THE PRESENCE/ABSENCE OF PLAIN ENGLISH IN SELECTED SENIOR PHASE SCIENCE MATERIAL FOR EDUCATORS

by

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The woods are lovely, dark and deep.
But I have promises to keep,
And miles to go before I sleep.
(Robert Frost)

ABSTRACT

At senior secondary and even tertiary levels, many South African science learners have a poor grasp of basic scientific concepts and processes. This is often blamed on poor teaching, as science teachers must create a connection between subject content and learners, and lay the foundation for a more advanced and technical understanding of science. Many local teachers are underqualified; moreover, gaps in language understanding may have a knock-on effect on science teaching. For more than 90% of South Africans, English is not their home language, but English is the primary medium of education in South Africa and the *lingua franca* of science. This is problematic because many science teachers are not necessarily fully proficient in English (any more than the learners in their classrooms), which makes it difficult for these teachers to digest the subject matter they must teach. If teachers are not comfortable with their subject matter, learners will be inadequately prepared.

This exploratory study investigates whether and how using plain language, in this case, Plain English, to communicate subject matter to Senior Phase Natural Science teachers who lack English language proficiency can help them to understand the curriculum and subject content. In theory, plain language ensures clarity of information by explaining difficult/misleading terminology, and by implementing various other strategies to communicate complex information clearly. It can make basic and more advanced scientific concepts more accessible to teachers, ensuring a less problematic transfer of knowledge and a foundation for a more advanced scientific vocabulary. Plain language also ensures a stronger correlation between the writer's intent and the reader's interpretation. This pioneering study goes beyond identifying the challenges of multilingualism in South Africa, by proposing proactive use of Plain English to make pertinent information accessible to Natural Sciences teachers.

The study adopts a mixed methods approach, combining a literature review on plain language with a qualitative study (interviews). Preliminary plain language criteria were identified from the literature and a few sample Plain English revisions were prepared. Then ten structured interviews were conducted with science teachers currently working in the Senior Phase to establish their qualifications and experience, their views on the resources available to them, whether these resources communicated concepts well, and whether the application of the selected Plain English criteria to the samples improved their understanding of problematic areas in the curriculum and additional teacher resources. Their views on communication via the *Curriculum Assessment and Policy Statement* (*CAPS*) document for Senior Phase (Gr. 7- 9) Natural Science varied. However, there was fair consensus that the Plain English revisions were clearer than the original versions, suggesting that the *CAPS* document could be improved by implementing these criteria. The respondents used different guides, and their views on these resources varied. Some liked the fact that the information presented allows for an individual teacher's interpretation, but others felt that the guides needed to be more specific. The respondents agreed that the guides would be improved by consolidating the information presented in the learner and teacher guides to create a more complete resource for teachers.

The preliminary plain language criteria were then refined, and three Senior Phase Natural Science resources were then selected for analysis in terms of these criteria and their readability was tested using a combination of readability measures. Samples from these resources were then revised according to the criteria and again tested for readability using the same combination of readability measures to quantify the readability of the original samples and the revised ones. These tests demonstrated that the most-used section of the *CAPS* document (according to the teacher interviews) could be dramatically improved by implementing the selected plain language strategies.

The analyses of samples from the learner and teacher guides showed that several plain language writing techniques have already been implemented in these guides, but also that the teacher guides could still be improved. It is recommended that the information in the learner and teacher guides be consolidated in the teacher guides to make a more complete resource for teachers. Based on the data gathered from the interviews and the readability tests, it is concluded that Plain English can be used successfully to enhance readers' ability to understand and absorb important science information.

Key terms

Accessibility
Comprehensibility
Plain language, Plain English
Readability
Science education
Science teacher guides
Scientific literacy
Teacher resources

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CHAPTER 1:

INTRODUCTION

1.1 BACKGROUND

> *Learning to read and write is central to the notion of education as a universal right.*
> (Spaull *et al*., 2016:13)

The results of the 2015 Trends in International Mathematics and Science Study (TIMSS) conducted on Grade 9 learners show clearly that South Africa has a science education crisis – it came last out of the 39 countries included in the study (Reddy *et al*., 2016:3). The contention that science education is a problem area in South Africa is borne out by the fact that many learners decide not to further their science education in the FET Phase, arguably due to an incomplete understanding of basic scientific concepts. Teachers are responsible for delivering information to learners, but they can only do so to the extent to which the teachers themselves understand the content, given the link between 'teacher content knowledge and student learning' (Spaull *et al*., 2016:8). What Elmore (2008:21) refers to as the instructional nexus between teacher, learner and content is especially complex in South Africa, where science teaching has been widely criticized for various reasons, some of which are discussed below. A key factor is the reality that the teaching of science is hampered by the fact that most teachers and learners are expected to communicate science in English, which may be their second (or even third or fourth) language (Reddy *et al*., 2016:12).

As the *Curriculum Assessment Policy Statement* (*CAPS*) for Senior Phase Natural Science indicates, 'Natural Sciences at the Senior Phase level lays the basis of further studies in more specific Science disciplines, such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences' (Department of Education, 2011:9). A lack of learner understanding in the Senior Phase (Grades 7, 8, and 9) thus filters through to the higher grades, making it difficult for learners to comprehend specialized scientific concepts. There are many reasons for this lack of understanding, but two of the primary issues are insufficiently qualified science teachers and difficulty comprehending the material in the language of learning and teaching – usually because English is used in science education. Science requires a specialized vocabulary (scientific jargon), and English is the language of further education in South Africa (Stein, 2017:215), even though, as I have already indicated, for many learners and teachