bibliography as well as in the text in order to acknowledge the ideas of other researchers.

3.7 TRUSTWORTHINESS

In order for the study to be trustworthy, it needed to adhere to the criteria of confirmability, dependability, credibility and transferability (Schwandt *et al.*, 2007:18). Credibility was ensured because of prolonged engagement, persistent observation and triangulation. Five lessons of each participant were observed in order to fully understand the natural setting of each Physical Sciences classroom and the academic climate in which teaching took place. Triangulation of the study was secured by conducting observations, interviews, and document analyses.

This study adhered to the criterion of credibility as set out by Schwandt *et al.* (2007:18-19), as there was intensive contact with the participants, not only through observations but also through interviews. The intensive contact with participants was important for credibility as it allowed the researcher to develop a trusting relationship with the participants, which aided the understanding of core issues that could affect the data (Anney, 2014:276). The triangulation of this study was used to ensure that the researcher remained objective during the data-collection and analysis processes. Triangulation allowed for the cross-examination of evidence because data collected during each method (document analysis, observation and interviews) were used to test the credibility of the different methods.

Apart from credibility, the study adhered to the criterion of dependability. Kortsjens and Moser (2018:121) argued that dependability can be seen as supporting hypotheses by using collected data that have specific bearing on the hypothesis. This study ensured dependability as recommendations were made by considering the data that had been collected during the study. Anney (2014:279) states that the use of coding to track similarities in data adds to dependability. In this study, coding focussed on reading strategies and how these were used by the Physical

Sciences teachers in their classrooms. The author also argues that the use of peer examination adds to the dependability of a study as it allows for input from a neutral source (Anney, 2014:280). This was achieved during the study when information collected and analysed was discussed with mentors from the North-West University Education Faculty to get a neutral opinion on the effectiveness of the data collection.

Another criterion for trustworthiness is transferability. Schwandt *et al.* (2007) listed transferability as a criterion for trustworthiness. Transferability refers to the degree or fit or similarity that may be made by others who may apply all or part of the findings of any particular study elsewhere (Schwandt *et al.*, 2007:19). Anney (2014:278) agrees that transferability means that findings can be applied in another context and not just the one in which it was researched. In terms of this study, the findings could be transferred to other content subjects that are taught through medium of English. The use of reading strategies in content classrooms is not limited to the Physical Sciences classroom. Confirmability was obtained through the correlation of data gathered during observations, interviews, and document analysis. It showed a correlation between the literature, as discussed in Chapter 2 of this study, regarding reading strategies and the use of these to aid comprehension. This correlation was the focus of this study as it investigated the use of reading strategies in the Physical Sciences classroom where teaching takes place through medium of English.

3.8 CONCLUSION

This chapter outlined the use of a qualitative research approach. The justification for using this approach was provided: that is, the study sought to understand the use of reading strategies in the Physical Sciences classroom. The use of a single case study was also explained, as were the characteristics of the study. In this chapter, a clear understanding of the research instruments, namely document analysis, observations, and interviews, was given. Justification of these methods was provided, as well as the means through which the data were captured and analysed. This included coding and identification of similarities and differences found during the different data-collection methods with regard to reading strategies and how these were used in the Physical Sciences classroom. Due to the fact that the research involved human participants, ethical considerations were applied. These included informed consent from the participants, and participants had the option of not taking part in the study or withdrawing at any stage if so desired. The ethical considerations were also explained as well as the need for informed consent from all parties concerned. The authenticity and validity of the study were also outlined to ensure that the findings of the study would be viewed as credible and valuable in the academic community.

Chapter 4 provides an in-depth analysis of the data that were collected and how the data were analysed and used to answer the research questions. It also unpacks the findings of each data-collection instrument, which is presented in terms of similar themes that were identified.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

In this chapter I seek to summarise themes and findings that emerged from this study. Firstly, the themes observed during the observation lessons are discussed. This is followed by an analysis of the interviews, highlighting themes in common with those found in the observations. Although the observations and interviews are discussed separately, the findings are integrated, since common themes emerged from the data. For the purposes of this chapter, all participants will be referred to as “he” (that is, without the pronoun being indicative of gender). The following documents will be referred to:

- Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences in the Further Education and Training (FET) phase (Grades 10-12) (“the CAPS document”),
- Lesson plans for Gr 10 provided to teachers who teach Physical Sciences in the FET phase (“lesson plans”); and
- Manual for Teaching English Across the Curriculum (DBE, 2013) (“the Manual”).

4.2 FINDINGS BASED ON CLASSROOM OBSERVATIONS

Observations of five lessons of each of the participants (Addendum A) were conducted with specific focus on the participants’ use of reading strategies. It was noted that in some cases the participants made use of reading strategies such as questioning and visualisation; however, there was often no explicit teaching of these reading strategies. Learners were not made aware of these strategies and how these could aid them in understanding unfamiliar concepts or in decoding different texts. The following section provides insight into the findings of the observations. I discuss each participant separately before I offer a composite summary of the findings in terms of all three participants. The findings for each participant are discussed in terms of implementation and teaching of reading strategies, teaching of language concepts and structures, and proficiency in English as medium of instruction.

4.2.1 Participant A’s implementation and teaching of reading strategies.

Participant A made use of the following reading strategies or implemented certain strategies in every lesson, while others were used only once or twice. Although some reading strategies were used, they were not explicitly taught to learners, as seen in the graph at figure 4.1.

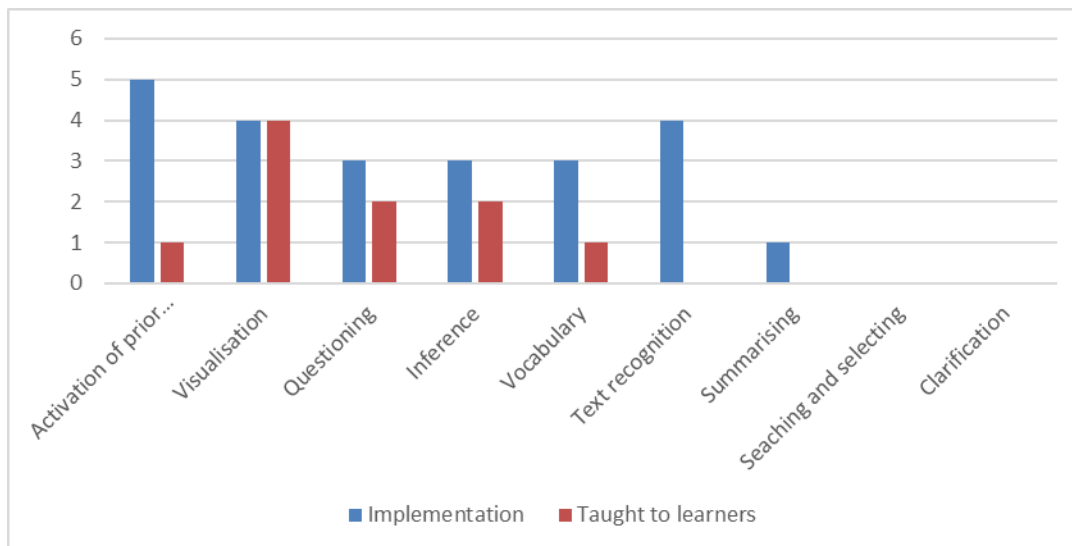


Figure 4-1: Graph of the implementation and teaching of reading strategies.

As seen in the graph, the participant made use of seven of the nine reading strategies that I set out to observe. The most common strategies used were the activation of prior knowledge and visualising – these strategies were used in four out of five lessons. With regard to the activation of prior knowledge, the teacher referred to it at the start of each lesson (e.g. the different types of forces). This was used to introduce Newton’s laws and diagrams. Unfortunately, most of the time, the teacher provided the prior knowledge without allowing learners to think aloud and verbalise their existing understanding of the topic so that they could establish links with the new text and construct meaning from it. This could be problematic as the assumption is made that all learners had mastered the previous knowledge and could use it as a foundation for new knowledge building. Another aspect of the activation of prior knowledge that was absent was the ability to link what the learners had already learned to their own real-life environment. If this is not done, the learners are unable to make their own connections between previous knowledge and the new content. This strategy was only taught on one occasion and in a superficial manner that did not aid learners with comprehension.

A strategy that was used to good effect was visualising. The participant made use of visual examples and asked learners to draw a visual representation of their answer, during one of the lessons that I observed. By asking the learners to apply knowledge in a visual manner, the participant made it easier for learners to express their understanding. The participant asked the learners to create a cartoon about the effects of deforestation. This allowed learners to visually represent the effects of deforestation by incorporating scientific elements to explain the concept. Another instance where visualising was used effectively was when the participant drew a graph indicating force relating to Newton’s laws. Learners were asked to visualise themselves on an escalator and then describe the different forces present. Learners were able to identify the different forces and explain them in terms of moving up and down the escalator. The use of

visualisation was by far the most effective strategy, since after the conclusion of the activity, learners showed a better understanding when responding to questions and they were able to explain the concepts better.

Strategies that were used fairly regularly included questioning, inferring, teaching subject-specific vocabulary and text recognition. These strategies were used, but not always explicitly taught to learners to enable application. Participant A made use of a variety of questions. These questions included questions that assessed understanding, e.g., “Why does deforestation happen?” Some learners were not able to provide a reason for deforestation and the participant asked them to provide a definition for deforestation, in an attempt to enhance their understanding. Higher-order questions were also asked, e.g., “What are the economic implications of deforestation?” Learners had to apply not only their knowledge on deforestation but also what they knew about the economy. In some instances, the questions required simple recall and did not allow for higher-order thinking, but rather basic yes/no answers. This can be problematic as expository texts demand higher-order thinking to facilitate learning. In some instances, the questions received a choir-like response, where learners would all give a very basic answer, either based on their remembering skills or portraying limited understanding. However, the participant used questioning to activate prior knowledge and to a lesser extent allowed learner to make inferences. Learners were also asked to self-question to assist with understanding. In one instance, the participant presented a diagram and asked the learners to come up with possible questions and answers regarding the components of the diagram, such as the position of the ball and the different forces that are present. Learners were then asked to explain the different forces and how they would influence the movement of the components. This allowed for self-questioning to happen.

Another reading strategy that was observed, but not explicitly taught, was inference. The participant mainly used this strategy himself without assisting learners in employing it. The participant would make the connections instead of challenging the learners to engage on higher cognitive levels. An example of this was when the participant explained different forces and gave his own examples –instead of asking learners to come up with examples based on real-life examples of how these forces manifest and what the effect is of each of them. The participant facilitated an opportunity for learners to critically engage when they were requested to make inferences based on the financial gains versus the environmental impact of mining. However, the skill to infer was not explicitly taught and practised by the learners in a follow-up exercise in the context of the Physical Sciences classroom. The impression was created that it could only happen with guidance from the participant.

The teaching of subject-specific vocabulary was done by providing definitions of words. The participant attempted to assist learners in understanding certain terms by making use of

synonyms. Unfortunately, learners were often given just the dictionary definition without being provided with a learner-friendly explanation. However, the participant attempted to help learners remember terms by making use of rhymes. The danger here is mechanical memorisation and eventual regurgitation of facts instead of critical engagement and deep understanding. The focus of these rhymes is on short-term recall. The participant encouraged learners to make use of the correct terminology when describing actions that were taking place. This allowed learners to practise using terms in context. Apart from the teaching of subject-specific vocabulary, attention was also given to aspects of text recognition during the observation of participant A's lessons.

The participant would teach the different components within a given text by explaining what a sketch should look like with the x and y axis and why each axis is important. Learners were then expected to answer questions using the diagram as the primary source of information. The information that learners got from the graph was then transferred to written text, as learners had to explain the movement that occurs on the x and y axis. Apart from a graph, the participant also explained the components of a chemical reaction. He explained that the reactants were written on the left, with the product on the right.

Other reading strategies that were either underutilised or not used at all include clarification, searching and selecting, and summarising. Clarification of concepts and terms was not always done effectively by this participant. He gave the definition without clarifying the meaning to assist learners with comprehension. When learners did not understand, the participant only referred them back to the definition, assuming that they understood the definition. This led to some learners not being able to apply concepts, for example Newton's laws. Learners were not taught to seek clarification of concepts or terms that they did not understand, in order to facilitate comprehension. The participant superficially went over terms without truly clarifying possible misunderstandings, e.g., vectors were just defined without attempting to clarify the elements of the concept that the learners did not understand.

Another strategy that was underutilised was searching and selecting. This is an important strategy because it teaches learners to make use of specific information in order to solve any given problem. Learners must be able to search for the relevant information and select what is needed to answer the question – and in doing so demonstrate understanding of the topic. Learners were asked to answer questions that entailed selecting information from a diagram. However, they were not taught to make use of searching and selecting as a reading strategy. Most learners were successful; however, there were some who struggled to select the correct information, which led to them misunderstanding and incorrectly answering the question. Unfortunately, the participant did not assist those learners with identifying and selecting the correct information to answer the

given question. For the most part, learners were able to search for the answers by looking at both written and visual texts, although they were not aware that they were using this strategy.

Summarising was also not used effectively. The participant summarised the order in which questions should be answered, and learners were not given the opportunity to summarise information for themselves. The lack of summarising affected the understanding of concepts, as learners were not challenged to put what they had learned into their own words. The ability to describe concepts and information in their own words assists learners, as they learn to identify the gist and verbalise their own understanding. The ability to summarise new knowledge is an indicator of true comprehension. This ability also depends on the learner's vocabulary. Unfortunately, learners often lack the needed vocabulary to explain a concept in their own words.

Participant A attempted to create an atmosphere conducive to learning by having relevant subject-related content displayed on posters on the classroom walls. This was effectively used to assist learners when they struggled to visualise a concept. Definitions were also displayed, which acted as reminders to learners who might have forgotten the definitions. PowerPoint presentations, as well as videos were used to explain and visually represent concepts. Participant A showed a video about gold mining to teach learners the processes involved in unearthing gold and how it is processed. This allowed learners, who would otherwise have no frame of reference, to visually witness the process of gold mining and processing. The participant was proficient in the verbal use of English and made only minor grammatical errors and redundancies in sentence constructions. He was able to introduce and maintain social interaction by using English, such as greeting the learners and asking questions to determine how they were, and to effectively use English as a medium of instruction.

4.2.2 Participant A's teaching of language concepts and structures

No explicit teaching of language concepts by the participant was observed. No activities bore witness to the implementation of word-attacking skills which could have aided learners in understanding concepts, such as vectors. No attention was paid to prefixes, suffixes, or root words. The word "vector" was used, and the assumption was that all learners understood the word. The prefix "vect" could have been explained as "the ability to carry/move". This links to the definition of a vector, which has direction and magnitude. By syllabifying the word, the participant could have made it easier for the learners to link the definition to the word. The lack of comprehension was seen in the responses of the learners, as the participant had to constantly provide the definition of vectors and scalars. This showed that the learners were unable to link the word to the definition, or to make sense of what could be deemed a complicated definition. The participant did not syllabify words to identify the root of the word to assist learners with

understanding not just the definition, but also the word itself. This was seen in the term “deforestation” that could have been broken down to assist learners with the understanding of the word so that they could make sense of the definition.

4.2.3 Participant A’s proficiency in English as medium of instruction

The participant displayed adequate proficiency to teach and communicate using English as medium of instruction. Although there were some lapses in pronunciation, tenses, and sentence construction, it did not necessarily impede the ability of the learners to understand what the participant was saying. An example of this is when the participant used the phrase “could have did” instead of “could have done”. The participant also guided learners in using the correct format when writing an essay in response to an equation (for example, Newton’s law and how it is used in airbags), by stating that it is a formal piece of writing that should have the correct tense and sentence construction. That having been said, the participant did not attempt to correct learners when they used incorrect language or pronunciation of words. It was uncertain whether the participant did not correct the learners because he did not want to embarrass or interrupt the learners, or whether the participant did not notice the error himself. The incorrect use of language by learners could affect communication regarding scientific concepts.

4.2.4 Participant B’s implementation and teaching of reading strategies.

Participant B’s lessons yielded different results regarding reading strategies and the explicit teaching of these strategies. Similar to participant A, participant B favoured certain strategies, with some not being used at all. Participant B’s teaching approach differed from participant A’s. He made use of the activation of prior knowledge, questioning, visualising, and teaching subject-specific vocabulary. The use of the different reading strategies and the explicit teaching of these strategies are presented in figure 4.2.

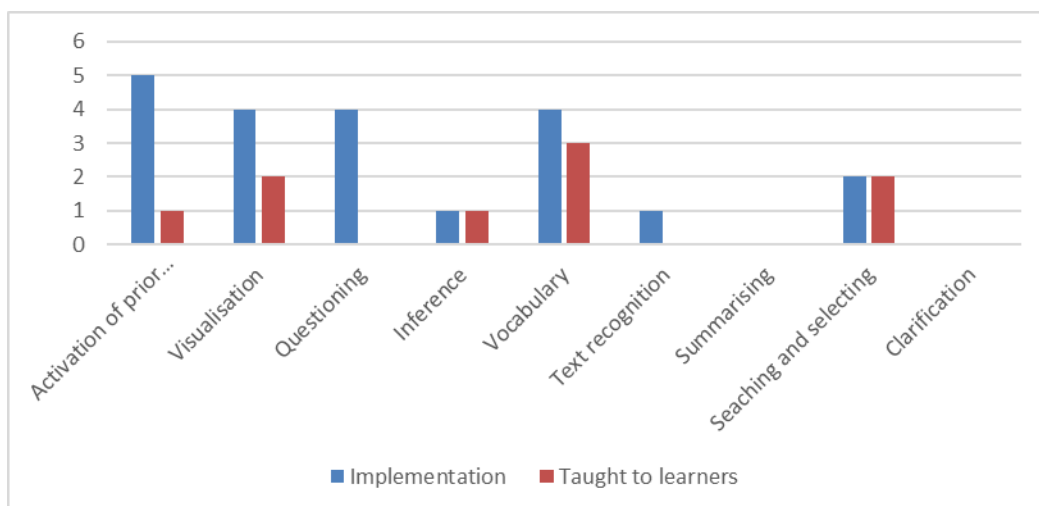


Figure 4-2: Graph of the implementation and teaching of reading strategies.

The participant activated learners' prior knowledge by asking questions that depended on previously learned concepts, such as the movement of an object.

Some learners portrayed a lack of prior knowledge, as they struggled to answer questions on the completed unit of work. The participant made no effort in clearing up misunderstandings and in linking prior knowledge to the new unit, which made it difficult for the learners to find a starting point which would have allowed them to engage effectively with the given activity regarding displacement. In most instances, the participant would refer superficially to previous content, without assessing and assuring understanding. In one instance, the participant merely reminded the students what "rest position" was, instead of allowing the learners to express their understanding of the concept so that he could clear up any misunderstanding.

Questioning was used more effectively than the activation of prior knowledge. Although most of the questions were posted on the lower levels of Bloom's taxonomy (remembering and understanding), the participant was able, on some occasions, to develop the simple questions into more complex ones, e.g., "How does calculate acceleration?" On several occasions the questions required learners to apply prior knowledge as well as to demonstrate new knowledge. Learners were asked to provide a definition for acceleration and, after providing their definitions, they were asked to apply the definition in order to solve an equation. The participant also assisted learners with the phrasing of questions and illustrated how different words like 'explain' as opposed to 'discuss' or 'evaluate' influenced the answer that learners should give. The participant answered learners' questions by providing practical and visual examples to explain acceleration. A question was asked about acceleration and the participant dropped a pencil to illustrate the concept. Participant B also used diagrams to visually explain concepts. By visualising the concepts, learners were assisted in gaining better understanding.

Participant B often made use of visualisation. He would visually illustrate concepts by using relevant examples. One of the examples he used was when he asked individual learners to explain what route they took from home to school. Taking into account learners' explanations, the participant drew diagrams and sketches on the board to explain calculations; this allowed him to explain the concept of distance. Unfortunately, he did not ask learners to create their own visual representation of the concept, which meant that the lesson fell short of giving the learners an opportunity to apply knowledge and demonstrate understanding. Participant B used a variety of objects to show the difference between "distance" and "displacement". He used the objects in different ways to ensure learners' conceptual understanding and their ability to link scientific knowledge to their real lives.

Participant B underutilised reading strategies like inferencing, clarification, searching and selecting, summarising and text recognition. Although he attempted to clarify terms, there was no explicit teaching of any strategy to equip learners. Clarification was limited to distinguishing between concepts and the application of formulae to solve equations. The participant did not facilitate the use of inferences and, as a result, learners were not always able to draw links among different concepts in order to derive meaning. The lack of inference was seen when learners were unable to apply a formula previously learnt to solve an equation about speed versus velocity. Learners were unable to distinguish between speed and velocity and they made the wrong connections in terms of applying the formula because they connected the formula to speed and not velocity.

Furthermore, learners struggled to extract information from a given sketch, as they were unable to search for and select the relevant information to solve the problem. The inability of learners to search for and select relevant information was seen when they responded to questions posed by the participant. Learners provided answers that contained irrelevant information and caused confusion when calculations were done. Another strategy that was not fully utilised was text recognition. On various occasions the participant made use of sketches, diagrams, and formulae to explain concepts. However, he did not break down the different components in order to simplify the text for the learners. The participant assumed all learners understood the text construction of a diagram as well as the position of the different components, such as speed, time, and distance within a formula. See the example given in figure 4.3

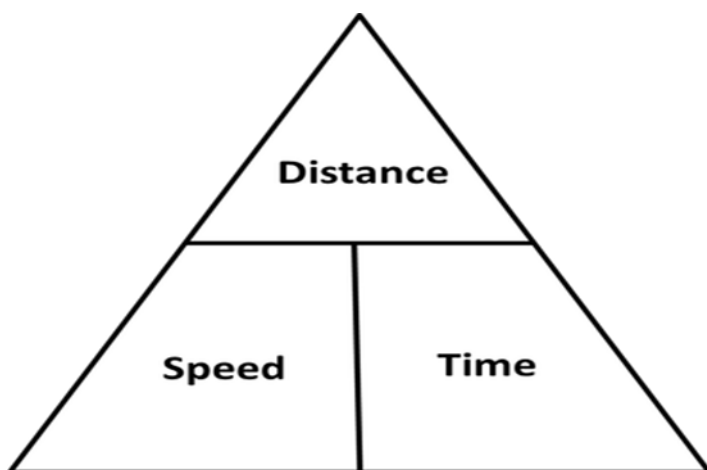


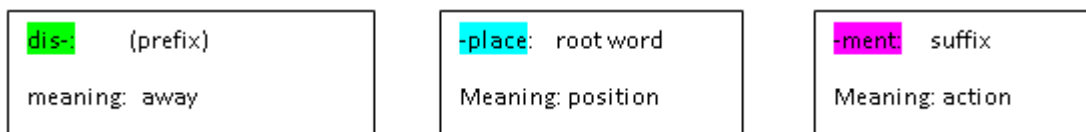
Figure 4-3: Distance triangle.

The participant did not explain how each component is calculated, and how the triangle is used to do so. Some learners did not use the triangle correctly and multiplied numbers when they were supposed to divide. There was also confusion between speed and velocity and as a result some learners referred to the wrong concept when calculating.

Participant B did not make use of summarising as a reading strategy. Learners were not asked to use their own words when talking about concepts or when indicating important aspects of newly acquired concepts. No summarising was done by the participant in an effort to extract important information to aid comprehension.

4.2.5 Participant B's teaching of language concepts and structures

Participant B paid little attention to the explicit teaching of subject-specific vocabulary, concepts, and English-language structures that are commonly used in Physical Sciences. No word-attacking skills were employed. The participant only focused on the meaning of words and concepts in Physical Sciences. Words were not syllabicated to foster understanding. The definitions that the participant provided were subject specific; they were never simplified by looking at the linguistic meaning behind the words. In other words, the definitions were also not learner friendly. An example of a definition that was used concerned the word 'displacement'. The participant defined displacement as "a change in position with respect to the starting point". The participant could have syllabicated the word 'displacement', as seen below, in order to create a link between the definition and the composition of the word.



In an attempt to assist learners with the visualisation of concepts, the participant used the example of the different routes from school to the learner's house, to explain the difference between "distance" and "displacement" (distance being the actual route and displacement the direct route). Unfortunately, some learners still struggled as they did not understand the difference between the two concepts – and the participant only gave the scientific definition to the learners without assisting them with comprehending these concepts through learner-friendly definitions. The participant could have syllabicated each word to show the morphology of the words in terms of roots and affixes to determine meaning.

4.2.6 Participant B's proficiency in English as medium of instruction

The participant was able to communicate effectively using English as medium of instruction. There were some instances where the participant did not pronounce the terms correctly, which could cause confusion. This was seen in the pronunciation of the word "axis" (which was pronounced as "access") when the participant explained a diagram. This mispronunciation could hinder learners' understanding. The teacher showed awareness of sentence construction when he corrected learners when subjects and objects were incorrectly used in sentences. This having

been said, the participant only pointed out what the subject and object were, without explaining the position of each in the sentence. By not offering any explanation, learners could possibly make the same mistakes, because they were not told how to identify subjects and objects in sentences. As a whole, the participant was able to convey the information effectively to the learners and communicate on a level that was easily accessible to the learners, which aided comprehension.

4.2.7 Participant C's implementation and teaching of reading strategies.

During the lessons observed, Participant C utilised most of the reading strategies suggested by McEwan. He used eight of the reading strategies; however, he did not explicitly teach these strategies to learners. Participant C's implementation and teaching of the various reading strategies is represented in figure 4.4 below.

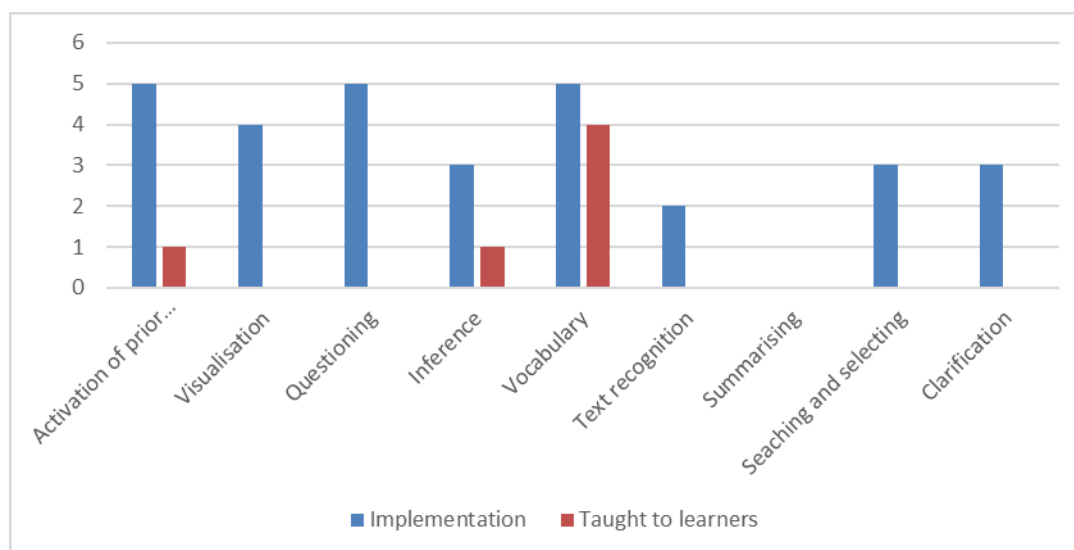


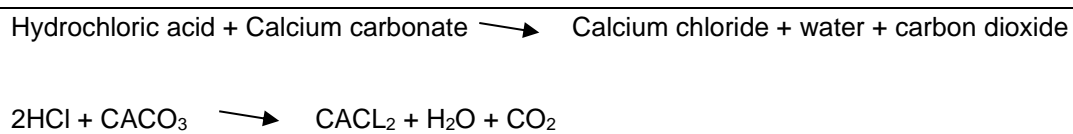
Figure 4-4: Graph of the implementation and teaching of reading strategies.

As seen in the graph, participant C used most of the strategies effectively, such as activating prior knowledge, inferring, clarification, questioning, searching/selecting, and visualising.

With regard to the activation of prior knowledge, participant C attempted to activate prior knowledge during all the observed lessons – but did not teach this strategy directly to learners. The participant briefly referred to work that had been previously covered. By not allowing and guiding learners to make their own links, based on their own experiences, the learners are unable to make the connection between real life and the content. When learners are explicitly asked questions about their prior knowledge, they are able to verbalise what they already know and how that may apply to the new content. Only on one occasion did the participant ask questions that linked to prior knowledge. The questions were asked in order to activate prior knowledge pertaining to chemical elements. This knowledge was used later in the lesson to solve chemical

equations. Unfortunately, some of the learners could not remember the difference between a weak and a strong base. The participant did not assist learners in understanding by using prior knowledge; he resorted to mechanically stating the difference between a weak and a strong base. During another lesson pertaining to chemical equations, learners had to use prior knowledge to solve the given problems, such as balancing the equations. On this occasion, the participant moved around among the learners, assisting them in activating their prior knowledge by reminding them what had previously been discussed.

Participant C also made use of inferences during lessons. Inferring was mainly seen in lessons that involved chemical equations. The participant taught inferences to learners on one occasion when he asked learners to explain why a certain element has a specific position on the periodic table. Learners had to state what the position of the element implies about the reactivity and composition of the element. However, in some lessons, the participant made the inferences for the learners, instead of allowing them to do so on their own. During the lesson, when the participant asked learners to make their own inferences, they made use of the following chemical equation.



Observations (2020)

The learners were asked to state why salt (CaCl_2), water (H_2O) and carbon dioxide (CO_2) formed. Learners stated that it formed because an acid and a base were combined – the acid being hydrochloric acid (HCl) and the base being calcium carbonate (CaCO_3). The participant explained to the learners that the combination of an acid and a base made up of carbonate would always give a salt, water, and carbon dioxide. Furthermore, the participant asked the learners where calcium chloride would be used in the real world. Learners were unable to answer, but the participant indicated that it was used as an antacid. In doing so, the knowledge was linked to learners' real lives.

Inferences made by the participant had to be clarified in some instances. Learners were confused about which component is added first when diluting acid. The participant indicated that the acid is always added first because, if it is added in a different sequence, the reaction may be very volatile. During the lessons, participant C made use of clarification to assist learners in understanding concepts. The clarification was provided by the participant and learners were not taught how to seek clarity for themselves by asking clarifying questions. In an attempt to clarify

concepts, the participant made use of visual examples that were written on the board. This included writing the words together with the chemical equations. By doing this, learners were able to link the words to the relevant chemical equation, e.g., H₂O as water. During another lesson, some learners confused decimetres and litres. The participant again explained the conversion to assist learners in solving the problem given on the board.

4.2.8 Participant C's teaching of language concepts and structures

Participant C attempted on several occasions to teach language concepts and structures. He attempted to simplify concepts by using an initialism to explain a concept. The following initialism was used to explain a redox reaction.



Figure 4-5: Initialism of concept

The initialism that the participant used was then linked to the definition of a redox- reaction, which is when the reduction of oxidation takes place. Apart from the initialism and definition, the participant also syllabicated the word to show the composition.

Re-	Reduction
-----	-----------

--dox:	Oxidation
--------	-----------

Participant C was able to create a link between the word and prior knowledge that the learners already had. Although he explained the word “redox”, he did not break up the word “oxidation”; he only provided the learners with a definition for oxidation. Another instance where Participant C attempted to break down terms was when he discussed the different types of flasks and tubes used during an experiment. While showing learners a pipette, he explained that the word “pipette” translates to “small pipe”. However, Participant C explained the concept of titration by only providing learners with the definition. Some learners did not fully understand the concept and could have benefited from the word being broken down or syllabicated.

4.2.9 Participant C's proficiency in English as medium of instruction

Participant C was able to communicate effectively with learners using English as medium of instruction. He made use of simple language to make the lessons more accessible to the learners. No lapses in pronunciation or syntax were observed. The participant tried to link scientific words to common terms in order to aid understanding, e.g., antacids that were explained by referring to Eno (popular antacid). There was no need for Participant C to correct the language use of the learners, as they used the language correctly to communicate their answers during the lessons that I observed.

4.2.10 Summary of observations

4.2.10.1 Implementation and teaching of reading strategies.

The participants made use of a variety of reading strategies during the observations. The strategies varied in use, as some participants favoured certain strategies above others. This is reflected in the figure 4.6.

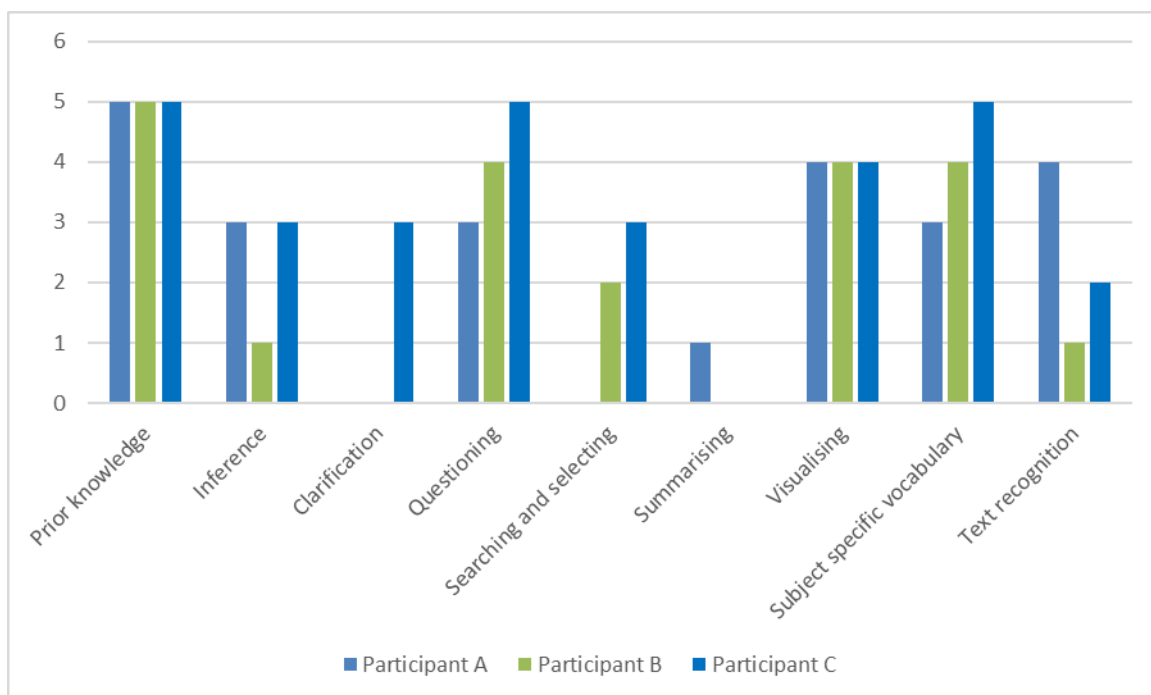


Figure 4-6: Graph of the implementation of reading strategies in observation lessons.

The participants made good use of activation of prior knowledge during their lessons. They used activation of prior knowledge as a departure point to facilitate the acquisition of new knowledge. Prior knowledge was used predominantly by referring to previous work; however, without always ensuring that the previous work was understood by each learner. For the most part, learners were

able to use prior knowledge to solve new problems. Regarding the use of visualisation, the participants illustrated concepts not only through diagrams but also the provision of physical examples. During one of the lessons, Participant C had the drawing of the pipette as an experiment component on the board, as well as the physical pipette. This allowed learners to see how it worked when the experiment was carried out by the participant. The use of visualisation allowed participants to create a link between what is written and what it looks like in a real-life scenario. The participants furthermore mostly used scientific jargon in their classrooms. The scientific terms were sometimes not fully explained, as the participants only offered definitions without assisting learners in understanding the terms. The participants also made use of questioning during their lessons. Questions sometimes led to a simplistic response that did not involve higher order engagement. In instances where questions were posed for increased cognitive engagement, learners struggled. The participants, on rare occasions, asked follow-up questions to facilitate understanding but would often just provide learners with the answers. The questions were asked to ascertain to what extent the learners understood the work that was being explained, as well as work that was previously covered. The participants' use of inferences was limited. It was mostly used by participants A and C.

Another strategy that was not regularly or optimally utilised, was text recognition. Unfortunately, the participants did not take time to indicate or focus on the structure of a given text, for example graphs. In many of the lessons, graphs were used but the components of a graph were never explained, and learners were not guided on how to interpret the graphs. While text recognition was not optimally utilised, there were instances where the participants attempted to explain the structure of the text. This was seen when chemical equations were explained. In addition to text recognition, the participants did not make effective use of searching and selecting. Only two of the participants made use of this strategy themselves – but without challenging the learners to search and select relevant information to solve the problem. The participants provided the answer without letting learners “attempt” to figure out the answer.

During the observations, some strategies were hardly used. This includes summarising and clarifying. Summarising could have been used in terms of shortening a longer text or to consolidate newly acquired content. Neither the participants nor the learners made use of summarising for either of the previously mentioned purposes. A possible reason for summarising not being used to shorten longer texts is the fact that written texts within the Physical Sciences classroom are not very lengthy. Therefore, the need to shorten these is not there because these are already at a manageable length. Summarising as a form of consolidation of what was taught, was not observed. The use of summarising for consolidation is possible within the Physical Sciences classroom, as the content lends itself to it. The consequence of not using summarising

in the lessons means that there was no way of determining whether learners understood the content that was taught. As a result, learners are not able to summarise what they have learned in a manner that reflects their level of understanding of the content. Another strategy that was not utilised by the participants, is clarification. Participants A and B did not use clarification and seemed to assume that learners understood the content. Unfortunately, some learners showed confusion that was not clarified by the participant. Also, learners were not taught to clarify for themselves by going back to the content and finding clarity within the text. In other words, self-monitoring of understanding as a form of metacognition, was absent.

During the observation lessons, reading strategies were utilised mainly by the participants and not explicitly taught to the learners in order to aid the comprehension of a given text. The explicit teaching of the different reading strategies by the different participants are reflected in figure 4.6.

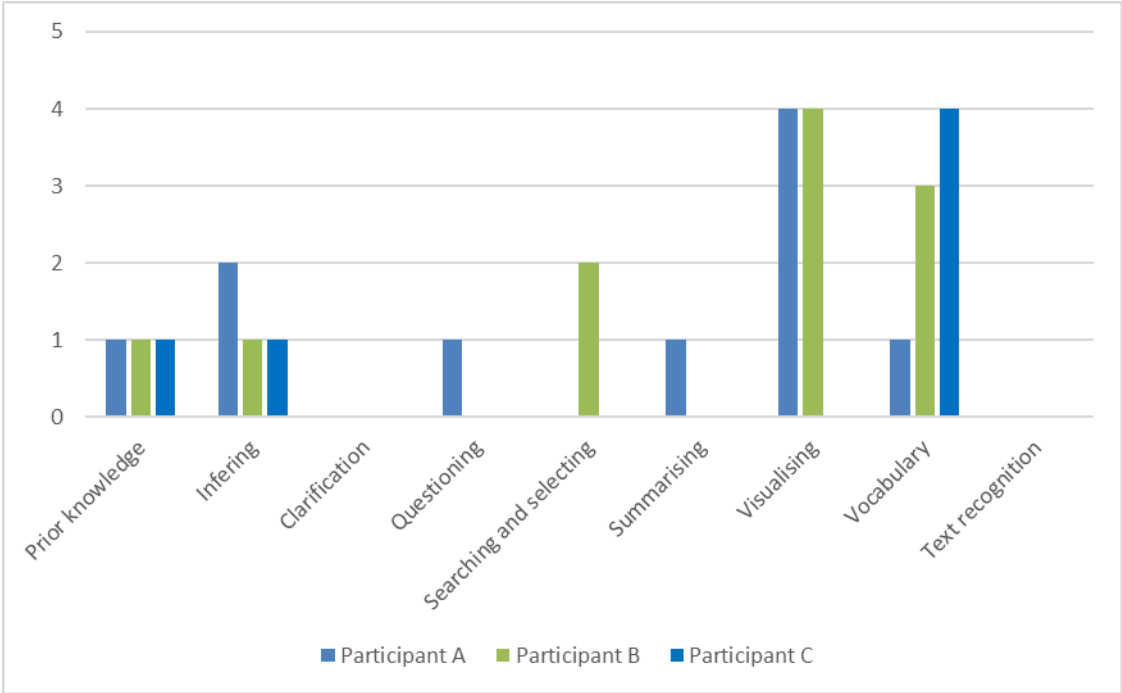


Figure 4-7: Graph of the implementation of reading strategies in observation lessons.

In most cases, the participants modelled the strategy themselves without assisting learners in the application of any strategy. The lack of explicit teaching of reading strategies could have a negative effect on learners who might struggle to read for meaning. An example of this was seen with inference, which was mainly used by the participants themselves. Unfortunately, the learners were not guided to make their own inferences and consequently learners were not able to identify and establish links between different sections by themselves. Thus, teachers modelled the strategies but did not teach these explicitly. Strategies like clarification and text recognition were

not taught to learners, which led to learners not being able to clarify concepts for themselves. They relied on the participants for clarification.

On the other hand, participants A and B taught visualisation to the learners to assist them with understanding new concepts. By doing this, the learners were able to link the content to their own idea/image, which aided comprehension. All three participants attempted to assist learners with the use of subject-specific vocabulary when offering a response to questions.

4.2.10.2 Participants' teaching of language concepts and structures.

There was limited teaching of English-language concepts during the lessons that I observed. Some participants, like participant C, attempted to assist learners with the understanding of terms by syllabifying these and explaining the morphology of words. Although this was done with some terms, other terms were not broken up for learners, which caused some confusion. This included words like titration, deforestation, and displacement. Little or no attention was paid to promoting learners' CALP in Physical Sciences. The focus during lessons was mainly on science terminology and not on developing an academic language proficiency beyond the Physical Sciences classroom. This may result in a limited understanding of content among learners, and an inability to express their understanding.

4.2.10.3 Participants' proficiency in English as medium of instruction

During the observations, the participants displayed proficiency in both BICS and CALP. They were able to communicate socially with their learners and to teach the academic content in a manner that is accessible and understandable to all learners who are proficient in English. Participants A and B made a few pronunciation errors. However, these errors did not impede understanding. Overall, all three participants seemed comfortable using English as medium of instruction and seemed confident when presenting subject content using English. The confidence of the participants to teach aspects of language in the Physical Sciences classroom was further investigated during the interviews.

4.3 FINDINGS BASED ON THE INTERVIEWS

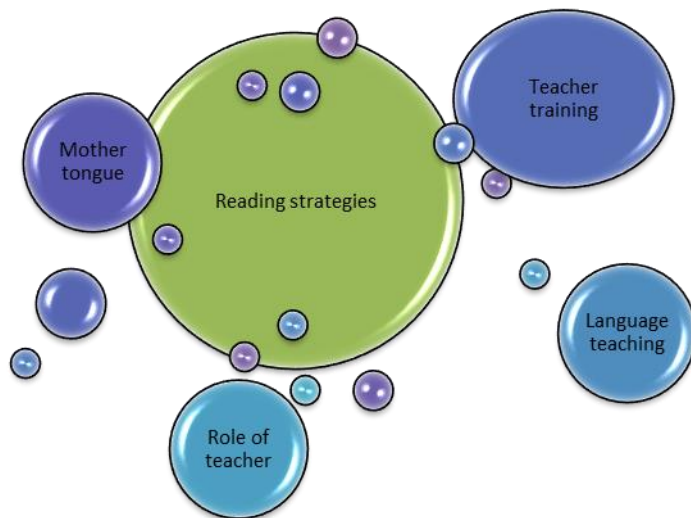


Figure 4-8: Findings of interviews

The aim of the interviews was to establish whether the participants were aware of reading strategies and if they implemented them in their lessons. I also wanted to establish what type of language training the participants had received to aid them in teaching through medium of English. The interviews (Addendum B) also revealed the participants' views on their role as language teachers, as well as possible explanations for the poor performance of learners in Physical Sciences.

4.3.1 Participant A's view on language and reading strategies.

During the interview, the participant was asked whether language and reading played an important role in the Physical Sciences classroom. His response was, "Yes, the English medium is very important. The kids will not be able to understand anything if they do not understand the language" (Interviews, 2020). He felt that if learners lacked the basic language skills, this could lead to them not understanding basic words such as "adding" or "subtracting". This could lead to the concept not being fully understood or the inability to apply knowledge in the form of calculations or graphs. When asked how he defined language, he replied: "verbal and non-verbal way of expressing life" (Interviews, 2020).

The participant referred to spoken or written discourse as verbal – and models, diagrams or experiments as non-verbal methods of teaching concepts. He felt that a combination of the two ways would assist a learner with the comprehension of new concepts. The participant felt that learners were able to read, but not with understanding. He stated that content teachers needed to make use of reading strategies to assist with comprehension. Although the participant was not

able to name reading strategies, he identified reading skills, such as highlighting important information. He mentioned some aspects that were used in the classroom, illustrating the use of reading strategies. The participant mentioned the use of PowerPoint presentations that contained text, diagrams, and sketches. This showed that he made use of visual representations to explain the content. A reference was made to assignments that required learners to interpret a combination of written and visual texts to derive meaning. Another text type that the participant used to encourage and develop reading, was cartoons. Learners were required to engage with certain texts and create cartoons in order to explain a concept, e.g., kinetic molecule theory, without learners realising that they were reading. This also speaks to the learners' ability to select the important elements and give a visual representation of what they mean. In doing so, learners were able to engage actively with the content, which assisted them with comprehension.

The participant felt that, "if you add a diagram or an illustration the learner does not only have to read words, but they also understand better when there are concepts illustrated or drawn for them" (Interviews 2020). The responses of the participant pointed to a heavy reliance on visualisation in the classroom. Unfortunately, the participant made no mention of the explanation of text structures. The implication of this is that not all learners might be aware of the different components that make up a text and therefore they might not understand all the aspects of a given text.

Nevertheless, the participant made use of repair strategies in order to assist learners who might not understand certain aspects of a concept. He made use of the highlighter method as a repair strategy. This includes the breaking down of paragraphs to derive meaning. The example offered by the participant referred to chemical equations. Learners wrote down the definition of the equation and highlighted the important parts. Next, they would write the equation and highlight the different parts of the equation. Finally, learners were asked to explain the definition by referring to the equation. By doing this, learners were able to explain the concept in their own words, which assisted them in identifying what they did not understand and repairing the part of the concept that was unclear.

Apart from the repair strategies, the participant felt that the use of prefixes and suffixes is very important. For instance, if learners did not know di=2 and tri=3, it would affect the comprehension of a concept. He felt that it is the role of the Physical Sciences teacher to clarify the relevant prefixes and suffixes to assist learners with understanding.

4.3.2 Participant A's view on the role of the content teacher as a language teacher

The participant felt that the role he plays as a language teacher is important on many levels. He felt that "I need to know not only English, but also the local cultural language" (Interviews, 2020). In other words, he had to assist learners in bridging the gap between their mother tongue and English, in order to assist learners with the acquisition of new knowledge. The participant believes that, due to the diversity of the cultures and languages, the content teacher needs to be able to use indigenous language/words and link it to English terms/words. The example that was given related to the fermentation process where the making of beer is explained. Some learners understand beer as being "umqombothi" (Xhosa and Zulu word for beer) and, by using the indigenous word, learners were able to understand better and link the new content to something they already knew.

Participant A offered insight as to what he believed the role of the content teacher is regarding language teaching. He stated that he sees himself as a language teacher, which means that he needs to ensure that he uses the correct language in order to communicate in the classroom. He feels that he "needs to have the correct language ability, communication ability, the ability to talk and assess on a level that the kid understands" (Interviews, 2020). The participant tries to incorporate reading strategies into his lesson by making use of a variety of written and visual texts. He feels that he needs to focus "not only on reading, but also reading and understanding" (Interviews, 2020). This is achieved by making use of a combination of a diagram and written text. The participant indicated that by combining the two texts, learners who struggle to read and understand the written text can look at the diagram and in doing so gain better understanding. He stated that most of the learners are visual learners, meaning they rely on the visual representation of the content as opposed to the audio explanation. Nevertheless, the participant felt that he needed to teach the content in a manner that they can understand. Another way to allow access to content is through cartoons. Learners were asked to draw a cartoon to illustrate a concept.

4.3.3 Participant A's training and confidence in using English as the medium of instruction.

According to the participant, he is able to explain prefixes and suffixes more effectively because of his training. However, follow-up questions revealed that the participant's training was limited to science training without any focus on language in the Physical Sciences class. The participant had the option of taking more modules that specialised in language at university but opted not to take them. I did not probe the reason for this decision. Nevertheless, the participant believes that any training can be beneficial. "I think any training is good. I do believe that the different

techniques in language have changed, just like the books we read and the way we communicate and teach” (Interviews, 2020). Thus, from what I understood from the participant, any training on reading comprehension and basic language skills would be welcomed as it would equip the participant in assisting learners with understanding the content, as well as staying up to date with the changes happening in education.

4.3.4 Participant B’s view on language and reading strategies.

Participant B offered insight into the difference between BICS and CALP. He stated that learners needed BICS to make sense of what is happening in the classroom and added that a certain level of academic proficiency is needed to engage successfully with the language of Physical Sciences. An example was given with the word “work”. In a social context or a language classroom, it could refer to a job when used as a noun or performing some duty/chore when used as a verb; whereas in science it refers to the amount of energy that is used. In light of this, the participant felt that he needed to assist learners in understanding and using content-specific language. He felt that “English is used as a basic language for just normal understanding, but the physics goes deeper, so if the child does not understand when you say “jump” or “sit”, the basic language is required” (Interviews, 2020). For example, “jump” refers to pushing oneself off a surface, whereas in Physical Sciences learners need to be aware of the different forces that are present when the word “jump” is used, such as gravity.

When asked about the elements of language and how they are incorporated into a lesson, the participant stated that he made use of diagrams. Diagrams are not part of language elements and, upon further questioning, the participant noted that they do not incorporate language elements, e.g., tenses. He stated that language elements, like tenses, made no difference in the understanding because, “if you say now John is throwing a ball up, whether he is throwing it now or he threw it yesterday, the ball is still going up” (Interviews, 2020). In other words, a different tense does not affect the meaning of an action or concept in science.

When asked about the main reason why learners struggle in Physical Sciences, the participant stated, “Reading, because they do not read every word, they just read the first ... like if you have a paragraph, they just read the first line and think they know” (Interviews, 2020). The participant referred to the use of written scenarios in the Physical Sciences classroom. According to the participant, learners tend to read only the first line and assume they understand a particular concept. However, the real meaning is often found later in the scenario. An example of this is when a learner reads a sentence about a moving car and assumes it is about start velocity. However, later in the scenario it is revealed that the car stopped. Due to the learner not reading the whole scenario properly, they will miss the concept of starting velocity and end velocity. He

also feels that “most of the learners are lazy to read” and that is why they often fail to fully understand what they are reading.

When asked about the use of reading strategies, the participant felt that they play an important role in facilitating understanding in Physical Sciences. He sees reading strategies as the identification of important concepts and the repetition of these concepts. The participant stated that learners often read a text once and assume that they can identify the important information. This leads to some of the important information not being assimilated, which in turn causes a gap in the comprehension of a concept. In order to assist learners with the identification of important information, the participant felt that reading the written text a number of times and highlighting important information is the best way to identify the important information. In addition to highlighting the important information, learners must also be able to visually represent the written text by either using diagrams or numbers. To facilitate this process, the participant indicated that he would ask guiding questions to assist learners with the understanding of the content.

Where understanding is lacking, the participant indicated that he made use of “repair” strategies to assist struggling learners. He felt that the best way to “repair” understanding was through repetition. Information that causes confusion must be presented in different ways in order to repeat the important information. This is done by combining written and visual text. Learners must explain the concept by using the various texts as well as their own words. By doing this, learners are able to build on their own understanding while the teacher asks guiding questions. He felt that his role in asking the guiding questions was important as it allowed learners to “repair” what they did not understand. Although the participant stated that summarising is important, it was not observed during any of the lessons.

4.3.5 Participant B’s view on the role of the content teacher as a language teacher

According to the participant, his role is not that of a language teacher *per se*, but that of a science language teacher who pays attention to scientific aspects and not pure English-language aspects. He stated that he informed learners that there is a difference between English and scientific language. With reference to the participant’s argument on the difference in meaning between the word ‘work’ in a social context and the word ‘work’ in Physical Sciences, the participant stated that the Physical Sciences teacher is challenged in teaching the language of the sciences. The logic of this statement is questionable, as BICS proficiency does not impede but rather aid learners when it comes to learning about academic concepts. When a teacher can compare and contrast the meaning of any particular word in a social context to that of an academic context, the learner should be able to develop clearer understanding. A learner who has knowledge of language structures will be able to use that knowledge, e.g., root words to derive meaning, and

then apply these skills in the academic classroom. Although the participant argued that BICS could interfere with CALP, he furthermore stated that learners who lacked knowledge of basic English vocabulary would struggle to understand academic language used in Physical Sciences classrooms. The example that was offered was the word “rest”. Learners need to understand what the word “rest” means in order to understand the concept of an object being “at rest”. The participant’s example shows a reliance on broad knowledge of English vocabulary, yet the assumption is made that learners whose mother tongue might not be English, already know these terms. The participant referred to the symbiotic nature of English for social purposes (known in the literature as BICS) and scientific language (known in the literature as CALP), and explicitly stated: “I am not teaching a language; I am teaching science language” (Interviews, 2020). In other words, the participant feels that there is a difference between English language and scientific language, and therefore the does do not create an opportunity for learners to make use of language skills in the Physical Sciences classroom.

4.3.6 Participant B’s training and confidence in using English as the medium of instruction.

With regard to teaching through medium of English, the participant felt highly confident. He felt that he was able to use language effectively for basic interpersonal communication, as well as for cognitive academic purposes. The participant received training in English language at university and this adds to his confidence in using English as a medium of instruction. He feels that “there is no need to study the actual language to say things in English” because the use of science language is more important than the use of the English language. This statement portrays limited understanding of the importance of language teaching in ensuring academic understanding and progress. The participant distinguished between the terminology used in Physical Sciences and the use of English for interpersonal communication and for teaching and learning. He felt it was his duty to teach what he called “science language” and not “English language” as if these are separate fields, with the former being more important than the latter. The participant stated: “there is no need to study the actual language” (Interviews, 2020).

This is consistent with the argument put forward Ness (2016:59) that some content teachers believe that it is the responsibility of the language teacher to teach language. The participant furthermore feels that training in the use of English in the Physical Sciences classroom would not be beneficial as it is not the focus of his subject. He concedes that there is a place for language elements, such as prefixes and suffixes within Physical Sciences if they are taught in the context of the subject. The participant welcomes any training if it is specifically directed at language scaffolding in the Physical Sciences classroom and feels that it could help in finding new intervention methods to assist struggling learners.

4.3.7 Participant C's view on language and reading strategies.

Participant C regards language and reading strategies as very important in Physical Sciences. The answering of questions requires learners to read with understanding. He incorporates reading and language into his lessons by “[paying] attention to reading questions and analysing questions” (Interviews, 2020). He believes that paying attention to how a question is asked can be beneficial, as it can assist learners who struggle with understanding. He stated that he pays attention to reading strategies that could assist learners with the understanding of the content. The participant referred to the structure of a question and the fact that he explicitly teaches the structure to draw the learners’ attention to the important parts of questions that are asked. This then leads to him asking the question “in a simpler form” (Interviews, 2020). The participant stated that he teaches his learners how to go about answering a specific question by making sure that all the important information is incorporated. He also asks guiding questions to assist learners in the logical presentation of their answers. The participant felt that reading strategies referred to “the way to understand and approach what is being said” (Interviews, 2020). This points to a rudimentary understanding of reading strategies.

According to the participant, the poor performance in Physical Sciences is due to the inability of learners to reason logically. Learners are unable to think logically and therefore struggle when it comes to the deeper application of concepts. He made a reference to mathematical/logical skills which are also needed and not just skills in Physical Sciences. The participant indicated that, “if they [learners] do not score high in that, they will not do well in my subject” (Interviews, 2020). It is noteworthy that both Physical Sciences and Mathematics rely heavily on logical thinking in order to comprehend concepts and apply them. This was confirmed by the participant as he stated that some mathematical skills that are needed to solve a Physical Sciences equation are sometimes absent, or learners are not able to use these skills in a sequential or logical manner.

When asked about repair strategies, the participant felt that one of the major strategies is to simplify the work. He stated that, “Usually, when you take a different angle, they somehow get it” (Interviews, 2020). The participant emphasised the use of simplification but did not provide an example of how he uses it. He stated that it is extremely important, as learners often struggle with complex terms and concepts and need assistance in simplifying them in order to fully understand and ultimately apply the knowledge.

4.3.8 Participant C's view on the role of the content teacher as a language teacher

During the interview with participant C, it became evident that he felt that his role as language teacher is an important one. He stated that his “role is to simplify and to use language that makes

the kids understand the concepts” (Interviews, 2020). The participant stated that he attempted to incorporate language by making use of the correct grammar and tense. He argued that, if the incorrect grammar or tense is used, it could confuse learners, which creates a barrier to learning as they do not understand what is being taught. This is in sharp contrast to the previous participant who felt that tenses did not matter. The participant feels that, as a Physical Sciences teacher, he needs to be able to use not only the English language, but also language used in the Physical Sciences. Although the participant agrees that language structures should be emphasised in Physical Sciences by being explicitly taught, he was unsure of how this could be done. The importance of language was stressed when the participant commented on the use of language to explain terminology, the structure of questions, as well as how to answer questions in a logical manner.

According to the participant, Physical Sciences relies heavily on terminology and the learner must show the ability to not only understand the basic definition, but also the ability to show a deeper application of the term. Once again, he stressed the importance of his role in making sure that learners understand these terms by either simplifying them or using a variety of examples to explain them. Apart from terminology, the participant felt that learners should understand how a question is asked in order to assist them in the answering of the question. He stated that his role is to simplify questions to assist learners with an understanding of what is expected of them in the answer. He feels by doing this he can guide them when they answer the questions. The answers to questions can then be constructed logically, as learners know what is needed in order to be allocated marks. The participant also stated that he would explain the exact way in which a question should be answered (teaching to test), for example when a definition is asked. Therefore, he defined his role as a language teacher as simplifying terms, giving questions and answers with reference to assignments and tests, and ensuring that the learners are able to apply knowledge correctly and show understanding.

4.3.9 Participant C’s training and confidence in using English as the medium of instruction.

The participant stated that he felt confident when it came to teaching through medium of English, as he has a good understanding of the language and is able to assist learners who struggle with the language. The participant did not receive any formal training in using language in the content classroom during his studies or at workshops. He feels that training in the use of language in the Physical Sciences classroom will be beneficial “because obviously we are thrown into this environment of teaching, but we are not necessarily equipped. We need some guidance” (Interviews, 2020). The participant was unsure of how the incorporation of language could be done and he could not give a clear example of how language is used in his classroom. He was

not aware of any language or reading pillars, such as the teaching of vocabulary or vocabulary teaching methods, e.g., word attacking skills. The gap in language training was seen when the participant struggled to answer questions directly related to language teaching. This makes his statement regarding guidance even more important, as he feels that he needs help in order to teach language in the context of Physical Sciences.

4.3.10 Participants' composite views on language and reading strategies.

During the various interviews, participants offered their views on language and the role it plays in the Physical Sciences classroom. Most of the participants felt that English language has an active role in the Physical Sciences classroom. However, it seems from their answers that they make a distinction between the English language and the scientific language used in the Physical Sciences classroom (as if these are two different languages). They struggled to formulate their belief that their focus is on content in the Physical Sciences classroom, but that knowledge of the English language in terms of structures, syntax and tenses could enhance learners' ability to understand content. The inability of learners to think logically was identified as problematic, and lack of reading was identified as one of the main problems, as learners are unable to understand what they read and present answers to problems in a logical manner.

All the participants agreed that a basic command of the English language is needed to communicate and express oneself in Physical Sciences. Learners must be able to use language skills when interacting with teachers and when presenting their answers. The participants showed a rudimentary understanding (or at times misconception) of reading strategies, as some participants believed these to be visual representations of a text to aid comprehension, while others believed these to be explanations of questions and concepts or the highlighting of important information.

4.3.11 Participants' views on the role of the content teacher as a language teacher

Each participant offered a different view on how they perceive their role as language teachers. Participant A felt that he had to act as a bridge when it comes to closing the gap between the language of instruction and the home language of the learners. For participant C, his role was to simplify terms, questions, and other aspects of the subject to help the learners to understand. On the other hand, participant B felt that he has no role to play as a language teacher. He felt that there was a difference between English language and language used in the Physical Sciences classroom and that his role was to teach content in the Physical Sciences classroom. However, all three participants agreed that the correct language needs to be used when teaching, as it will prevent confusion.

4.3.12 Participants' training and confidence in using English as the medium of instruction.

The training that the participants received at tertiary level was diverse. Participant A received basic language training, but not specifically in academic literacy. However, he did have the option to further his knowledge of language with additional modules in reading. Participant B received basic communicative training that was not linked to Physical Sciences. Participant C received no language training in terms of the use of language in the content classroom. Both participants A and C indicated that training in the use of language in the Physical Sciences classroom would be beneficial as any training is better than no training. On the other hand, participant B felt that the only language training that would be beneficial was language training in the context of Physical Sciences (that is, not general English-language training).

4.4 FINDINGS BASED ON THE ANALYSES OF THE LESSON PLANS

The lesson plans that were analysed are provided by the Gauteng Department of Education on what seems like a fixed template for lesson design in Physical Sciences. In alignment with the CAPS document, the template makes provision for filling in the specific Grade (e.g., Grade 10), the subject, the week during which this topic will be taught, the topic of the lesson, and the lesson number, e.g., Lesson 3 (indicating the number of the lesson in a series of lessons allocated to the topic). The teacher is requested to fill in the date on which lessons on that particular topic start, and the date on which the last lesson of the series will be taught. Thereafter, the template sets out to provide a lesson overview called a 'lesson summary' as it attends to each main component of the lesson plan: lesson objectives and teaching and learning activities. Under teaching and learning activities, the template makes provision for the teaching methods to be filled in before moving on to a section called 'lesson development'. The lesson-development section starts with the introduction comprising pre-knowledge, baseline assessment and corrections where answers are provided to the suggested baseline activity. There is a time indication of 5 minutes for the baseline assessment. It then moves on to what is called the 'main body' of the lesson, which is 'lesson presentation'. Thirty minutes is to be spent on the presentation of the content, which is given in text form on the template. The final part on the template makes provision for the teacher to indicate which learner activities will be completed. The teacher is guided to provide a scenario to the learners, challenging them to solve the problems by applying the new knowledge that they have gained during the lesson presentation phase.

For the purpose of this study, I analysed two lesson plans, in the form of two populated templates issued by the Gauteng Department of Education for Grade 10 Physical Sciences. The topic of the

one lesson plan for week 29 is ‘Distance, Displacement and calculations’ and the topic of the other (for week 30) is ‘ \bar{v} and \vec{v} calculations’ (Annexure C).

On each lesson plan, the lesson objectives indicate what the learners must be able to do by the end of the lesson. On the lesson plan for ‘Distance, Displacement, and calculations’ for example, the following two lesson objectives are given: Define displacement and distance and give the difference between distance and displacement and calculate distance and displacement for one dimensional motion. The objectives of the second lesson plan are to calculate average speed and velocity of an object. There are no objectives in terms of language acquisition – such as, learners should be able to explain what distance is in their own words, explain what displacement is in their own words, and use their own words to distinguish between distance and displacement. This means that learners may ‘fake’ understanding by simply memorising and mechanically regurgitating definitions without ever gaining an understanding of the concepts. If no deep understanding is developed in week 29, a learner will find it extremely challenging to perform the calculations in week 30.

The lesson objectives are followed by teaching and learning activities. The teaching methods on the template are those commonly associated with Physical Sciences: demonstration and observation. On the second lesson plan, questioning and answering are added as teaching methods.

The first part of the lesson (in the framework of lesson development) is the introduction. The suggested activities for this phase of the lesson on distance and displacement, are illustrated below:

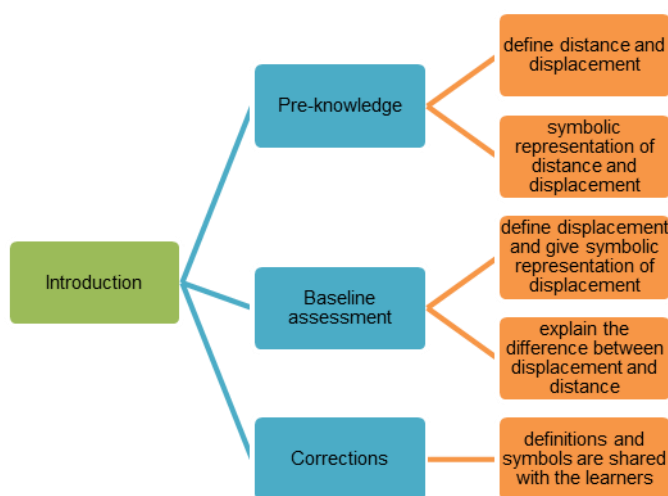


Figure 4-9: Lesson development

As seen in the figure, the introductory phase is broken up into pre-knowledge, assessment, and corrections. Activities are suggested for each part. In the pre-knowledge part, it is stated on the template that learners need understanding of the following: (i) definitions of distance and displacement and (ii) symbolic representation of distance and displacement. The teacher is guided to submit the learners to a baseline assessment activity to activate their pre-knowledge. The completion of a worksheet is indicated as the preferred baseline activity, as using a transparency or writing questions on the board may take up too much time. Only 5 minutes is to be devoted to baseline assessment and the purpose thereof, as indicated on the lesson plan, is to “gauge learners’ memory of their relevant prior knowledge”. The suggested questions for the worksheet are: (i) define displacement and give symbolic representation of displacement, and (ii) what are the differences between displacement and distance? On the template, the baseline activity is directly followed by corrections as the part of the introduction where the correct answers are provided to the learners. The definition of displacement is given as: “Displacement is the change in position with reference to the starting point”. Differences between displacement and distance are then given in table form in sentences such as “displacement is that single vector with the same effect as other vectors together”; “distance is the length of the path followed by a moving object”; “magnitude and direction (vector quantity); magnitude only (scalar)”.

It transpires that the introduction, to be completed in 5 minutes, is nothing more than a mechanical activity during which learners are prompted to tap into their memory and recite a learned definition, give the symbols for distance and displacement, and list a number of differences between distance and displacement. If that can be done successfully, the teacher moves on. If answers cannot be elicited from learners, or if they give the wrong answers, the teacher provides the correct answers and moves on to the presentation of new content as there is no time to be ‘wasted’. Learners are in no way guided to unpack the definitions in order to make sense of them, or to read for meaning in the sentences used to distinguish between distance and displacement. Concepts like ‘single vector’, ‘length of the path’, ‘magnitude’, ‘vector quantity’, ‘magnitude only (scalar)’ are used without directing teachers on how to explain the vocabulary by, for example, focusing on the origin of words or root words, or using visual representation.

The ‘main body’ of the lesson is the lesson-presentation phase that should take 30 minutes. This phase is introduced by text that offers an explanation of distance and displacement. Once again, subject-specific words and concepts are strung together in sentences which will be meaningless to learners who lack understanding of individual concepts. The differences between distance and displacement are repeated in table form, followed by an example on how to calculate distance and displacement based on a graph. The assumption is that learners can read the graph, i.e., identify the elements on the graph and extract the information from there to do the calculation.

Once the teacher has worked through the example in no more than 20 minutes, learners are allowed 10 minutes in which to perform activities to portray their level of understanding. They are given a certain scenario and are requested to illustrate the motion graphically, to calculate the distance covered, and to find resulting displacement. They are furthermore challenged to calculate the sun's 'elevation angle'. This is the first time in the lesson that the concept 'elevation angle' is used. A learner who does not know what is meant by 'elevation angle' will not be able to understand the question in order to perform the activity. The same goes for the next problem, which refers to a bridge crossing a 'chasm' and that is 'inclined at an angle of 20 degrees to the horizontal'.

Lesson number 2 follows the same formula without paying any attention to language teaching in order to ensure the thorough understanding of scientific concepts. A Grade 10 learner who lacks CALP will find it difficult to make sense of the definition given for speed: "speed is a scalar quantity with magnitude only, whereas velocity is a vector quantity with magnitude and a direction". Also, in this lesson plan, no attention is given to language: neither to the explicit teaching of scientific terms and concepts nor to syntax or morphology. The template makes no provision for teachers guiding learners in the use of parts of speech, such as the use of the conjunction "whereas", which means that the learners' attention is not drawn to the contrast between the speed and velocity.

As is evident from the above, the Gauteng DBE lesson plans for Weeks 29 and 30 for Grade 10 Physical Sciences make no provision for language teaching and no attention is given to guiding learners in reading for meaning. On the contrary, it is assumed that learners who are able to recite definitions have conceptual understanding and that they are able to unpack complex sentences in order to complete activities.

4.5 FINDINGS BASED ON THE ANALYSES OF THE CAPS AND THE MANUAL FOR TEACHING ENGLISH ACROSS THE CURRICULUM

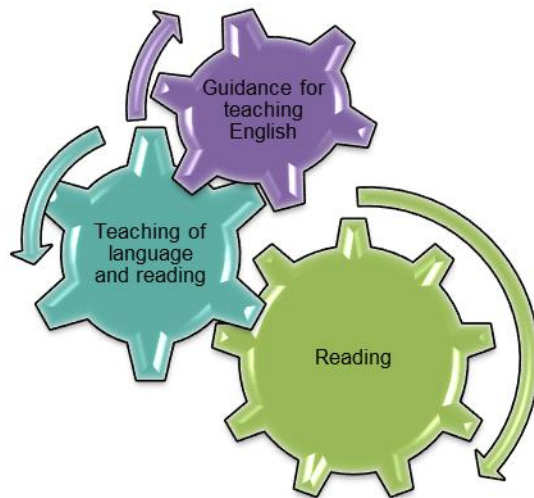


Figure 4-10: CAPS and the Manual for Teaching English Across the Curriculum

Through document analyses I sought to show, through the available data, to what extent Physical Sciences teachers in the FET phase are guided and assisted by the Department of Basic Education to promote reading in the Physical Sciences FET classroom. The analysis of the CAPS document showed elements of reading and the expectation that teachers facilitate the use of these elements in the classroom.

4.5.1 CAPS document

The CAPS document states that skills relevant to Physical Sciences are “hypothesising, identifying and controlling variables, inferring, observing and comparing, interpreting, predicting, problem solving and reflective skills” (DBE, 2011:8). The document states that teachers who teach Physical Sciences must also keep in mind that they are making use of language to teach across the curriculum. Therefore, they are tasked with creating opportunities for learners to develop their language skills within Physical Sciences (DBE, 2011:14). This includes exposing learners to scientific texts and the writing of short essays. This shows commitment to the development of language within the Physical Sciences classroom and an emphasis on language, but with the assumption that teachers are equipped to teach language.

Reading strategies that were focussed on during the data collection mirrored the skills that were identified by the DBE (2011). An example of this is the use of inferences. The connections that learners are able to make between various aspects of the content in order to derive meaning, are important. An example of this was seen during the observations of participant A, when learners

were asked to discuss the effect of deforestation on more than just nature. Learners had to show a clear understanding of deforestation and link it to the effect it may have on the economy. Some learners were able to show that it is due to the increase in demand and the search for higher profits. Others argued that because of it [deforestation] there are fewer places for people to farm and get food.

Unfortunately, the document does not give further guidance on how teachers should go about developing and/or assisting learners in applying the skills mentioned in the document. It seems to be assumed that teachers as well as learners already possess these skills. The skills indicated by the Department of Education are also strategies needed in order to read with comprehension. The function of a curriculum is to set out the content that should be taught and assessed and does not pay attention to issues of pedagogy.

The table below is an adaptation of the CAPS document for Physical Sciences in the FET phase for Grade 10. It shows concepts and skills that teachers must teach as well as guidelines for teachers to assist them in teaching the given concepts.

Table 4-1: Adaptation of Physical Sciences CAPS document for Grade 10.

Topics Grade 10	Content, Concepts & Skills	Practical Activities	Guidelines for Teachers
Pure substances: elements and compounds.	<ul style="list-style-type: none"> • Revise the microscopic and symbolic representations for elements, compounds and mixtures. • Revise the definition of an element. • Revise the definition of a compound. • Revise the definition of pure substances. • Revise the classification of substances as pure, as compounds or as elements. 	<ul style="list-style-type: none"> • Decide which of the following substances are pure substances: water, tea, salt water, copper, brass, air, oxygen. • Use molecular models to build pure substances, elements and compounds. <p>Activity:</p> <ul style="list-style-type: none"> • Do experiment with paper chromatography to show that water-soluble ink-pens or “Smarties” are not pure colours, but are mixtures of colours. 	None were given to educators.
Names and formulae of substances.	<ul style="list-style-type: none"> • Revise the cation and anion table. • Revise the writing of names when given the formulae. • Revise the writing of formulae when given the names. • Revise the meaning of the name endings like -ide, -ite and -ate. • Understand the meaning of prefixes di-, tri- etc. 	<p>Activity:</p> <ul style="list-style-type: none"> • Identify the elements that make up a compound on the food labels collected by the learners. • Compare the scientific names with traditional names for compounds known by learners. 	<p>Indicate the relationship between names and chemical formulae and chemical bonding to learners.</p> <p>Pay attention to the names of covalent compounds and the names of ionic compounds.</p>
Pulse, amplitude	<ul style="list-style-type: none"> • Define a pulse. • Define a transverse pulse • Amplitude. • Define amplitude as 	<p>Practical Demonstration:</p> <p>Let learners observe the motion of a single pulse</p>	Sometimes learners are taught about waves without ever learning about pulses. A pulse is a single disturbance. It has

Topics Grade 10	Content, Concepts & Skills	Practical Activities	Guidelines for Teachers
	maximum disturbance of a particle from its rest (equilibrium) position.	travelling along a long, soft spring or a heavy rope.	an amplitude and pulse length, but no frequency, since it only happens once.

(DBE, 2011)

The table above shows numerous examples where teachers must revise or define concepts. It does not make a clear distinction between defining a concept and explaining the word in terms of how it is constructed. As seen, there is no guidance for teachers on how to go about explaining the word or language structures. For example, no mention is made of creating and sharing a learner-friendly definition and an image to support such a definition. The practical activities provide some visual representation but the linguistic aspects are lacking. Another example of language concepts in the Physical Sciences CAPS document is where teachers are asked to teach prefixes and suffixes. No support is offered to assist the teachers with morphemes; it is merely assumed that Physical Sciences teachers have a good understanding of affixes. This could be problematic, as not all Physical Sciences teachers are comfortable with affixes and morphology and could struggle to fully explain concepts.

Furthermore, the document expects learners to describe and distinguish between various concepts. An example of this is seen in the table in figure 4.1 where learners have to distinguish between various types of motion. The assumption is made that learners already understand the concepts (like motion) and are able to draw their own inferences. In order to fully express the meaning of a concept, a learner must be able to understand the deeper meaning behind the concept. With regard to distinguishing, learners need to be able to select information from a given text in order to derive meaning. Once again, the assumption is that learners are able to effectively select information to derive meaning. The guidelines given to teachers do not assist them in developing the skill of searching and selecting. Emphasis is placed on concept formation and testing understanding, yet teachers are given no clear outline of strategies that might be employed in assisting learners with the formation and testing of concepts. The CAPS document does not include linguistic aspects, such as subject-specific vocabulary that needs to be sounded out, decoded, or syllabicated in order to derive meaning. No strategies are suggested to assist teachers and learners with ensuring or “repairing” understanding where needed.

The reference to the different graphs can also become problematic. The document does not give a clear indication of explicit teaching of diagram structures. Consequently, this could result in teachers not focusing on these structures to assist learners with comprehension. The

assumption that teachers know how to teach diagram structures also fails to consider numerical skill and the ability to interpret both a written and a numerical text. If the ability to interpret either numerical or written text is lacking, comprehension and knowledge assimilation will not take place (Meyer & Ray, 2017:127). Teachers are informed that learners must be able to reason using both written text and graphs. However, no mention is made of reading strategies and how teachers should employ these to assist learner comprehension since the construction of a written text and graph differs, meaning that different approaches are needed to extract knowledge.

The section in the CAPS document that focusses on Grade 11 also does not provide explicit guidance to teachers regarding reading. The practical application of knowledge acquired previously is emphasised. However, there are no clear guidelines for teachers to ensure that learners are in fact aware of previously acquired concepts. The table below illustrates what is expected from learners and sets out the guidance given to teachers as per the CAPS document for Grade 11.

Table 4-2: Adaptation of Physical Sciences CAPS document for Grade 11.

Topics Grade 11	Content, Concepts & Skills	Practical Activities	Guidelines for Teachers
Resolution of a vector into its horizontal and vertical components.	Draw a sketch of the vector on the Cartesian plane showing its magnitude and the angle (θ) between the vector and the x-axis.	N/A	Use examples involving force and displacement vectors.
Bond energy and Length.	<ul style="list-style-type: none"> • Give a definition of bond energy. • Give a definition of bond length. • Explain the relationship between bonds energy and bond length. • Explain the relationship between the strength of a bond between two chemically bonded atoms and 	N/A	<p>Link to potential energy diagram used to explain bonding above and point out the bond energy and bond length on the diagram.</p> <p>BEWARE!!</p> <p>That you do not elevate the Lewis presentations as physical truths in chemical bonding.</p> <p>There are NO PHYSICAL BONDS: the chemical bond just represents an area of high electron</p>

Topics Grade 11	Content, Concepts & Skills	Practical Activities	Guidelines for Teachers
	<ul style="list-style-type: none"> - the length of the bond between them - the size of the bonded atoms - the number of bonds (single, double, triple) between the atoms. 		density and low potential energy.
Intermolecular Forces	<ul style="list-style-type: none"> • Explain the relationship between the strength of intermolecular forces and melting points and boiling points of substances composed of small molecules. • Contrast the melting points of substances composed of small molecules with those of large molecules where bonds must be broken for substances to melt. 	N/A	<p>The larger the molecule the greater the dispersion force. Dispersion forces are only significant in the absence of any other interaction.</p> <p>Also note that molecular size is only a significant factor in dispersion forces.</p>

(DBE, 2011)

As seen in figure 5.1.2, defining terms are seen as concepts and skills that learners should apply. Unfortunately, as with the Grade 10 CAPS document, teachers are not given any guidance as to how to assist learners with the definition of terms or concepts. Furthermore, the focus is just on defining; no room is made for word explanation. It is notable that teachers are given guidance regarding the use of prior knowledge in order to convey new knowledge. For example, learners could be asked what would happen if you put a rock into a container full of water. The learners need to indicate that the water level will rise, because it is getting displaced by the rock. This can then be used as an introduction to the new content.

Diagrams are used to present knowledge. Emphasis is placed on diagrams and the ability to visually demonstrate information. An example of this is the use of the periodic table of elements.

It is stated in the CAPS that, “(how) the periodic table of elements is arranged is not as important as the information that can be derived from the table for example valence, orbitals, bonding and electronic structure” (DBE, 2011:22). The understanding of the information provided by the periodic table is crucial as it provides the basis for the conceptual understanding of the content. The assumption is made that learners understand the composition of various diagrams like the periodic table of elements; therefore, teachers do not spend enough time on ensuring that learners are able to identify and use the information contained in diagrams. Teachers are not supported to assist with text recognition as the guidelines mainly focus on providing examples.

Apart from diagrams and definitions, learners are required to explain terms that relate to each other. Learners must also be able to compare and contrast various concepts to derive meaning. To be able to execute the skills, learners need to make use of inference and selection strategies. For example, before learners are able to explain the link between bond energy and bond length, they need to understand each concept individually. After that they need to select information that would assist with inferences, in order to gain the needed knowledge.

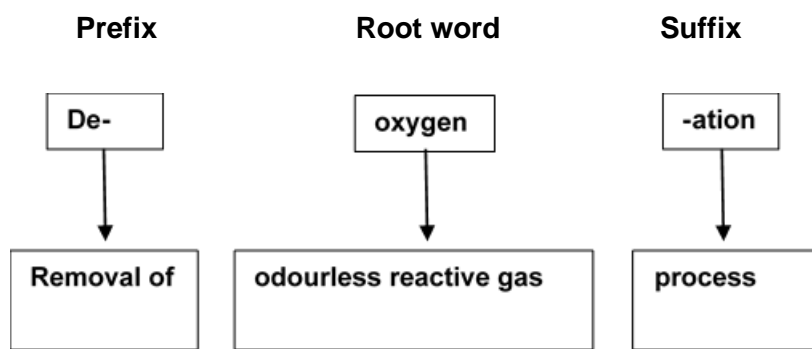
Inferring and selecting are also important when comparisons and contrasts need to be made. Learners should be able to identify and select similar information in order to draw links. Similarly, they should be able to spot differences in information. The ability to compare and contrast information allows for inferences to be made and knowledge to be assimilated. Unfortunately, the CAPS for Physical Sciences Grades 10-12 (DBE, 2011) do not assist teachers in guiding learners when it comes to inferring and selecting. These strategies are not taught explicitly in order to make it easier for learners to achieve reading comprehension. I still maintain that the CAPS document creates confusion regarding the expectations of teachers to teach language and reading in their classroom, yet they are constantly under pressure to teach the content as there is no time allocated to the specific teaching of language in the Physical Sciences classroom. The focus seems to be on content knowledge which is presented as a tick list. The prescription to teach language in the content classroom leaves the content teachers confused in terms of their role as language teachers, as they are only focused on the content to be taught as set out by the document. Elmore and Sykes (1992:186) insist that policy statements usually lack “sufficient detail” on how content should be taught. It is assumed that teachers have sufficient pedagogical content knowledge to make content accessible to learners by applying the correct pedagogy. The same argument may apply to the teaching of language concepts. It is assumed that teachers have sufficient knowledge of language structures and the pedagogy thereof.

4.5.2 Manual for Teaching English Across the Curriculum

In a bid to try and negate shortcomings that could impact the understanding of learners, the DBE released a “Manual for Teaching English Across the Curriculum” (DBE, 2013). This initiative may be regarded as praiseworthy as it indicates that the DBE is aware of the importance of focusing on language in the Physical Sciences class. This manual seeks to offer guidance to content teachers regarding reading comprehension, which has an impact on the understanding of learners. The document states the importance of language awareness as well as “pedagogy for dealing with language” (DBE, 2013:6) in the Physical Sciences classroom. This shows that Physical Sciences teachers must adapt the way they teach content in the science classroom and incorporate language teaching to assist with the understanding of different texts, e.g., diagrams, directions to conduct reports on experiments or written text. The document also states that learners should be able to use “strategies for previewing text, e.g., monitoring their understanding, determining the most important ideas and relationships between them, remembering what they read, and making connections and inferences” (DBE, 2013:11). The afore-mentioned strategies set out by the manual can assist learners with reading comprehension. However, instead of providing clear guidance to teachers on how to teach these strategies, it is assumed that teachers of Physical Sciences have the pedagogical knowledge to teach these strategies. No scaffolding is provided to content teachers for teaching language in their subjects. An example of this is seen in the suggestion that learners need to monitor their own understanding. This can only be done if learners are able to ask questions of their own and apply “repair” strategies, if needed. Taboada *et al.* (2012:87) agree that the use of self-questioning when reading a text helps with cognitive and language processes. The ability to understand a text is dependent on cognitive processes, as it is the process responsible for constructing understanding. The benefit of self-questioning is that learners will be able to use different language aspects to not only ask pertinent questions, but also to answer them.

Another aspect discussed in the manual is the importance of language structures and text recognition (DBE, 2013:12). Once again, the importance of language is reiterated and the assumption is that content teachers are aware of the different aspects of language. This is however not true; teachers are often unable to assist learners with language, as they are not equipped to handle language constraints (Ness, 2016:59). The same applies to text recognition. In the manual, a text-based approach is referred to without guiding teachers on teaching text structure. A text-based approach allows teachers to explain how a text is constructed in order to assist learners with understanding the content. An example from the Physical Sciences classroom is the use of diagrams. Teachers need to explicitly teach the different components that make up a diagram to ensure that learners will be able to read and understand the text.

A different aspect mentioned in the manual, that aids understanding, is the use of affixes. The document states that these could be “used to great benefit for the learners” (DBE, 2013:14). A variety of examples is provided, and prefixes and suffixes are explained, but once again the ‘how to’ aspect is not addressed. The content teacher who knows how to teach prefixes and suffixes in any specific subject domain will help learners understand subject-specific concepts better (Colombo & Furbush, 2008:97). Learners ought to be taught how to break up unfamiliar and what often seems to be difficult terms, in order to derive meaning. An example of a term in the Physical Sciences classroom that appears to be incomprehensible is ‘deoxygenation’. If a learner, especially an English first additional language learner, is not guided in syllabifying the word, comprehension will be difficult. Breaking the word up into syllables will foster understanding. The word should be broken up as follows:



Thus, deoxygenation can be seen as the process of removing an odourless reactive gas. Learners can be made aware of the use of the prefix de- in their real lives, e.g. in words such as “detox” or “deregister”, meaning “remove from”, as well as the use of the suffix –ation, meaning “action” or “process” in familiar words such as “registration” and “forestation”. Once they understand the meaning of the particular affix, they will be able to understand any unfamiliar word that has any of the known affixes. The function of the manual is to assist teachers in using language concepts in their classrooms to assist learners with comprehension. However, as valiant an effort as it is, it lacks specific guidance for teachers to help learners understand the given content that is taught through medium of English. The “how to” or pedagogy needs attention to assist teachers, seeing that the CAPS document lacks the “sufficient detail” that Elmore and Sykes (1992:186) refer to and which is not a normal feature of a curriculum policy.

4.6 SUMMARY

In this chapter, data relating to reading strategies and the use of reading strategies in the Physical Sciences classroom were analysed. The document analysis of the Physical Sciences CAPS document, lesson plans, as well as the “Manual for Teaching English Across the Curriculum” (DBE, 2013) showed that the ability to read with meaning was identified as being a key component

in understanding content in the Physical Sciences classroom. However, language aspects that appeared in these documents were provided without offering any guidance to the content teachers on how to go about teaching language in the content classroom. The effect of this is that teachers often feel ill-equipped to teach language in the content classroom (Vázquez & Ellison, 2013:70).

Although the document analysis showed that teachers received no assistance or guidance with reading strategies, these strategies were still observed during the lessons. Some strategies were favoured above others and were seen in the majority of lessons. Other strategies were hardly utilised and could be beneficial in assisting learners that struggle to understand subject content. The use of reading strategies was observed; however, not all the strategies were explicitly taught to learners, which meant that the learners were unable to use them to aid comprehension.

The attitudes of teachers regarding reading strategies and language were gauged during the interviews. Although all the participants stated that reading strategies are important, the participants were not able to identify and explain how reading strategies are used to assist learners with comprehension in the Physical Sciences classroom. Perceptions varied regarding their role as language teachers in the content classroom, but the majority felt that it was part of their responsibilities to focus on English- language structures to teach their subject. Two of the participants felt that their main focus in the Physical Sciences classroom is the teaching of content and not English-language aspects. They, however, agreed that the development of language aspects in the context of their subject is important and that they would welcome training in this regard.

In Chapter 5, I provide a summary of the literature review, as well as discuss the findings of Chapter 4 in answering the research questions. I also provide various recommendations based on the findings, as well as discuss the limitations of the study.

CHAPTER 5 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This study sought to investigate the use of reading strategies by Physical Sciences teachers in their classrooms to aid learner comprehension and to improve learners' academic performance. The poor performance of South African learners in Physical Sciences motivated this study and it is hoped that the findings may assist in addressing this problem. In this chapter, I provide a brief summary of the literature review, the empirical study, and the findings of this study. A section on limitations of the study and recommendations follows, before I offer concluding thoughts.

5.2 LITERATURE REVIEW

South Africa's education system lags far behind, in comparison to international counterparts, with South African learners performing poorly in Physical sciences and Mathematics. In this study, the focus was on the performance of learners in Physical Sciences. This is discussed in Chapter 2, which focuses on the various factors that influence the performance of learners in Physical Sciences classrooms. Existing research, discussed in Chapter 2, shows that South African learners still have a long way to go before their performance in Physical Sciences is on par with their peers internationally. Factors like BICS and CALP are explored, as well as the fact that South African learners come from a variety of language backgrounds; that plays a significant role in the assimilation of knowledge, as the medium of instruction is not necessarily the learners' mother tongue. In this study, I investigated the role of reading skills in the comprehension of academic texts. I argued that, in order to be successful in the Physical Sciences classroom and formal examinations, learners must be able to read with comprehension. Chapter 2 dealt with the factors that influence comprehension, the distinction between BICS and CALP, and reading for pleasure versus reading for academic purposes, as well as other aspects of language (such as vocabulary and word recognition and syntactical awareness). The literature indicates that South African learners have poor reading skills when it comes to reading academically demanding texts in Physical Sciences. In an attempt to assist learners in coping with challenging texts, the study focused on reading strategies and their use in the Physical Sciences classroom. The role of the teacher is highlighted in the literature review, as the content teacher plays a pivotal role in assisting learners with reading. To this end, I sought to answer the primary research question, namely: "To what extent do Physical Sciences teachers in the FET phase, who teach their subject through medium of English, implement reading strategies to aid comprehension?"

A variety of reading strategies are discussed, as well as the extent to which they may aid learners to read with understanding. These include: the activation of prior knowledge, summarising,

visualising, text recognition, questioning, searching and selecting, inference, and focusing on vocabulary. Each of these strategies is discussed in relation to Physical Sciences education, and I endeavoured in Chapter 2 to show how each strategy aids learners in reading academic texts with better comprehension, which in turn leads to a better understanding of subject-specific concepts and content generally. I also discussed the role of teachers when implementing reading strategies, as their role is to explicitly teach reading strategies in the Physical Sciences classroom. To this end, I sought to answer secondary questions which relate to the training of content teachers and their confidence in teaching language, and reading strategies specifically, in their content classes. I also probed into the perceptions teachers have of their additional role as language teachers. Finally, I explored the extent to which reading strategies are explicitly taught in Physical Sciences classrooms.

5.2.1 Empirical study

The data-collection instruments were chosen for their suitability to obtain relevant data in order to answer the main research question, as stated in the previous section. In Chapter 3, I explained the different data-collection tools and how they were used to gather the required data to answer the primary research question, as well as the secondary research questions. Document analysis was done to show to what extent content teachers are assisted in teaching language in the content classrooms. The document analysis in Chapter 4 shows that very little guidance is offered to content teachers, specifically in Physical Sciences, in terms of teaching language. An example of this is the Physical Sciences Curriculum and Assessment Policy Statement (CAPS) document that refers to prefixes and suffixes. The document does not guide teachers in identifying prefixes and suffixes, and how these may assist in the meaning of a scientific term (e.g., the use of dis- in displacement). In an attempt to assist teachers, the Department of Basic Education released a manual to guide teachers in teaching language in content classrooms. As with the CAPS document, the manual falls short in offering definite guidance to teachers. The lesson plans provided to the teachers also contain no guidance on integrating language and content teaching to assist learners when engaging with content and reading for comprehension. It is simply assumed that learners understand definitions, and that they are able to engage with new content, read and interpret graphs, and comprehend text with unfamiliar words. During the introductory phase of each of the lesson plans that I analysed; the emphasis was on the learners' ability to regurgitate definitions that they had to memorise. It is even stated on each of the lesson plans that the purpose of the baseline assessment activity is to "gauge the learners' memory of their relevant prior knowledge". Learners' level of comprehension is not assessed before the teacher moves on to the next lesson – where, once again, no attention is given to vocabulary or teaching scientific concepts. Extended pieces of text are shared with the learners and the teacher is not

guided in breaking up the sentences to assist the learners with reading for meaning. No attention is given to text type, which varies in Physical Sciences. It is assumed that learners will be able to read graphs and make sense of instructions to perform complicated tasks.

Apart from the document analysis, I conducted interviews with the different participants to establish how they defined their additional role as language teachers in the content classroom. During the interviews with participants, it became apparent that there is a need for further training and guidance to assist Physical Sciences teachers to incorporate language teaching in their classes. It also became apparent that the participants feel that language plays a role, and they agreed that learners are not able to read with comprehension. This aligns with the findings in Chapter 2, which indicate that learners often struggle to read with comprehension in content classrooms. When asked about the implementation of reading strategies in the content classroom, the participants noted that strategies for reading are very important. Although the participants were not able to name the various reading strategies, the application of these strategies were still observed during the lessons. The observations showed that the teachers implemented some reading strategies in their classrooms, although they did not explicitly teach these to learners. Teachers also intuitively favoured certain strategies, like visualisation, which was seen in the presentation of results in Chapter 4.

5.3 DISCUSSION

This study sought to identify the extent to which Physical Sciences teachers in the FET phase, who teach their subject through medium of English, implement reading strategies to aid comprehension. After analysis of the data, I was able to summarise the findings on reading strategies, and the use of these strategies in the Physical Sciences classroom. The ability to manipulate language in order to derive meaning is important when it comes to reading with comprehension. The use of reading strategies aids comprehension, as it makes use of language concepts, e.g., vocabulary and word-attacking skills to assist with understanding.

During my study, I found that Physical Sciences teachers in the FET phase utilise some of the reading strategies discussed in Chapter 2 (for example visualisation and activation of prior knowledge), and they focus on/attend to subject-specific vocabulary. These were among the strategies that were frequently identified, either during the interviews or the observations (Chapter 4). I focused on the reading strategies suggested by McEwan (2014). The teachers were able to integrate these strategies in order to assist learners with comprehension. However, some strategies like clarification, summarising, and searching and selecting, were not utilised. This showed that there are still strategies that could be utilised by the teachers to assist with reading comprehension. I also found that teachers are unaware of most of the reading strategies, such

as searching and selecting, clarification, and inference. This results in these strategies not being taught to learners to aid comprehension of a specific text. However, the teachers were able to provide examples of reading strategies without specifically naming the reading strategies. During the observations, it was clear that the participants made use of reading strategies. They therefore seem to have a tacit understanding of these.

The data collected during the interviews allowed me to establish how equipped Physical Sciences teachers feel to teach reading strategies in the Physical Sciences classroom in the FET phase, who teach their subject through medium of English, feel to teach reading strategies. The interviews showed that the teachers have little understanding of reading strategies and how these can be utilised in the content classroom. Although they mentioned visualisation and subject-specific vocabulary, they were mostly unaware of strategies that could be beneficial to learners. The observations revealed that the teachers do not create opportunities for learners to practise and implement reading strategies. This negates the recommendation of Swanson *et al.* (2016:219), that teachers must create opportunities in the content classroom to improve comprehension. The limited implementation observed was accidental, as the learners used a strategy like inference on their own without being guided by the educator. Class activities were not designed in a manner that allowed for practising of the different strategies to improve comprehension.

In terms of the extent to which Physical Sciences teachers use reading strategies, I found that the participants made use of reading strategies during lessons, but it was not common practice to teach the strategies to learners. Some learners were able to use reading strategies on their own but received no guidance from the teacher on how to use reading strategies. When exploring how equipped Physical Sciences teachers felt to teach reading strategies, this study found that teachers are not given sufficient guidance to teach reading strategies in the content classroom. The CAPS document, lesson plans, as well as the Manual for Teaching English in the Content classroom, do not assist teachers when it comes to incorporating English-language teaching into their content lessons. Physical Sciences lesson plans are not structured to address language issues in order to assist struggling learners, as was pointed out by Wexler *et al.* (2016:4) in Chapter 1. Apart from the structure of the lesson plans, teachers are restricted by time constraints and need clear guidance on how to integrate content and language teaching. As a result of poor guidance, teachers tended to pay little attention to the integration of language and content teaching in their Physical Sciences lessons. No time is allocated to language teaching in the lesson plans that were analysed. The lesson plans only indicated the topics that needed to be taught and the time allocated for these, as well as the different phases of the lesson. In terms of time slots, the lesson plans only allow for content to be introduced and taught, while no time is

allocated to teaching the language of the subject. Furthermore, no provision is made for assisting learners with comprehension. The lesson plan makes no provision for teaching language skills, such as writing, despite it being seen as an important skill in the CAPS document. The assumption is made that teachers will be able to teach the basic elements of writing, for example conjunctions that should not be used at the start of a sentence (e.g., starting a sentence with “because”). Therefore, an assumption is made that the learners need not pay attention to language aspects when reading or writing, as they are not taught these skills.

The role of the teacher also became apparent when ascertaining to what extent reading strategies are taught in the Physical Sciences classroom. For the most part, the participants felt that they had an active role to play with regard to language. In chapter 1, I discussed Wexler *et al.*'s (2016:2) views on the role of the content teacher regarding the teaching of language. They felt that content teachers must be aware of language structures in order to assist learners in becoming scientifically literate. Unfortunately, the teachers showed a limited awareness of language and only focused on the correct use of language by the teacher. The majority of participants, however, indicated that language and language teaching have a place in Physical Sciences classrooms. The use of reading strategies and language was further discussed in the interviews, and I found that teachers felt ill-equipped to teach English-language concepts and structures that are commonly used in Physical Sciences because they had never been trained to teach these in the content classroom. This links to the argument made by Ness (2016:59) in Chapter 2, that content teachers are often not trained to teach language in the content classroom. During this study, it was also evident that linguistic diversity plays a role in the use of English for academic purposes. The different participants indicated that the use of scientific language is often impeded by the learners' mother tongue, as learners are not aware of the correct English word that describes a particular concept. In Chapter 2, I discussed the argument by Colombo and Furbush (2008:97) on the effect of a lack of linguistic awareness on the ability of learners to use language as a means to aid comprehension. The degree to which tasks and assignments focus on the different higher-order thinking levels was discussed in Chapter 1. As pointed out in Chapter 1, tests and assignments are needed to develop learners' CALP (Cummins, 2000:57); however, the lesson plans that were analysed did not allow for the development of CALP. Therefore, teachers need to assist learners by creating a linguistic awareness as a means to not only teach academic content and enhance learners' CALP, but also to assist learners in communicating effectively as they grow in confidence regarding BICS.

5.4 LIMITATIONS OF STUDY

This study is limited in the sense that it utilised only a small sample. This was due to logistical constraints. Unfortunately, the number of participants restricts the findings, as no generalisations

can be made due to the limited data collected. The study was also limited to one high school in Gauteng, which means that the findings are not necessarily indicative of common practices within Physical Sciences classrooms across South Africa. This being said, the purpose of this study was to establish a theoretical generalisation. The theoretical generalisation is based on the data that was analysed. Therefore, the study is merely a theoretical generalisation on the use of reading strategies in the Physical Sciences classrooms observed for this study.

Another factor that limited the study is the diversity of teachers and learners. Although the participants' years of experience was mentioned, it had no bearing on the current study as the study focused on the use of reading strategies in the Physical Sciences classroom. The different participants had different training – which includes a PGCE in Science and a B.Ed. degree majoring in Physical Sciences. This study did not take these variables in terms of training into consideration. The diversity of learners in terms of socio-economic background was not investigated, although the role of the learners' mother tongue was discussed in Chapter 2. The focus was only on reading strategies and the use of reading strategies in the Physical Sciences classroom.

I only investigated reading strategies as a possible solution for poor reading comprehension. However, there are many other aspects of reading that were not taken into consideration for this study, such as the pillars of reading (phonemic awareness, phonology, vocabulary, fluency and comprehension), and background knowledge, to name but a few. Reading is complex, and the scope of this dissertation did not allow for a more comprehensive exploration.

Learners' perceptions and their input did not form part of this study. This aspect may be considered for subsequent studies.

5.5 RECOMMENDATIONS

As shown in the literature review in Chapter 2, there is a clear need for improvement in reading in South Africa. The lack of reading comprehension negatively impacts the academic performances, as was seen in the Progress in International Reading and Literary Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS) reports. Consequently, strategies should be put in place to assist learners with coping in academically demanding subjects like Physical Sciences.

To this end, I make the following recommendations:

- (1) Re-evaluation of content teacher training, with increased emphasis on language teaching, specifically in terms of reading for meaning.

- (2) Re-structuring of the CAPS document for Physical Sciences in the FET phase, so that it makes provision for language teaching. Re-structuring of the CAPS could be an important focus of a follow-up study.
- (3) The development of a manual that focuses on specific reading strategies, with practical examples that content teachers may use in their different disciplines to aid comprehension. Lesson plans shared by the DBE should be aligned with the manual.

Regarding teacher training, my study showed that the participants felt they needed training so that they could guide learners to read with comprehension. Traditionally, the training of content teachers included only subject-specific content and there was no focus on improving their language skills in the context of teaching Physical Sciences. This was confirmed by the participants, who stated that they received no formal language training. In order to create a “content-language teacher”, there needs to be a change at university level in how teachers are trained. The implication for Physical Sciences teacher training is that prospective teachers should be made aware of the importance of language in their subject, as well as how to integrate content teaching and language teaching. This would imply that teacher educators are also knowledgeable on how to train students to address language issues in content subjects. Furthermore, it is important to provide clear guidelines on exactly how to teach applicable linguistic aspects, such as reading for meaning – in specific content areas, e.g., attending to certain text structures, interpretation of tables and figures, decoding complex words in the sciences, and recognising the meaning of certain morphemes. To address the problem, one cannot focus only on the training of pre-service teachers. An evaluation should be done of current in-service teachers’ content and pedagogical knowledge and ability to integrate content and language teaching, to assist them in subject-specific language teaching. More specifically, there should be training on how to effectively teach reading strategies in their classrooms. Current Physical Sciences teachers may attend workshops on how to incorporate language in their lessons to assist learners to read for meaning. Although a manual for teaching English in the content classroom was released by the DBE, the manual falls short of guiding teachers. Therefore, the need for training courses or workshops becomes pronounced, as these may offer teachers hands-on training on implementing reading strategies and content-specific language teaching.

Apart from teacher training, the Physical Sciences CAPS document can be re-structured in order to provide more guidance to teachers in terms of incorporating language in the content classroom. A greater focus on reading should be included to ensure that learners are trained to become proficient readers in Physical Sciences. As discussed in Chapter 4, the current CAPS document makes reference to the importance of reading but does not assist teachers to teach reading. It is for this reason that I propose that the CAPS document be altered to include specific

scaffolding for teaching reading in the Physical Sciences classroom. The CAPS document does not offer guidance on subject pedagogy, as the document is concerned with 'what;' should be taught, rather than 'how' it should be taught. Yet, some teachers feel that the document must also assist with guidelines in terms of pedagogy. Nevertheless, the CAPS document cannot become too prescriptive about how educators should teach. It can, however, provide guidance on how content and language should be integrated. Teachers' pedagogical content knowledge comes into play and their ability to synthesise the 'what' and 'how' is important.

Lastly, a manual for reading needs to be developed, which specifically focuses on reading strategies and their use in content classrooms. The different strategies need to be explained as well as the benefit of each strategy in assisting learners with reading for meaning. The manual should be clearly structured to provide subject-specific examples of each strategy and how it could be incorporated into a lesson. A specific template may be provided to guide content teachers on the integration of content and language teaching. Examples of lesson plans, which include a variety of strategies, could be given. This would allow content teachers to develop their own lessons by using a combination of reading strategies that would be beneficial when faced with different types of texts.

5.6 CONCLUSION

This study has explored reading strategies and the use of these in the Physical Sciences classroom. The benefits of reading strategies in Physical Sciences were highlighted, and it was pointed out that they could aid learners in comprehending texts that are often challenging. The application of reading strategies to aid comprehension was explored, as well as the role of the Physical Sciences teacher in the implementation of reading strategies. The importance of reading and the effect it has on learner comprehension cannot be over-emphasised. Teachers should make a conscious effort to incorporate language in their lessons in a functional manner to assist learners to assimilate knowledge in their meaningful engagement with a text. This study showed the possibility for further studies on reading strategies within the South African education system. It also showed that content and language should be integrated to overcome the language barrier faced by many struggling learners. The use of language in content classrooms is not limited to Physical Sciences, and further studies can be done on the application of reading strategies in other subjects, such as Mathematics. The contribution of this study to the academic community is its investigation of a prominent problem, namely reading comprehension. The findings and recommendations could be used as a departure point for future studies on reading – not only in the Physical Sciences classroom but also in other content classrooms where reading with comprehension is seen as problematic. The focus of this study was specific to South Africa, which

creates opportunities for further research concerning reading in South Africa and how to strengthen the skills of learners so that they become more internationally competitive.

REFERENCE LIST

- Afflerbach, P., Cho, B.-Y. & Kim, J.-Y. 2015. Conceptualizing and Assessing Higher-Order Thinking in Reading. *Theory into Practice*, 54(3):203-212.
- Anderson, N.J. 1991. Individual differences in strategy use in second language reading and testing. *Modern Language Journal*, 75(4):460-472.
- Andrianatos, K. 2018. *First year university students' reading strategies and comprehension: implications for academic reading support*. Potchefstroom: North-West University. (Thesis – PhD).
- Anney, V.N. 2014. Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, 5(2):272-281.
- Ardasheva, Y., Newcomer, S.N., Firestone, J.B. & Lamb, R.L. 2017. Mediation in the relationship among EL status, vocabulary, and science reading comprehension. *The Journal of Educational Research*, 110(6):665-674.
- Arya, D.J., Hiebert, E.H. & Pearson, P.D. 2017. The effects of syntactic and lexical complexity on the comprehension of elementary science texts. *International Electronic Journal of Elementary Education*, 4(1):107-125.
- Baller, S., Dutta, S. & Lanvin, B., eds. 2016. *The global information technology report 2016: innovating the digital economy*. Geneva: World Economic Forum.
http://www3.weforum.org/docs/GITR2016/WEF_GITR_Full_Report.pdf Date of access: 15 May 2018.
- Baxter, P. & Jack, S. 2008. Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, 13(4):544-559.
- Bharuthram, S. 2012. Making a case for the teaching of reading across the curriculum in higher education. *South African Journal of Education*, 32(2):205-214.
- Bharuthram, S. & Clarence, S. 2015. Teaching academic reading as a disciplinary knowledge practice in higher education: articles. *South African Journal of Higher Education*, 29(2):42-55.
- Blair, E. 2015. A reflexive exploration of two qualitative data coding techniques. *Journal of Methods and Measurement in the Social Sciences*, 6(1):14-29.

Bloom, B.S., ed. 1956. *Taxonomy of educational objectives. Vol. 1: Cognitive domain*. New York: McKay.

Botsas, G. 2017. Differences in strategy use in the reading comprehension of narrative and science texts among students with and without learning disabilities. *Learning Disabilities: A Contemporary Journal*, 15(1):139-162.

Bowen, G.A. 2009. Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2):27-40.

Brown, A.L. 1980. Metacognitive development and reading. In: Spiro, R.J., Bruce, B.C. & Brewer, W.F., eds. *Theoretical issues in reading comprehension: perspectives from cognitive psychology, linguistics, artificial intelligence, and education*. Hillsdale, NJ: Erlbaum. pp. 453-481.

Brown, P.L. & Concannon, J.P. 2016. Students' perceptions of vocabulary knowledge and learning in a middle school science classroom. *International Journal of Science Education*, 38(3):391-408.

BusinessTech. 2019. *These are the most-spoken languages in South Africa in 2019*. <https://businesstech.co.za/news/business/319760/these-are-the-most-spoken-languages-in-south-africa-in-2019/> Date of access: 11 Sep. 2020.

Calvo, S., Celini, L., Morales, A., Martínez, J.M.G. & Utrilla, P.N. 2020. Academic literacy and student diversity: evaluating a curriculum-integrated inclusive practice intervention in the United Kingdom. *Sustainability*, 12(1155):1-14.

Cantrell, S.C., Almasi, J.F., Carter, J.C., Rintamaa, M. & Madden, A. 2010. The impact of a strategy-based intervention on the comprehension and strategy use of struggling adolescent readers. *Journal of Educational Psychology*, 102(2):257.

Carrell, P.L., Pharis, B.G. & Liberto, J.C. 1989. Metacognitive strategy training for ESL reading. *Tesol Quarterly*:647-678.

Cekiso, M.P. 2007. *Evaluating reading strategies instruction*. Potchefstroom: North-West University. (Thesis - PhD).

Cerdán, R., Gilabert, R. & Vidal-Abarca, E. 2011. Selecting information to answer questions: Strategic individual differences when searching texts. *Learning and Individual Differences*, 21(2):201-205.

Chinedu, C.C., Olabiyi, O.S. & Kamin, Y. 2015. Strategies for improving higher order thinking skills in teaching and learning of design and technology education. *Journal of Technical Education and Training*, 7(2). pp 34-45

<https://publisher.uthm.edu.my/ojs/index.php/JTET/article/view/1081> Date of access: 15 May 2018.

Clark, C. & Rumbold, K. 2006. *Reading for pleasure: a research overview*.

<https://eric.ed.gov/?id-ED496343> Date of access: 20 Jun. 2016.

Colombo, M. & Furbush, D. 2008. *Teaching English language learners: Content and language in middle and secondary mainstream classrooms*. London, UK: Sage.

Craig, S.D., Sullins, J., Witherspoon, A. & Gholson, B. 2006. The deep-level-reasoning-question effect: The role of dialogue and deep-level-reasoning questions during vicarious learning. *Cognition and Instruction*, 24(4):565-591.

Creswell, J.W. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J.W. & Poth, C.N. 2017. *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.

Cummins, J. 1999. BICS and CALP: clarifying the distinction. In: Street, B. & Hornberger, N.H., eds. *Encyclopedia of language and education*. 2nd ed. New York: Springer. pp. 71-83.

Cummins, J. 2000. Putting language proficiency in its place: Responding to critiques of the conversational/academic language distinction. *English in Europe: The acquisition of a third language*: 54-83.

Cummins, J. 2008. BICS and CALP: empirical and theoretical status of the distinction. In: Street, B. & Hornberger, N.H., eds. *Encyclopaedia of language and education. Vol. 2: Literacy*. 2nd ed. New York, NY: Springer. pp. 487-499.

Cummins, J. 2017. BICS and CALP: Empirical and theoretical status of the distinction. *Literacies and Language Education*: 59-71.

Davoudi, M. & Sadeghi, N.A. 2015. A Systematic Review of Research on Questioning as a High-level Cognitive Strategy. *English Language Teaching*, 8(10):76.

De Koning, B.B. & van der Schoot, M. 2013. Becoming part of the story! Refueling the interest in visualization strategies for reading comprehension. *Educational Psychology Review*, 25(2):261-287.

De Vos, A.S., Strydom, H., Fouché, C.B., & Delpont, C.S.L. 2011. *Research at Grass Roots*. 4th ed. Pretoria: Van Schaik Publishers.

Deacon, S.H. & Kieffer, M. 2018. Understanding how syntactic awareness contributes to reading comprehension: Evidence from mediation and longitudinal models. *Journal of Educational Psychology*, 110(1):72.

Department of Basic Education **see** South Africa. Department of Basic Education.

Devlin, A.S. 2017. *The research experience: Planning, conducting, and reporting research*. Connecticut College, USA: SAGE Publications.

Dreyer, C. & Nel, C. 2003. Teaching reading strategies and reading comprehension within a technology-enhanced learning environment. *System*, 31(3):349-365.

Echeverri Acosta, L.M. & McNulty Ferri, M. 2010. Reading strategies to develop higher thinking skills for reading comprehension. *Profile Issues in Teachers Professional Development*, 12(1):107-123.

Edwards, N. 2010. An analysis of the alignment of the Grade 12 Physical Sciences examination and the core curriculum in South Africa. *South African Journal of Education*, 30(4).

Ellis, R. 2008. *Understanding Second Language Acquisition - Oxford Applied Linguistics*. New York: Oxford university press.

Elmore, R. & Sykes, G. 1992. Curriculum policy. In: Jackson, P.W., ed. *Handbook of research on curriculum: a project of the American Educational Research Association*. New York, NY: Macmillan. pp. 185-215.

Englander, M. 2012. The interview: Data collection in descriptive phenomenological human scientific research. *Journal of Phenomenological Psychology*, 43(1):13-35.

Evans, R. & Cleghorn, A. 2012. *Complex classroom encounters: a South African perspective*. Rotterdam: Sense Publishers.

Forehand, M. 2010. Bloom's taxonomy. *Emerging perspectives on learning, teaching, and technology*, 41(4):47-56.

- Gallik, J.D. 1999. Do they read for pleasure? Recreational reading habits of college learners. *Journal of Adolescent & Adult Literacy*, 42(6):480-488.
- Gibbons, P. 1991. *Learning to learn in a second language*. Portsmouth, NH: Heinemann.
- Gnaedinger, E., Hund, A. & Hesson-McInnis, M. 2016. Reading-specific flexibility moderates the relation between reading strategy use and reading comprehension during the elementary years. *Mind, Brain and Education*, 10(4):233-246.
- Gómez González, J.D. 2017. A model for the strategic use of metacognitive reading comprehension strategies. *Profile Issues in Teachers' Professional Development*, 19(2):187-201. <http://dx.doi.org/10.15446/profile.v19n2.58826> Date of access: 15 Aug. 2019.
- Grosser, M. & Nel, M. 2013. The relationship between the critical thinking skills and the academic language proficiency of prospective teachers. *South African Journal of Education*, 33(2).
- Halamish, V. & Elbaz, E. 2020. Children's reading comprehension and metacomprehension on screen versus on paper. *Computers & Education*, 145:103737.
- Hall, C. & Barnes, M.A. 2017. Inference instruction to support reading comprehension for elementary students with learning disabilities. *Intervention in School and Clinic*, 52(5):279-286.
- Harris, L.R. & Brown, G.T.L. 2010. Mixing interview and questionnaire methods: Practical problems in aligning data. *Practical Assessment, Research & Evaluation*, 15(1):1-19. <http://pareonline.net/getvn.asp?v=15&n=1> Date of access: 20 Nov. 2019.
- Harvey, J. 2018. Building solid language foundations for achievement. *HSRC Review*, 16(2):15-16.
- Hassan, F. 2017. Metacognitive strategy awareness and reading comprehension. *The English Teacher*, 18.
- Hlabane, A.S. 2014. *Exploring effects of incorporating English language in secondary school science education: a case of secondary school physical sciences learners in Mpumalanga Province*. Pretoria: University of South Africa. (Dissertation – MEd).

- Hodkinson, P. & Hodkinson, H. 2001. *The strengths and limitations of case study research. Paper presented to the Learning and Skills Development Agency Conference: Making an Impact on Policy and Practice, Cambridge, 5-7 December.*
http://education.exeter.ac.uk/tlc/docs/publications/LE_PH_PUB_05.12.01.rtf Date of access: 08 Jun 2017.
- Horning, A.S. 2007. Reading across the curriculum as the key to student success. *Across the Disciplines*, 4. <http://wac.colostate.edu/atd/articles/horning2007.cfm> Date of access: 9 Aug. 2017.
- Howie, S., Combrinck, C., Roux, K., Tshele, M., Mokoena, G. & Palane, N. 2017. *PIRLS literacy 2016: South African children's reading literacy achievement.*
<https://repository.up.ac.za/handle/2263/65780> Date of access: 20 Aug. 2020.
- İlter, İ. 2017. Concept-teaching practices in social studies classrooms: Teacher support for enhancing the development of students' vocabulary. *Educational sciences: theory & practice*, 17(4).
- Januarty, R. 2018. Extensive reading (ER) practices and the development of language fluency. *Lingua*, 12(3):267-272.
- Javanbakht, N. & Hadian, M. 2014. The effects of test anxiety on learners' reading test performance. *Procedia-Social and Behavioral Sciences*, 98:775-783.
- Jones, L.R., Wheeler, G. & Centurino, V.A. 2015. TIMSS 2015 science framework. *TIMSS*: 29-59.
- Joseph, L.M. & Ross, K.M. 2018. Teaching middle school students with learning disabilities to comprehend text using self-questioning. *Intervention in School and Clinic*, 53(5):276-282.
- Joseph, L.M., Alber-Morgan, S., Cullen, J. & Rouse, C. 2016. The effects of self-questioning on reading comprehension: A literature review. *Reading & Writing Quarterly*, 32(2):152-173.
- Kallio, H., Pietilä, A.M., Johnson, M. & Kangasniemi, M. 2016. Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, 72(12):2954-2965.
- Kawulich, B.B. 2005. Participant observation as a data collection method [81 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 6(2), art. 43.
<http://nbnresolving.de/urn:nbn:de:0114-fqs0502430> Date of access: 19 Jul. 2018.

- Klapwijk, N.M. 2015. EMC²= comprehension: A reading strategy instruction framework for all teachers. *South African Journal of Education*, 35(1):1-10.
- Knutson, E.M. 1997. Reading with a purpose: Communicative reading tasks for the foreign language classroom. *Foreign Language Annals*, 30(1):49-57.
- Korstjens, I. & Moser, A. 2018. Series: practical guidance to qualitative research. Part 4: trustworthiness and publishing. *European Journal of General Practice*, 24(1):120-124.
- Krashen, S.D. 1985. *The input hypothesis: Issues and implications*. New York, NY: Longman.
- Küçükoğlu, H. 2013. Improving reading skills through effective reading strategies. *Procedia-Social and Behavioral Sciences*, 70:709-714.
- Landine, J. & Stewart, J. 1998. Relationship between Metacognition, Motivation, Locus of Control, Self-Efficacy, and Academic Achievement. *Canadian Journal of Counselling*, 32(3):200-212.
- Le Cordeur, M. 2010. The struggling reader: identifying and addressing reading problems successfully at an early stage: language learning notes. *Per Linguam: A Journal of Language Learning*, 26(2):77-89.
- León, J.A. & Escudero, I. 2015. Understanding causality in science discourse for middle and high school students: summary task as a strategy for improving comprehension. In: Santi, K.L. & Reed, D.K., eds. *Improving reading comprehension of middle and high school students*. Cham, Switzerland: Springer. pp. 75-98.
- Leopold, C. & Leutner, D. 2012. Science text comprehension: Drawing, main idea selection, and summarizing as learning strategies. *Learning and Instruction*, 22(1):16-26.
- Leppänen, U., Niemi, P., Aunola, K. & Nurmi, J.E. 2004. Development of reading skills among preschool and primary school pupils. *Reading Research Quarterly*, 39(1):72-93.
- Li, M. & Kirby, J.R. 2015. The effects of vocabulary breadth and depth on English reading. *Applied Linguistics*, 36(5):611-634.
- Lin, G.H.C. 2008. Pedagogies Proving Krashen's Theory of Affective Filter. *Online Submission*.
- Lincoln, Y.S. & Guba, E.G. 1985. *Naturalistic inquiry*. Newbury Park, California: Sage.

- Makoni, R.T. 2016. The relationship between mother tongue and English second language learning strategies. Johannesburg: University of Witwatersrand. (Thesis – MA).
- Martens, C.E. 2014. An analysis of the vocabulary and reading comprehension challenges faced by first year B. Ed. learners. Potchefstroom: North-West University. (Thesis – M.Ed.).
- Marzec-Stawiarska, M. 2016. The influence of summary writing on the development of reading skills in a foreign language. *System*, 59:90-99.
- Mason, J. 2006. Mixing methods in a qualitatively driven way. *Qualitative Research*, 6(1):9-25.
- Mavuru, L. & Ramnarain, U.D. 2019. Language affordances and pedagogical challenges in multilingual grade 9 natural sciences classrooms in South Africa. *International Journal of Science Education*:1-21.
- Maxwell, J.A. 2012. *Qualitative research design: An interactive approach. Vol 41: Applied social research methods series*. Thousand Oaks, California: Sage publications.
- McEwan, E.K. 2004. Seven strategies of highly effective readers: using cognitive research to boost K-8 achievement. Thousand Oaks, CA: Corwin Press.
- McNamara, D.S. & Magliano, J.P. 2009. Self-explanation and metacognition. *Handbook of metacognition in education*: 60-81.
- McNamara, D.S., Ozuru, Y. & Floyd, R.G. 2017. Comprehension challenges in the fourth grade: The roles of text cohesion, text genre, and readers' prior knowledge. *International Electronic Journal of Elementary Education*, 4(1):229-257.
- Milligan, L.O. & Tikly, L. 2016. English as a medium of instruction in postcolonial contexts: Moving the debate forward. *Comparative education*, 52(3):277-280.
- Mills, K.A. 2008. The seven habits of highly effective readers. In: Cormack, P., ed. *Stories, places, spaces: literacy and identity: proceedings of the 2008 National Conference for Teaching of English Literacy*. <https://eprints.qut.edu.au/14966> Date of access: 2 Jun. 2016.
- Mogofe, R.A. 2016. *Integrating language literacy skills in teaching physical sciences in Riba Cross District, South Africa*. Limpopo: University of Limpopo. (Thesis – MA).
- Mokhtari, K. & Thompson, H.B. 2006. How problems of reading fluency and comprehension are related to difficulties in syntactic awareness skills among fifth graders. *Literacy Research and Instruction*, 46(1):73-94.

- Moreau, L.K. 2014. Who's really struggling?: Middle school teachers' perceptions of struggling readers. *RMLE Online*, 37(10):1-17.
- Mouton, J. 2011. *How to succeed in your master's and doctoral studies*. Pretoria: Van Schaik Publishers.
- Msimanga, A., Denley, P. & Gumede, N. 2017. The pedagogical role of language in science teaching and learning in South Africa: a review of research 1990–2015. *African Journal of Research in Mathematics, Science and Technology Education*, 21(3):245–255.
- Mullis, I.V., Martin, M.O. & Sainsbury, M. 2016. PIRLS 2016 reading framework. *PIRLS*: 11-29.
- Nel, C., Dreyer, C. & Klopper, M. 2004. An analysis of reading profiles of first-year learners at Potchefstroom University: a cross-sectional study and a case study. *South African Journal of Education*, 24(1):95-103.
- Nergis, A. 2013. Exploring the factors that affect reading comprehension of EAP learners. *Journal of English for Academic Purposes*, 12(1):1-9.
- Ness, M.K. 2016. Reading comprehension strategies in secondary content area classrooms: Teacher use of and attitudes towards reading comprehension instruction. *Reading Horizons*, 49(2):5.
- Ntuli, D. & Pretorius, E.J. 2005. Laying foundations for academic language competence: the effects of storybook reading on Zulu language, literacy and discourse development. *Southern African Linguistics and Applied Language Studies*, 23(1):91-109.
- OECD. 2019. *TALIS 2018 results. Vol. I: Teachers and school leaders as lifelong learners*. <http://www.oecd.org/education/talis-2018-results-volume-i-1d0bc92a-en.htm> Date of access: 15 May 2020.
- Opendakker, R. 2006. Advantages and disadvantages of four interview techniques in qualitative research. *Forum qualitative sozialforschung / Forum: qualitative social research*, 7(4).
- Park, J., Yang, J. & Hsieh, Y.C. 2014. University level second language readers' online reading and comprehension strategies. *Language Learning & Technology*, 18(3):148-172.
- Plourde, L.A. & Prado, L. 2011. Increasing reading comprehension through the explicit teaching of reading strategies: is there a difference among the genders? *Reading Improvement*, 48(1):32.

Plüddemann, P. 2015. Unlocking the grid: language-in-education policy realisation in post-apartheid South Africa. *Language and Education*, 29(3):186-199.

Prince, J. 2017. English Language Learners in a Digital Classroom. *CATESOL Journal*, 29(1):51-73.

Qian, D.D. 2002. Investigating the relationship between vocabulary knowledge and academic reading performance: An assessment perspective. *Language Learning*, 52(3):513-536.

Rai, M.K., Loschky, L.C., Harris, R.J., Peck, N.R. & Cook, L.G. 2011. Effects of stress and working memory capacity on foreign language readers' inferential processing during comprehension. *Language Learning*, 61(1):187-218.

Ramnarain, U., 2012. The readability of a high stakes Physics examination paper. *Acta Academica*, 44(2), pp.110-129.

Razak, S.A. & Yunus, M.M. 2018. *ESL primary classroom: knowledge of cognitive academic language proficiency (CALP) or academic language and basic interpersonal communication skills (BICS) or social language among pre-service teachers*. <http://ijeisr.net/Journal/Vol-2-No-1-Issu-04.pdf> Date of access: 30 May 2020.

Reddy, V. 2018. *TIMMS in South Africa: Making global research locally meaningful*. <http://www.hsrc.ac.za/en/review/hsrc-review-april-june-2018/timss-in-sa> Date of access: 30 May 2020.

Rollnick, M. 2000. Current issues and perspectives on second language learning of science. *Studies in Science Education*, 35(1):93-121.

Saido, G.M., Siraj, S., Nordin, A.B.B. & Al_Amedy, O.S. 2018. Higher order thinking skills among secondary school students in science learning. *MOJES: Malaysian Online Journal of Educational Sciences*, 3(3):13-20.

Schram, T.H. 2006. *Conceptualizing and proposing qualitative research*. 2nd ed. Upper Saddle River, NJ: Pearson Education Inc.

Schwandt, T.A., Lincoln, Y.S. & Guba, E.G. 2007. Judging interpretations: But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New Directions for Evaluation*, 2007(114):11-25.

Semtin, S.A. & Maniam, M. 2015. Reading Strategies among ESL Malaysian Secondary School Students. *International Journal of Evaluation and Research in Education*, 4(2):54-61.

- Shih, M. 1992. Beyond comprehension exercises in the ESL academic reading class. *Tesol Quarterly*, 26(2):289-318.
- Soto, C., Gutiérrez de Blume, A.P., Jacovina, M., McNamara, D., Benson, N. & Riffo, B. 2019. Reading comprehension and metacognition: The importance of inferential skills. *Cogent Education*, 6(1):1565067.
- South Africa. Department of Basic Education. 2001a. *National curriculum statement. Curriculum and Assessment Policy Statement English Home Language Grades 10-12*. Pretoria: Government Printers.
- South Africa. Department of Basic Education. 2001b. *National curriculum statement. Curriculum and Assessment Policy Statement English First Additional Language Grades 10-12*. Pretoria: Government Printers.
- South Africa. Department of Basic Education. 2009. *Report of the task team for the review of the implementation of the National Curriculum Statement*. Pretoria: Government Printers.
- South Africa. Department of Basic Education. 2011. *National curriculum statement. Curriculum and assessment policy statement Physical Science Further education and training phase grades 10-12*. Pretoria: Government Printers.
- South Africa. Department of Basic Education. 2018. *National curriculum statement. Curriculum and assessment policy statement Physical Science Further education and training phase grades 10-12*. Pretoria: Government Printers.
- South Africa. Department of Basic Education. 2013. *Manual for Teaching English Across the Curriculum*. Pretoria: Government Printers
- South African Department of Basic Education. 2018. *Physical Sciences P1 November 2018*. Pretoria: Government Printers.
- Stanovich, K.E. 1986. Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, 21:360-406.
- Swanson, E., Wanzek, J., McCulley, L., Stillman-Spisak, S., Vaughn, S., Simmons, D., Fogarty, M. & Hairrell, A. 2016. Literacy and text reading in middle and high school social studies and English language arts classrooms. *Reading & Writing Quarterly*, 32(3):199-222.
- Tan, M. 2011. Mathematics and science teachers' beliefs and practices regarding the teaching of language in content learning. *Language Teaching Research*, 15(3):325-342.

Taylor, N. 2016. Thinking, language and learning in initial teacher education. *Perspectives in Education*, 34(1):10-26.

Teddlie, C. & Yu, F. 2007. Mixed methods sampling: A typology with examples. *Journal of Mixed Methods Research*, 1(1):77-100.

The Physics classroom. 2021. Conductors and insulators.

<https://www.physicsclassroom.com/class/estatics/Lesson-1/Conductors-and-Insulators>.

Accessed: 25/1/2021

Van den Brook, P., Kendeou, P., Lousberg, S. & Visser, G. 2017. Preparing for reading comprehension: Fostering text comprehension skills in preschool and early elementary school children. *International Electronic Journal of Elementary Education*, 4(1):259-268.

Van Kraayenoord, C.E. 2010. The role of metacognition in reading comprehension. *Focal Points of the Research and Development of Pedagogically-Psychological Perspectives*: 277-302.

Van Staden, S. & Howie, S. 2010. South African teacher profiles and emerging teacher factors: The picture painted by PIRLS 2006. *Reading & Writing-Journal of the Reading Association of South Africa*, 1(1):47-60.

Vázquez, V.P. & Ellison, M. 2018. Examining teacher roles and competences in Content and Language Integrated Learning (CLIL). *Linguarum Arena: Revista de Estudos em Didática de Línguas da Universidade do Porto*, 4:65-78.

Vieira, R.M. & Tenreiro-Vieira, C. 2016. Fostering scientific literacy and critical thinking in elementary science education. *International Journal of Science and Mathematics Education*, 14(4):659-680.

Warner, G.J. & Fay, D. 2017. Relations among Personal Initiative and the Development of Reading Strategy Knowledge and Reading Comprehension. *Frontline Learning Research*, 5(2):1-23.

Wassenburg, S.I., Bos, L.T., de Koning, B.B. & van der Schoot, M. 2015. Effects of an inconsistency-detection training aimed at improving comprehension monitoring in primary school children. *Discourse processes*, 52(5-6):463-488.

Webb, P. & Mayaba, N. 2010. The effect of an integrated strategies approach to promoting scientific literacy on grade 6 and 7 learners' general literacy skills. *African Journal of Research in MST Education*, 14(3):34-49.

- Weideman, A. 2003. Assessing and developing academic literacy. *Per Linguam: A Journal of Language Learning*, 19(1&2):55-65.
- Wexler, J., Mitchell, M.A., Clancy, E.E. & Silverman, R.D. 2017. An investigation of literacy practices in high school science classrooms. *Reading & Writing Quarterly*, 33(3):258-277.
- Wiley, J., Griffin, T.D., Jaeger, A.J., Jarosz, A.F., Cushen, P.J. & Thiede, K.W. 2016. Improving metacomprehension accuracy in an undergraduate course context. *Journal of Experimental Psychology: Applied*, 22(4):393.
- Whitten, C., Labby, S. & Sullivan, S.L. 2019. The impact of pleasure reading on academic success. *Journal of Multidisciplinary Graduate Research*, 2(1).
- Yamashita, J. 2007. The relationship of reading attitudes between L1 and L2: An investigation of adult EFL learners in Japan. *Tesol Quarterly*, 41(1):81-105.
- Yin, R.K. 1994. *Case study research*. Thousand Oaks, Cal.: Sage Publications.
- Yin, R.K. 2009. *Case study research: design and methods*. 4th ed. London: Sage.
- Yore, L.D. & Treagust, D.F. 2006. Current realities and future possibilities: Language and science literacy—empowering research and informing instruction. *International Journal of Science Education*, 28(2-3):291-314.
- Zhang, L.J. & Wu, A. 2009. Chinese senior high school EFL learners' metacognitive awareness and reading-strategy use. *Reading in a Foreign Language*, 21(1):37.

ANNEXURES

Annexure A

Private Bag X6001, Potchefstroom



South Africa 2520

Tel: +2718 299-1111/2222

Web: <http://www.nwu.ac.za>

North-West University Education, Management

**and Economic Sciences, Law, Theology,
Engineering and Natural Sciences
Research Ethics Office (NWU-EMELTEN-
REC)**

NOTIFICATION: APPROVAL OF YOUR APPLICATION BY THE NWU-EMELTEN-REC

Ethics number: NWU-00531-19-S2

Kindly use the ethics reference number provided above in all correspondence or documents submitted to the NWU-EMELTEN-REC secretariat.

Study title: The use of reading strategies in English Medium of Instruction Physical Sciences classroom in the FET phase

Student: Ms. S Swart

Application type: Single study

Risk level: Minimal

You are kindly informed that your application was reviewed at the meeting held on 10 June 2019 of the NWU-EMELTEN-REC and was approved on 8 August 2019.

The commencement date for this study is 8 August 2019 dependent on fulfilling the conditions indicated below. Continuation of the study is dependent on receipt of the annual monitoring report and the concomitant issuing of a letter of continuation up to a maximum period of one year when extension will be facilitated during the monitoring process.

After ethical review:

Translation of the informed consent document to the languages applicable to the study participants should be submitted to the NWU-EMELTEN-REC (if applicable).

The NWU-EMELTEN-REC requires immediate reporting of any aspects that warrants a change of ethical approval. Any amendments, extensions or other modifications to the proposal or other associated documentation must be submitted to the NWU-EMELTEN-REC prior to implementing these changes. Any

adverse/unexpected/unforeseen events or incidents must be reported on either an adverse event report form or incident report form.

A monitoring report should be submitted within one year of approval of this study and before the year has expired, to ensure timely renewal of the study. A final report must be provided at the completion of the study or the NWU-EMELTEN-REC must be notified if the study is temporarily suspended or terminated. The monitoring report template is obtainable from the NWU-EMELTEN-REC Office at Ethics-EMELTEN-mon@nwu.ac.za. Annually a number of studies may be randomly selected for an external audit.

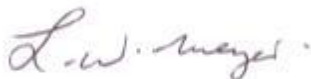
Please note that the NWU-EMELTEN-REC has the prerogative and authority to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.

Please note that for any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the NWU-EMELTEN-REC Office. Ethics approval is required BEFORE approval can be obtained from these authorities.

The NWU-EMELTEN-REC complies with the South African National Health Act 61 (2003), the Regulations on Research with Human Participants (2014), the Ethics in Health Research: Principles, Structures and Processes (2015), the Belmont Report and the Declaration of Helsinki (2013).

We wish you the best as you conduct your research. If you have any questions or need further assistance, please contact the NWU-EMELTEN-REC Office at Ethics-EMELTEN-apply@nwu.ac.za.

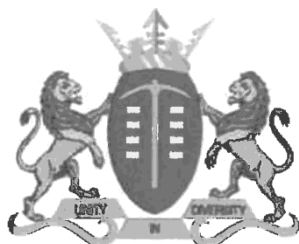
Yours sincerely



Prof Lukas Meyer

Chairperson NWU-EMELTEN-REC

Annexure B



GAUTENG PROVINCE

Department: Education

REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	21 August 2019
Validity of Research Approval:	04 February 2019 - 30 September 2019 2019/239
Name of Researcher:	Swart S.M
Research Topic:	The use of reading strategies in English Medium of Instruction Physical Science classrooms in the FET phase.
Type of qualification	Masters' in Education
Number and type of schools:	One Secondary School
District/s/HO	Johannesburg West

Re: **Approval in Respect of Request to Conduct Research**

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Simmonds Street, Johannesburg, 2001

Annexure C



Office of the School Director:

School of Language Education
Faculty of Education

PARENTAL CONSENT

I, the undersigned (Full names and Surname):

parent of (Full names and Surname):

hereby give consent that my child may be present during data collection in the Physical Science classroom at Allen Glen High in grade 10 and 11 for a study that focuses on “The use of reading strategies in English Medium of Instruction Physical Science classrooms in the FET phase”. The aim thereof is to establish whether English Medium of Instruction Physical Science teachers in the FET phase are aware of reading strategies and if so, whether they focus on the implementation of these strategies in teaching and learning in order to enhance learners’ academic understanding and performance in Physical Science.

I understand that my child will not be a direct participant in the study and will only be there in the peripheral as the focus of the study is on the teacher and not the learners.

Please contact research supervisor, should you need more information about the research study.

Signature of parent: _____

Date: _____

Annexure D



Office of the School Director:
School of Language Education
Faculty of Education

LEARNER ASSENT FORM

I, the undersigned (Full names and Surname of Learner):

hereby assent to be present while a study at Allen Glen High of grade 10 and 11 is conducted in the Physical Science classroom regarding “The use of reading strategies in English Medium of Instruction Physical Science classrooms in the FET phase. The aim thereof is to establish whether English Medium of Instruction Physical Science teachers in the FET phase are aware of reading strategies and if so, whether they focus on the implementation of these strategies in teaching and learning in order to enhance learners’ academic performance in Physical Science.

I understand that I will not be a direct participant in the study and will only be there in the peripheral and that the focus of the study is on the teacher and not the learners.

Please contact, the supervisor of the research, should you need more information about the study.

Signature of learner: _____

Date: _____

Annexure E

Observation Checklist

Lesson topics: Mining, Processing of gold ore, Vectors, Diagrams, Newton's laws + diagrams

Teacher: A

No.	Reading strategy	Used by teacher	Taught to learners	Questions linking to strategy	Comments
1	Prior knowledge activation	Used in all lessons	Taught in one lesson	Linking questions asked in two lessons	<p>2) Learners were asked to make use of prior knowledge with regards to mining processes.</p> <p>3) Learners were asked to make use of their prior knowledge with regards to vectors.</p> <p>5) Learners were asked about the different types of forces.</p>
2	Inferring	Used in two lessons	Taught in two lessons	None	<p>1) Learners were asked to make inferences based on money vs environmental impact of money. Strategy was not taught explicitly, but learners were able to use it.</p>

					<p>2) The teacher made the connection between the different mining sectors and processes without allowing the learners to do so.</p> <p>4) The teacher explained how the different forces are used and the effect it has. Could have asked learners to explain the different effects.</p>
3	Clarification	None	None	None	3) Basic questions asked.
4	Questioning	Used in three lessons	Taught in one lesson	Linking questions asked in one lesson	
5	Searching& Selecting	None	None	None	
6	Summarising	Used in one lesson	None	None	5) Educator summarised the order in which questions should be answered.
7	Visualising	Used in four lessons	Taught in four lessons	None	2) Learners were asked to visualise the process of gold ore Mining and the processed needed to extract the ore. The teacher made use of visual examples to explain the concepts. Video was shown to explain mining.

					<p>3) Learners were asked to draw a sketch about vectors in order to explain the concept.</p> <p>4) Learners had to draw a visual representation of their answer relating to forces.</p> <p>5) Learners were asked to visualise themselves on and escalator to determine the force</p>
8	Teaching subject specific vocabulary	Used in three lessons	Taught in one lesson	Taught in one lesson	4) Learners were expected to make use of subject specific terminology when answering questions.
9	Text recognition	Used in one lesson	None	None	3) Teacher explained the different components to assist learners when it came to drawing the sketch.

Comments on classroom setup (posters, visual aids, use of aids)

- 1) A variety of posters are seen in the class that is subject related. The participant makes use of slide shows during the lesson.

Vocabulary (Word explanation vs defining, word attacking, repairing of vocabulary? used by learners):

e.g. looking at the origin of words; root words; role of prefixes and suffixes.

- 1) Words are explained in simple terms. Some words are used that might cause confusion and the teacher makes the assumption that the learners understand the terms. The word alluvial was used on a slide without an explanation of the word.
- 2) Subject vocabulary was used, but the terms were not explained again. Terms like Redox not explained. Rhyme used to explain concept. Learners struggled with the pronunciation of deforestation. The teacher did not assist learners with the pronunciation and assumed that all the learners understood the meaning of the word.
- 3) Subject specific terms were explained but not defined. No reference was made to the root word or prefixes/suffixes to assist learners with understanding the words vectors and scalars. The teacher explained the common mistakes made with regards to these terms but did not explain how to avoid those mistakes.
- 4) Learners were asked to provide the definition of the different terms, which did not show a full understanding but merely a memorisation of a definition. No word repairing strategies were used as the teacher only stated what the right answer was without explaining the word to assist with comprehension.
- 5) Definitions of terms given without explain the word. Vocabulary repairing was seen when the teacher provided synonyms to help learners understand. It was assumed that learners understood a word like "inverse". Could have broken up the word to assist with the understanding.

Text recognition (explanation of text structure, explanation of language specific to text e.g. tense).

- 1) Not sketches were used. The slides contained subject specific language but not fully explained. The teacher used a rhyme to teach the density formula in a triangle.
- 2) Flow diagram used, structure not explained. No attention was paid to language aspects. Explanation of a chemical equations seen, each aspect was identified and explained in the context. Essay was explained to learners. Indicated that essay can be done in point form. Point form does do not constitute an essay.

- 3) Teacher explained the sketch in terms of the position of the x and y axis. The diagram was explained in order to assist learners in the answering of questions relating to the diagram.
- 4) The teacher walked around the class and pointed out the missing components like units or direction. Although he pointed out the mistakes, he did not explain again why these components need to be at a specific place.
- 5) The teacher explained the different components of the diagrams on vectors. He explained how the equations are represented in diagram form.

Language (awareness of semantic inference).

- 1) Teacher attempts to simplify concepts and terms. No language awareness seen.
- 2) Teacher not aware of the structure and format of essay writing.
- 5) The use of explanations by learners when it comes to force were used/experienced in cars allows learners to use language to explain a concept and link it to their own lives.

Questioning to assist with understanding (does it allow for critical engagement and thinking i.e. open-ended questions (on which cognitive levels according to Bloom's taxonomy); does the teacher mostly use yes/no questions.

- 1) Questions asked of learners go beyond yes/no. Learners are required to make use of general knowledge in order to give and answer regarding mining and ethics.
- 2) Questions extracted answers that was more than just yes/no. Although some questions still prompted the "choir" response. Higher order thinking questions were asked when learners had to explain the economic impact of mining. Teacher asked guiding questions to make sure that learners are able to not only understand the content but form good arguments around it.
- 3) Questions that were asked did not utilise higher level thinking skills. Exam questions were explained in terms of how they look and how to go about answering them.
- 4) The teacher asked questions that forced learners to make inferences in order to answer questions. Learners had to analyse a diagram and come up with various answers based on the different components in the given sketch.
- 5) Questions only tested the basic understanding of Newton's laws.

Educator proficiency (language use, spelling, pronunciation)

- 1) Teacher shows a good level of language proficiency. Pronunciation and sentence construction good. Sometimes talking too fast which could distort the meaning. Tautology seen in some instances.

2) Minor pronunciation errors could be due to dialect.

4) Tense errors seen with the use of “did” versus “done”

Other comments and observations regarding reading and comprehension.

1) Some concepts were not fully explained. Lesson made use of a lot of discussions from learners in order to extract information. Learners’ own point of view linked to concepts. Teacher made no attempts to correct the incorrect language use by learners.

2) Teacher tries to explain the concepts as practical as possible.

3) Helped learners incorporate colours into sketch in order to aid visualisation. Learners wrote their answers on the board and the teacher helped them fix the mistakes they made.

4) When revision is done, the teacher could focus more on language aspects such as word recognition and repair strategies.

Observation Checklist

Lesson topics: Distance + Speed, Vectors + scalars, Conversion of units + calculations, Motion,

Description of motion

Teacher: B

No.	Reading strategy	Used by teacher	Taught to learners	Questions linking to strategy	Comments
1	Prior knowledge activation	Used in all lessons	Taught in one lesson	None	<p>1) Teacher referred to prior knowledge regarding distance, but did not ask learners questions to test their understanding.</p> <p>3) Teacher needs to establish a link between prior knowledge and activity.</p> <p>5) Learners were reminded of rest position.</p>
2	Inferring	Used in one lesson	None	None	<p>1) Learners were asked to use mathematical skills in order to do calculations.</p>
3	Clarification	None	None	None	<p>4) The teacher did not always clarify confusion. Learners did not know.</p>

					how to clarify for themselves.
4	Questioning	Used in four lessons	None	None	<p>1) Questions asked not of higher order, basic questions.</p> <p>2) Questions could be structured to get a more comprehensive response from the learners.</p> <p>4) Learners were not taught to question for themselves.</p>
5	Searching & Selecting	Used in two lessons	Taught in one lesson	None	<p>4) Teacher selected certain information from the diagram to answer question. The teacher asked learners to identify the needed information.</p> <p>5) Learners are asked to select words in order to draw graph.</p>
6	Summarising	None	None	None	
7	Visualising	Used in four lessons	None	None	<p>1) Learners asked to imagine the route they take home.</p> <p>2) Helped learners understand by using sketches to assist with comprehension.</p> <p>4) A diagram was used to aid comprehension</p> <p>5) Statement in words also represented in word form.</p>

8	Teaching subject specific vocabulary	Used in four lessons	Taught in three lessons	None	2) Teacher explained vector and scaler. Learners also made use of subject specific vocabulary when responding.
9	Text recognition	Used in one lesson	None	None	

Comments on classroom setup (posters, visual aids, use of aids)

1) Basic posters in class. Some subject specific posters seen. No models or other visuals seen. Slide show used during lessons. Sketches used to explain content.

Vocabulary (Word explanation vs defining, word attacking, repairing of vocabulary? used by learners):

e.g. looking at the origin of words; root words; role of prefixes and suffixes.

1) The word displacement could cause a problem for some learners. Terms were not explained, learners had to read the definition of distance and displacement. The teacher attempted to explain the difference by making use of a sketch on the board. Words not broken down to assist learners with comprehension. Speed and velocity compared. No explanation of the words was done. Another word that was used but not explained is scaler quality.

3) Subject specific terms were explained but not defined.

4) Terms were defined, but the word was not explained. The teacher attempted to assist learners by making use of practical examples.

5) No word attacking seen. Scientific terms are used with explanations but the word is not broken down.

Text recognition (explanation of text structure, explanation of language specific to text e.g. tense).

- 1) A sketch was used making reference to Pythagoras. Aspects not explained. Answers to the questions regarding the sketch was just given without a lot of explaining. Questions not fully explained and the sketch did not aid all the learners in understanding the concepts.
- 2) Graphs on scale explained by showing learners were the different components go. No explanation of why they go there or what can be used to recognise the different types of graphs.
- 3) Teacher referred to a vector sketch, did not explain the composition and important aspects that makes a vector sketch.
- 5) The teacher broke down a question and pointed out words that are important for understanding the question. Equations used. Did not explain the components of the formula, this caused some confusion as learners did not know how to use the formula. Graph drawn by using information represented in the text.

Language (awareness of semantic inference).

- 1) The teacher does do not attempt to use language in order to simplify concepts. Relies on verbal instruction and basic sketches without paying attention to the language. Questions and words not broken up to assist learners.
- 2) Awareness of sentence construction seen when the teacher corrected the learners with regards to subject and object. Did not explain why the change of subject and object.
- 5) No language awareness seen.

Questioning to assist with understanding (does it allows for critical engagement and thinking i.e. open-ended questions (on which cognitive levels according to Bloom's taxonomy); does the teacher mostly use yes/no questions.

- 1) Limited questions were asked to test understanding. When questions were asked, they mainly prompted a yes/no response. No specific questions were asked to test whether the learners understood the task. Learners' questions answered using different examples even practical examples. Questions not always challenging.
- 2) Teacher is making use of questions that is dependent on prior knowledge and the application of it.
- 3) Questions that were asked did not utilise higher level thinking skills.
- 4) Teacher asked questions that required learners to provide definitions. Questions developed into more complex questions, although learners were not able to answer. E.g. how acceleration is calculated.

- 5) Questions asked required learners to apply knowledge that they previously learnt. Learner still not able to fully convey work that was covered. The teacher discussed the phrasing of questions and how to use the words to derive meaning in order to answer the questions. Composition of a question explained in a very superficial manner. Some words such as the verbs could have been explained further to provide clarity.

Educator proficiency (language use, spelling, pronunciation)

- 1) Language use is sufficient. Slight pronunciation errors which could be attributed to dialect. Axis vs access.
- 2) Some pronunciation errors. Good communication.
- 4) Simplistic language used to assist learners with comprehension.

Other comments and observations regarding reading and comprehension.

- 1) No clear attempt made to teach reading or comprehension. The lesson does not lend itself fully to reading/comprehension teaching. However, some of the terms and concepts could have been developed more to aid comprehension. Assumptions regarding mathematical terms were made and the teacher only re-explained the concept when the learners asked.
- 2) Class very distracted, some learners talking causing them to not understand some of the concepts.
- 3) Teacher making the assumption that all the learners understand the mathematical equations that is being used.
- 4) Teacher uses diagrams to visually represent content.
- 5) Learners struggled with prior knowledge, the teacher could have gone back and re-explained the concepts. The teacher only corrected learners without explaining why they were wrong. Learners cannot do calculations, knowledge needed to do calculations not established. (not sure if the mathematics or science skills are lacking)

Observation Checklist

Lesson topics: Chemical equations, Acid-Base reactions, Solutions, Titration, Redox Reactions

Teacher: C

No.	Reading strategy	Used by teacher	Taught to learners	Questions linking to strategy	Comments
1	Prior knowledge activation	Used in all lessons	Taught in one lesson	None	<p>1) Quick reference made to prior knowledge, however the learners did not seem to understand the previous work.</p> <p>2) Learners were asked to make use of prior knowledge with regards to mining processes.</p> <p>3) Learners were asked to make use of their prior knowledge with regards to vectors.</p> <p>5) Learners were asked about the different types of forces.</p>
2	Inferring	Used in four lessons	Taught in one lesson	Taught in one lesson	<p>2) Connection made between the different mining sectors and processes without allowing the learners to do so.</p> <p>4) The teacher explained how the different forces are used and the effect</p>

					it has. Could have asked learners to explain the different effects.
3	Clarification	Used in three lessons	None	None	<p>1) Concepts not clarified. Learners sought their own clarity.</p> <p>3) Basic questions asked.</p>
4	Questioning	Used in all lessons	Taught in one lesson	None	<p>1) Questions were asked by both the teacher and the learners.</p>
5	Searching& Selecting	Used in three lessons	None	None	
6	Summarising	None	None	None	
7	Visualising	Used in four lessons	Taught in one lesson	None	<p>2) Learners were asked to visualise the process of gold ore Mining and the processed needed to extract the ore. Visual examples used to explain the concepts. Video was shown to explain mining.</p> <p>3) Learners were asked to draw a sketch about vectors in order to explain the concept.</p> <p>4) Learners had to draw a visual representation of their answer relating to forces.</p> <p>5) Learners were asked to visualise themselves on and escalator to</p>

					determine the force
8	Teaching subject specific vocabulary	Used in all lessons	Taught in four lessons	None	<p>1) Teacher and learners used subject specific vocabulary.</p> <p>4) Learners were expected to make use of subject specific terminology when answering questions.</p>
9	Text recognition	Used in two lessons	Taught in one lesson	None	<p>3) Teacher explained the different components to assist learners when it came to drawing the sketch.</p>

Comments on classroom setup (posters, visual aids, use of aids)

- 1) There are posters in the class, not all are subject specific. Used board to write down equations and explain concepts.
- 2) The teacher made use of the white board as well as the projector.
- 3) Sketches and physical experiments were used.
- 4) Visuals and sketches used.
- 5) Sketches used together with the projector.

Vocabulary (Word explanation vs defining, word attacking, repairing of vocabulary? used by learners):

e.g. looking at the origin of words; root words; role of prefixes and suffixes.

- 1) Words like conduit was used and the assumption was made that all learners understood it. Carbonic acid was explained as an acid that contains carbon. Confusion regarding acid and base seen. No repairing strategies were used in order to clear up confusion. Word attacking was not used, very limited clarification of terms was used. Did explain conduit pairs in simple terms without making use of the definition.
- 2) Subject vocabulary was used.
- 3) The educator explained the purpose of a standard solution. Some words could have been re-explained to assist comprehension. Definition of a standard solution was given. Names of the different flasks were explained by breaking down the words. The teacher clarified concepts and terms in order to repair the confusion between decimetres and letters. The definition of titration was given. The word could have been broken down so that the learners understand the name and not just the definition.
- 4) The teacher explained the concepts without explaining the words. Anhydrous was explained as being without water. The prefix was not explained, only the concept.
- 5) Used initialism O.L.R.G to help learners remember "Oxidation is lost ... Reduction is gained". The word redox was broken up into re=reduction and dox=oxidation. The concept of a redox reaction was explained by using what learners already know. Learners were already taught non-redox reactions. The teacher linked the definition to the visual explanations that was done. Oxidation could have been broken up Oxide meaning O₂ bonded to one or more positive atoms.

Text recognition (explanation of text structure, explanation of language specific to text e.g. tense).

- 1) The structure of a chemical equation was not explained fully. Did use parts of the structure to derive answer.
- 2) Periodic table of elements used. Structure of the table was explained as well as the names of the elements and the ions. The chemical equations were written on the board and explained. The teacher explained the elements and what happens during the interaction. An experiment was done, but the structure (steps) was not explained. Names of the chemical were given. Teacher explained that calcium carbonate is used in Enos. He explained that the acid is added to the water and not the other way around.

- 3) Steps were given on how to make a standard solution. The various components of the experiment were explained not just by using sketches, but also the physical components. The teacher used written steps together with sketches to explain concepts. The physical experiment was done.
- 4) Learners had to use the correct chemical equations and calculations. the teacher explained the different components of the equation and how to make the conversions.
- 5) The teacher explained the particles that are present in the chemical equation. Sketches used on the board and the different components explained. Balancing of elements explained and applied.

Language (awareness of semantic inference).

- 1) No language awareness seen. No attempt was made to make links to real world scenarios.
- 2) Tried to link concept to real world by explaining common a common word like indigestion.
- 3) The teacher created a link between the experiment and ecology. Ecology was explained.

Questioning to assist with understanding (does it allows for critical engagement and thinking i.e. open-ended questions (on which cognitive levels according to Bloom's taxonomy); does the teacher mostly use yes/no questions.

- 1) Questions asked were basic. Did not prompt responses that showed a deeper understanding of the content. Questions go a "choir" response. Answers that were wrong were not fully explained.
- 2) Questions asked was basic but did test the understanding of the learners. Questions during the experiment was more complex and caused learners to think more about the answer.
- 3) Questions were given which required learners to apply what was taught. In order to answer the questions, learners had to select and use the relevant information to assist with the application.
- 4) The teacher asked questions that forced learners to make inferences in order to answer questions. Learners had to analyse a diagram and come up with various answers based on the different components in the given sketch.
- 5) At the beginning of the lesson, questions were only yes/no in natures. Questions became a bit more complex when learners were asked to work out the charge based on a sketch. Questions allowed for higher order thinking as learners had to balance the equation and state the by-products.

Educator proficiency (language use, spelling, pronunciation)

- 1) Teacher shows a good level of language proficiency. Pronunciation and sentence construction good.

Other comments and observations regarding reading and comprehension.

- 1) Learners seem to not have fully grasped previous knowledge regarding weak and strong basis. This caused confusion when they needed to apply the knowledge. The teacher did not attempt to repair this gap, told learners to read previous work. Learners were able to clear up confusion on their own by using questioning and inferring even though it was not taught to them.
- 2) Used an indicator to show if the liquid was an acid or a base. Tried to simplify how the questions would appear in the exam. Made use of practical experiments to explain how the reaction takes place. Explained flammability by making use of a practical experiment. The teacher sent around a beaker containing the salt that formed during the reaction for the learners to see.
- 3) The teacher explained why liquids are put in a certain order. New formula was explained, but only some components. There were some elements that was not explained. The combination of written steps, sketches and physical experiment help to establish understanding.
- 4) Practical application of knowledge seen. Learners were guided by the teacher when it came to chemical equations. Learners had to apply previous knowledge in order to solve problem. Teacher walked around and assisted where learners did not understand.
- 5) Explanation of electrons done using visual representations. The teacher answered questions by learners by simplifying the language in order to assist the learners with understanding. Learners were given various examples.

Annexure F

Participant A

Researcher:	Hello and welcome. Please can you state the number of years that you have been teaching Physical Sciences.
Participant A	6 years.
Researcher	How would you define your role in terms of language instruction? Do you think that it is important for you to be a language instructor in your classroom?
Participant A	Yes, but on many different levels. I need to not only know English, but also the local cultural language in order to explain concepts. It was very challenging at the beginning, because if my instructions are not clear, the learners will not be able to understand.
Researcher	How would you define your role of teaching language concepts that you touched on just now?
Participant A	It is very important. I found out in a classroom that it is not about how much I know, but how much I instil in a kid, so how much the learner understands. That is important because a teacher needs to have the correct language ability, communication ability, the ability to talk and assess on a level that the kid understands. For example, I found that if you know common words from indigenous knowledge where the locals are aware of it, so when I teach for example for Gr 10 the beer making process. Here the common term known to us is alcohol, you go down the street and people will be able to list alcohol. But when I bring that knowledge into a classroom they might know it as other words like " umqomboti " because they will have different ways that they know alcohol as.
Researcher	Do you consciously incorporate elements of language into your lesson planning?
Participant A	I have to, for Physical Science it is important to not only teach the concepts, but for learners to understand why they are learning the concepts. Language is very important, I use a site called ScienceDaily, it is a platform where research introduce their topics. For example, the major thing right now is soil found during the moon landings and they are using new technology to test it. I explain to the learners the processes and machinery, because I am not only preparing them for the school environment, but also for university.

Researcher	How would you then define language in your subject?
Participant A	Verbal and non-verbal way of expressing life. I will show them with models and drawings as well as, verbally with words and illustrating to the best of my knowledge how the universe works.
Researcher	In your opinion, what are some of the main reasons why learners fail to understand your subject?
Participant A	Language barrier. That is the major thing. I found this out with experience, it is not something that is taught to you in university. Because of the different cultures they have different names for the different concepts. I am not that the kid does do not understand the concept, they were just taught it by another word and the way of understanding it according to their culture. If a kid comes with indigenous knowledge or cultural knowledge into the class, I need to link my content to their knowledge instead of just throwing the concept to them. I have to find the common link. Language barrier is a major problem that I suffer with. Also, Mathematics. Many kids are very good at "swotting" and understanding concept, but unfortunately, they cannot calculate in. In Physical Science, Mathematics plays a major role.
Researcher:	What about reading?
Participant A	Reading is very important. I find that when the kids read, they read well but they do not understand what they are reading.
Researcher	Do you pay specific attention to reading and reading strategies when you teach?
Participant A	Yes, my PowerPoint simulations have reading on them, they use MiEbooks as well as extra assessments that require them to read and understand. I focus not only on reading, but also reading and understanding. I found out that if you add a diagram or an illustration the learner does not only have to read words, but they also understand better when there are concepts illustrated or drawn for them. More of a visual learner sometimes, compared to the normal learner you get in the classroom.
Researcher	What do you see as reading strategies?
Participant A	Reading for me is not only words, but also graphics. I started the thing where I use cartoons now, to break the ice. Learners create own cartoon for example, explaining the kinetic molecule theory. I find that it is much more stimulating on their side and without them knowing, they actually do read.

Researcher	You said you use cartoons to integrate language into your classroom. Do you find that it is successful to the extent that it improves reading comprehension?
Participant A	I find that according to research a child's concentration is only for 15 minutes, so I find if you break the written work with illustrations, they understand better. The comprehension is better when you not only have words, but diagrams as well to reinforce concepts.
Researcher	How confident are you to teach language and language structures in your classroom?
Participant A	In terms of my curriculum I am 100% confident. In terms of linking it to the cultural language it is an everyday learning experience. For example, I could master the Zulu way in which words are used or concepts are explained. Then I get a learner that is Venda and their way is completely different. So, when it comes to a classroom, it is a broad band of cultures. Unfortunately, English is not the only medium that they understand. It is taught in English but they know it by different names.
Researcher	Seeing as this is an English home language school, the interaction when it comes to teaching your subject through English medium of instruction, how do you transcend that barrier of learners not being able to understand concepts by using language as an aid?
Participant A	I try to use easier English words that they do understand. I try to explain it in a way that they will understand, but I also ask them to explain it to me in their culture so that I can also learn something from them. I find that the more I try over and over again to talk about English even in an English medium school, unfortunately we have kids who are not speaking in English language. I feel it is my responsibility help them understand concepts. The language barrier is overcome by nr 1 illustrating things, nr 2 demonstrations with practical's, nr 3 YouTube videos, they help a lot. I also use the cartoon why of explaining concepts. I ask them questions so I can understand how to explain to them better.
Researcher	Which repair strategies do you use, should a learner struggle with comprehension?
Participant A	I love the highlighter method, where you highlight certain things, where you ask learner to underline and explain what they have underlined. The second strategy is breaking it down into the paragraph form. For example, if I have one chemical equation, I will have them write it down, then write down the definition, they highlight the equation and explain the definition in terms of the equation.

Researcher	From my understanding, you give the definition and the learner needs to explain in their own words what it means.
Participant A	No. The definition gives birth to an equation, they have to know both. They take the highlighter and the highlight common words e.g. density which is equal to mass over volume. They will highlight density in one colour, mass in another and volume in another. There are three quantities that they are working with. In any comprehension or situation, they are able to highlight in the same colour in the problem.
Researcher	In your CAPS document it talks about prefixes and suffixes. Do you pay attention to that?
Participant A	We have to, we are training kids to become doctors. A wrong prefix could lead to an overdose, or actually someone committing suicide. There is a big difference between di- which is two and tri- which is three. The section is called names and formulas.
Researcher	With regards to using language as a vessel to teach you subject, do you feel that you had sufficient training as an educator to assist you with teaching language concepts in your classroom?
Participant A	I think that I am lucky when it comes to the teaching of prefixes, because we use the international ones. I know they changed the way of calculations four years ago but I was lucky. The new way that they inform educators is a workshop that they have to attend.
Researcher	When I talk about language concepts that includes amongst others syntax, root words, tenses...
Participant A	I think the way the curriculum that I was taught was much more compared to what is taught in university at the moment. I was lucky because I was the only one that taught Technical Science. There were certain subjects that not educators were taught at university. I received more information than what was required for teaching Physical Science. I was also privilege, that even though it is not taught at the moment, I can teach it at university. I do know that it was not compulsory for me to learn it. If you want to know more about reading and the strategies you can study further on.
Researcher	Would there be a benefit in getting training in language?
Participant A	I think any training is good. I do believe that the different techniques in language has changed, just like the books we read and the way we communicate and teach. So, any training is welcome.

Researcher	Do you think language concepts has a place in your subject?
Participant A	Yes, the English medium is very important. The kids will not be able to understand anything if they do not understand the language. For example, there is a big difference between add and subtract, or put in and take out. When we do chemical experiments and equations if they do not know the basic language they will not understand. As I said we prepare them for the medical field and language barriers will not be able to cope at all.
Researcher	Do you see yourself as a language teacher?
Participant A	Yes. I have to use my words verbal and non-verbal and be an instrument in taking the knowledge that I know and playing it out to the kid so the kid understands the tune that I am playing.
Researcher	How do you equip learners to use reading strategies?
Participant A	The three "r's" are nice revise, review, repeat. Another thing is mind maps. I use it a lot after sections. Also tests. I find also that a summary after each section is necessary. Even if it is just writing the definitions or formulas. I give a lot of exercises, because I find that a kid might understand the concept but might not be able to demonstrate it.

Participant B

Researcher:	Thank you much for allowing me to get some insight into a teaching a subject with reference to the observation I have conducted I would like to ask a couple of questions. First, your please can you tell me your age.
Participant B	I will be 51 in June.
Researcher	And how many years have you been teaching physical science specifically?
Participant B	Since 2003, specifically Physical Science, not math or anything else.
Researcher	That is 17 years. In your own words how would you define the role of language? First, in terms of instruction in your class and B how do you understand the concept with understanding of the concepts that taught and C relation to the fact/ facts in your

	lesson. How would you define the role of language in terms of your instruction of language?
Participant B	Well, language in general differs. There is the English language English language and how use the physics language. Because now in English when you talk about distance, we could be talking about just from one point to the other, but in physics you differentiate between distance and displacement. The medium of instructions is the same, it is English, but the deeper meaning of the word in physics differs.
Researcher	Your example of distances that you have just used will that differ because in science does not distance also mean from point A to point B?
Participant B	No, from point A to point B is displacement. the shortest distance would be the displacement, but distance is the whole path taken. So, if we talk about work ... work in English is different than it is in physics. In physics when we talk about work, we talk about the amount of energy used a second.
Researcher	What would you say what is the role then of language with regards to understanding of concepts that is being taught? What role would language play there?
Participant B	Simple basic English it is a requirement because we have a lot of misconceptions anyway so when you explain, your concept must be the physics way but still using the normal English.
Researcher	How do you then take that language and read it in relation to the facts in your lesson? How do you use language to relay facts or in relation to the facts?
Participant B	English is used as a basic language for just normal understanding, but the physics goes deeper so if the child does do not understand when you say jump or sit, the basic language is required.
Researcher	Do you consciously incorporate elements of language in your lesson?
Participant B	Like the past tense or present tense?
Researcher:	Yes, and other elements of language like for example you just use the example, distance and displacement. Do you go and say for example okay distance you are taught distance as this, yes distance is that, but in science displacement...
Participant B	Yes, we do this in terms of diagrams. Just say you are moving from here to Sasol, you will go through the gate, pass the old gate, pass the other school until you get to

	Sasol. That would be distance. But displacement would be from here, where you and I are seated, that straight part between A and B is displacement.
Researcher	In other words, you said earlier that the tenses are past and present tense. Do you incorporate those things in your teaching when you try and explain concepts or don't you?
Participant B	No not necessarily, because if you say now John is throwing a ball up. Whether he is throwing it now or he threw it yesterday, the ball is still going up. So, the past in the present does do not help in the explanation.
Researcher	Do you have examples of how you plan or integrate language into your class-based activities or anything like that?
Participant B	No.
Researcher	In your opinion, what are some of the main reasons why learners fail to understand your subject?
Participant B	Reading, because they do not read every word, they just read the first... like if you have a paragraph, they just read the first line and think they know. But you need to read the whole scenario, but our scenarios are quite short because in the scenario itself, the meaning is deeper. Even if it is two lines, those two lines carry a lot of weight. So, they just read the first sentence and think I know this is talking about velocity that not knowing that if you say somebody is driving a car then it eventually stops. They are now missing that part of eventually stops. If you read the whole, that it eventually stopped then you know the final velocity. So, the problem is, most of the learners are lazy to read.
Researcher	When I say reading strategies, what comes to mind?
Participant B	For me reading strategies would be identifying the underlying concept of what you are reading. Like repeating what is written. So, my problem is that they do not repeat, they just read once. So, they must read and read it again whilst you underline the importance.
Researcher	So, for you, if you underline the important parts that is a reading strategy?
Participant B	It is a strategy.

Researcher	If I may take your example that you have just used with regards to the scenario. Do you or how do you go about assisting the learners to do the deeper read and not just the first part? Do you assist them at all?
Participant B	You see if you have a scenario. You take the scenario from the story or from the paragraph like an essay. Now then you write it in numbers. To say John is driving his car at the velocity of 25 meters, so that would be the initial velocity. So, they write VR. So now they are taking the scenario into loud numbers, to say VI25 meters per second and it takes 2 hours which they write small t and 2 hours so there is now extrapolating from the paragraph.
Researcher	And how do you assist learners that is unable to get the information? How do you assist them in understanding why you are using certain information etc.?
Participant B	For those we are taking it very slow. This is given in the scenario. You can see that you have 25 meters per second. So, what is meters per second? What are those units for? so, a unit is also a guide to what you are given. You see it takes them 2 hours, then you know that is time. But if they are lazy to read. But reading is important, because at some stage the car is not just moving there, it is going to stop or increase speed. They must read.
Researcher	Apart from what you just said, how you would assist learning what other if I can pull them repair strategies do you think should be used when the learner struggles with comprehension?
Participant B	Repetition. But not all our content is essay based, or scenario based. Some of them are diagrams. So those who are struggling with reading, the diagrams are there to help. So, if you look at the diagrams, it can give you the whole story to say oh, this is the starting point and that is the end point. Those are the values. That is why in their question paper you see that there is a question that has diagrams. They are answering based on a diagram. Then you have that learner that is struggling with reading, with diagrams, struggling with the problems of the diagnosis. Tell me in words what this diagram is telling you, then if they tell you in words, then you give them, and say what is the difference between this scenario and the diagram, and they read. In doing that, then they now get use to reading.
Researcher	How confident are you when it comes to teaching language in your subject?
Participant B	I think I am highly confident, because I know the difference between normal daily speaking and the physics language.

Researcher	Your training that you received over the years, was there anything that would assist you with teaching language in your content subject? In other words, did you have you know course or something that will allow you to use language and language concepts in your class?
Participant B	<p>At varsity we had language proficiency in both English and Afrikaans, but it was just for communication because the physics has its own language hence when we do each chapter, it got its own terminology. That is why, from grade 8 before you start their section, you start with terminology. Then Grade 9 you start with terminology and in grade 10 now you do not at all start on terminology, but when you do definitions, the terminology is there. When you define a concept, it is part of terminology, not just to say: what is this?" it is just a terminology which is in line with the language then you go with you now moving to 10, 11 and 12 terminology and definitions. For 10 to 12, the terminology is exam guideline based so the learner cannot define it in their own words. So, there are keywords that they must have in the definition. If you talk about displacement, you must talk about shortest distance between the two points.</p> <p>When you talk about distance, you need to talk about the actual path taken. So, if the learner does do not say anything about the path taken or path traveled, they are missing out. So, there is no need to study the actual language to see in English we say this. The exam guideline gives them the definition</p>
Researcher	Do you feel that the training you received was sufficient to assist you to support learners struggle with language comprehension?
Participant B	I would not call it language comprehension. Like I said, our scenarios are physics based, so weather a learner understand the tense.... its does do not have to understand the past tense or present but just to know if I am talking about something that is decreasing speed, what am I talking about. Am I talking about acceleration or dissolution – know those terminology? So, for us we refer to it as terminology.
Researcher	Would you say that there might be some benefit in getting training with regards to language teaching your content subject? Do you think that can be of benefit to you?
Participant B	Not really.
Researcher	If I may ask, why?
Participant B	Language how? Because physics like if you put the prefix physics in front of the language then I would I agree, but if you just say language in general, I would not.

Researcher	In other words what would be your idea of then valuable language training?
Participant B	Valuable would be terminology, like science language, scientific terms would be beneficial if our level one and Two's and three learners excel on terminology, because most of the content is too heavy for them. So, when we have our intervention for them, they have to recite like in grade one the terminology because the examiner expects them to say it like that. If you talk about Newton's first law, that first law where an object will remain address of course the learner needs to say it like that. And the bold ones are the keywords. So, our level one and two's.... This is the terminology that we use. This is two marks, grade 10, 11 and 12. So if the learner is drilled on understanding what do we mean when we say remain at rest. So, they should know at rest means not moving. So that is the main type of language that we use. At rest means not moving.
Researcher	Do you feel then that language has a place in your subject?
Participant B	Yes
Researcher	Why?
Participant B	Because when you say at rest, someone does do not understand the term rest, they would have problems understanding the concept.
Researcher	From your example, what if you have a learner that does not understand what rest is? Are you making assumptions that the learners already understand it, or do you go out from the point of view that maybe the child does do not understand it?
Participant B	You know explanation it took an object remain at rest. We have a moving object. So, we have a trolley, we have everything, we have a bottle, a box. They see this box is there, it is not moving - we say this is at rest. Now they understand. So, I am doing this.... now it is moving. It is no longer at rest. So, if something is at rest, its velocity is 0. It is not moving. So, there is a misconception of vibration cause in grade 8 we say all particles are moving. Now you must now say OK, there's solids but the movement is so minimal that you do not see it.
Researcher	Lastly, describe your role towards teaching language. What would your roll be?
Participant B	I am not teaching a language; I am teaching science language. does that sound strange what I am saying?
Researcher	Do you think there is a major difference between the two?

Participant B	Yes, cause you talk about tenses, correct use of words. I had a learner here.... could I talk about it?
Researcher	If you do not mention the learners' name.
Participant B	<p>Oh no! I have a learner. I was talking about collisions. Then I said elastic and inelastic collisions. So, he says no there is no words like collisions. In English, my teacher said collisions is not a word. Then I said no in science collisions is a word. In science, two particles collide with each other. But now in a container, you do not just have one collusion. Most of the particles are colliding with each other. So, in that container, there are multiple collisions. No ma'am. Please ask my English teacher there is no word like collisions.</p> <p>So, this now where I tell my learners there is a physic language and an English language. So, in your container there is 2 cars collide then it is a collusion. But if there are two particles in a container or in a box and there are so many particles colliding there are collisions. No ma'am. So, it becomes difficult with learners that are aware of language and say no in English you do not say that.</p>
Researcher	Thank you very much.

Participant C

Researcher	<p>Thanks once again for allowing me to interview you. I am going to start off with the first question. In your own words, how would you define your role when it comes to language in your classroom? In terms of language.</p> <p>Specifically, English because this is an English medium school. Do you think you have a role when it comes to using language?</p>
Participant C	Yeah absolutely. My role is to simplify language especially in my subject where you are using terms that might not be familiar to kids. You want to simplify it to them as much as possible.
Researcher	And do you continuously incorporate elements of language into your lesson planning or the way that you then ultimately teach your lesson?
Participant C	Yes, you do. In what way do you mean?

Researcher	For example, elements of language. It is like you said earlier, to simplify, what do you do for example to help them understand a text for example comprehension comes into a play. Things like tenses, does it plays a role in science?
Participant C	Yes, absolutely. I mean when you teach you must make sure that the language that you use must be correct in terms of grammar, in terms of tense. Because if you do not, you are going to confuse the learners.
Researcher	Is there a specific example that you can think of where, say for example, tense? If you use the incorrect tense that might influence the understanding. Is there something specifically or not really? Are you just referring to general usage?
Participant C	I cannot really think of an example. I have to really think hard for an example.
Researcher	Like I said I was just interested. Now how do you integrate language? Can you give an example how do you integrate it into your lesson? Language, how do you integrate it?
Participant C	I am not sure I understand the question.
Researcher	Let me start with this. What is your definition when I use the word language what do you think of?
Participant C	English. Are you specifically referring to things like grammar and tenses?
Researcher	Yes, things like that. You said earlier that you help learners. You explained, so that of course, also could be seen as a language technique. So how do you integrate things like that that is a typical example of a technical language aspect, or you know, explaining something. So, what I mean is, how do you integrate language? How do you take things that would normally be associated with a language and apply it to your subject? So, do you think it is possible?
Participant C	Yeah, I think it is possible. I am not sure if I get your question.
Researcher	See I am trying to not lead your answer because it is going to taint my study. So, when you are in your class, how do you use language? Is it just mainly the vehicle to give the content or do you actively pay attention to a child with the use of language for example? Did that clarify it a bit more?
Participant C	Not really.

Researcher	Then we are going to leave that one as “Not sure” Now in your opinion, what is the main reason/reasons that children fail your subject or actually do not do well in your subject?
Participant C	I think the main reason they fail or not do well, is mainly because they do not score high in the mathematical intelligence. Because remember you have different intelligence.
Participant C	I am not sure if it is called mathematical or logical intelligence, but if they do not score high in that, they will not do well in my subject. So usually, the ones who do not do well in my subject, are also the ones who do not do well in maths.
Researcher	Do you pay specific attention to reading and reading strategies? In other words, are you aware of reading strategies and do you pay attention to them?
Participant C	Yes, we do because ultimately when they answer their questions in a question paper, they need to read the question and understand it. So, in class we pay attention to reading questions and analysing questions.... Understanding exactly what is asked.
Researcher	What is your understanding and I say reading strategy, what do you think what a reading strategy is?
Participant C	I think it is the way you approach a paragraph or a question. Yeah, the way to understand and approach what is being said.
Researcher	When you see a learner does not understand what “repair” strategy do you use to help a learner to comprehend? How do you repair their knowledge?
Participant C	I think the way to repair the knowledge is maybe to ask the question differently, asking maybe in a simpler form, or maybe just from a different angle. Usually when you take a different angle, they somehow get it.
Researcher	Do you find that strategy actually works for you? Rephrasing the question.
Participant C	Yes.
Researcher	How confident are you to teach language in your class?
Participant C	Language as a subject?
Researcher	You know, the language component that you previously mentioned. How confident are you to incorporate language in your class?

Participant C	I am pretty confident. I think my understanding of language is not great, but sufficient.
Researcher	Now, did you have specific training or when you studied to assist you with teaching your subject using English medium. In other words, using the English language to assist you?
Participant C	No, I did not.
Researcher	Would you, or do you think you would have benefited from training that is not specifically teaching your subject, through medium of instruction which is English? Would you. Would you say of course with an explanation, that you could have benefit from it?
Participant C	Yes, I think so for sure. I think so because obviously we are thrown into this environment of teaching but we are not necessarily. We need some guidance.
Researcher	Do you feel that language has a place in your subject? If so, why? If not, why?
Participant C	No absolutely! It has a role in the subject, a big role, and because we are talking about terminology and asking questions and answering questions it plays a big role, apart from maths.
Researcher	Then I forgot to ask you at the beginning, how old are you Sir? How many years have you been teaching physical science?
Participant C	42, Physical science... uhm 12 years
Researcher	So lastly, how would you describe your role with regards to teaching language? What is your role?
Participant C	As I said in the beginning, my role is to simplify and to use language that makes the kids understand the concepts.
Researcher	Thank you very much.

ANNEXURE G

GRADE	10	SUBJECT	Physical Sciences	WEEK	29	TOPIC	Distance, displacement and calculations	LESSONS	3
LESSON SUMMARY FOR: DATE STARTED:						DATE COMPLETED:			
LESSON OBJECTIVES		At the end of the lesson learners should be able to: <ul style="list-style-type: none"> Define displacement and distance and give the difference between distance and displacement. Calculate distance and displacement for one dimensional motion 							

TEACHING and LEARNING ACTIVITIES

1. **TEACHING METHOD/S USED IN LESSON:**
Demonstration; observation
2. **LESSON DEVELOPMENT** learners need understanding of the following:
 - 2.1 **Introduction**
 - a) **PRE-KNOWLEDGE** learners need to understand the following
 - (i) definitions of distance and displacement
 - (ii) symbolic representation of the distance and displacement
 - b) **BASELINE ASSESSMENT** (educator to design a worksheet/ transparency or write questions on the board [preferable a worksheet to save time] to gauge the learners memory of their relevant prior knowledge) [5 min]

Questions for **BASELINE ASSESSMENT**

 - i) define displacement and give symbolic representation of displacement
 - ii) what are the differences between displacement and distance?
 - c) **Do corrections**
 - i) displacement is the change in position with reference to the starting point.

Differences between displacement and distance

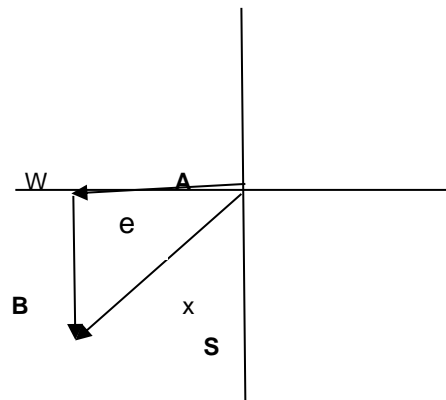
	Displacement	Distance
Symbol	+	D
Definition	Displacement is that single vector with the same effect as other vectors together	Distance is the length of the path followed by a moving object
	Magnitude and direction (vector quantity)	Magnitude only (scalar)
	Can be positive or negative	Positive only

2.2 Main Body (Lesson presentation) [30 min]

Distance is the length of the path followed by a moving object. Distance is a scalar quantity and can therefore be represented by magnitude only, not direction. Displacement is that single vector with the same effect as other vectors together. It is a vector quantity with magnitude and direction. Displacement starts at the beginning of the motion and ends at the end of the motion. It must be represented by the line with an arrowhead. Wherein the line indicates the magnitude and the arrowhead indicates the direction. An object ending its start point has displacement of zero (0 m)

Example

A car travels 3 km due west and then 4 km due south as shown on the sketch below:



a) what is the car's distance?

b) Find the displacement of the car

Solution:

$$D = A + B$$

$$= 3 + 4$$

$$= 7 \text{ km}$$

(b) $\Delta x^2 = A^2 + B^2$

$$\Delta x^2 = 3^2 + 4^2$$

$$\Delta x = 5 \text{ km}$$

$$e = \tan^{-1}(4/3)$$

$$= 53.1^\circ \text{ South of west}$$

Learners activities 10 min

2.2.1 Old American cowboys went horse riding. They went 5 km west and the sun intensity caused them to change the direction. They headed North for 12 km then camped.

a) Illustrate the motion graphically.

b) Calculate the distance covered

c) Find the resulting displacement of the cowboys.

2.2.2 A 500 m tall building casts a shadow of 800 m long over level ground. What is the sun's elevation angle above the horizon?

2.2.3 A bridge 50 m long crosses a chasm. If the bridge is inclined at an angle 20° to the horizontal, what is the difference in height between the ends?

2.2.4 While a boat is being rowed across a river 800 m wide the boat is swept 200 m downstream by the time it reaches the opposite bank. Determine the displacement of the boat by means of an accurate drawing.

GRADE	10	SUBJECT	Physical Sciences	WEEK	30	TOPIC	\bar{v} and \vec{v} calculations – Time: 60 min.	LESSONS	1
--------------	----	----------------	-------------------	-------------	----	--------------	--	----------------	---

LESSON SUMMARY FOR: DATE STARTED:		DATE COMPLETED:	
--	--	------------------------	--

LESSON OBJECTIVES	<p>At the end of the lesson learners should be able to:</p> <ul style="list-style-type: none"> • Define displacement and distance and give the difference between distance and displacement. • Calculate distance and displacement for one dimensional motion
--------------------------	---

TEACHING and LEARNING ACTIVITIES

<p>1. TEACHING METHOD/S USED IN LESSON: Demonstration; observation, question and answer method</p> <p>2. LESSON DEVELOPMENT learners need understanding of the following: 2.1 Introduction</p> <p>a) PRE-KNOWLEDGE learners need to understand the following</p> <p>(i) Average velocity and average speed</p> <p>(ii) Equations for calculating velocity, speed, average speed and average acceleration</p> <p>b) BASELINE ASSESSMENT (educator to design a worksheet/ transparency or write questions on the board [preferable a worksheet to save time] to gauge the learners memory of their relevant prior knowledge) [5 min]</p> <p>Questions for BASELINE ASSESSMENT</p> <p>i) Define speed</p> <p>ii) What is the difference between speed and velocity?</p> <p>iii) What are the units in which speed and velocity is measured respectively?</p> <p>c) Do corrections</p> <p>i) Speed is the rate at which distance is transverse</p> <p>ii) Speed is a scalar quantity with magnitude only whereas velocity is a vector quantity with magnitude and direction. Speed is always positive and velocity could be either positive or negative</p> <p>iii) Standard units are $\text{m}\cdot\text{s}^{-1}$ but $\text{km}\cdot\text{h}^{-1}$ is also used</p>

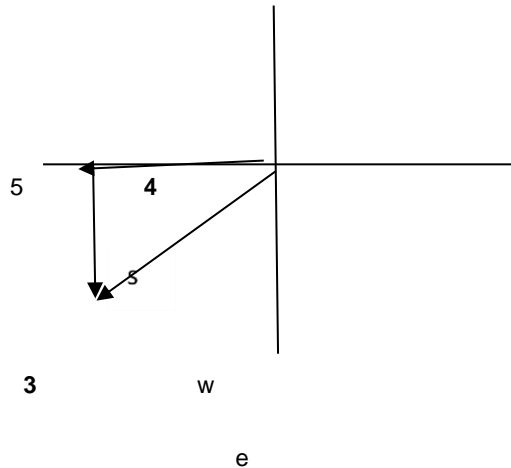
2.2 Main Body (Lesson presentation) [30 min]

Average speed is the rate at which total distance is covered and the **average velocity** is the total displacement divided by the total time.

$$V_{ave} \text{ (speed)} = \frac{\text{total distance}}{\text{time taken}} \quad \text{and} \quad V_{ave} \text{ (velocity)} = \frac{\text{displacement}}{\text{time taken}}$$

Example

A car travels 3 km due west and then 4 km due south as shown on the sketch below:



- i) Calculate the average speed it take 1 minutes to reach end position
- ii) Calculate the average velocity

Solutions

Distance and displacement were calculated previously.

$$D = A + B \quad (b) \quad \Delta x^2 = A^2 + B^2$$

$$= 3 + 4 \quad \Delta x^2 = 3^2 + 4^2$$

$$= 7 \text{ km} \quad \Delta x = 5 \text{ km}$$

$$e = \tan^{-1}(4/3)$$

$$= 53.1^\circ \text{ South of west}$$

i)	average speed (\bar{v}) = $\frac{D}{\Delta t}$	average velocity (\vec{v}) = $\frac{\Delta x}{\Delta t}$
	= 7 / (1x60)	= 5 / (1x60)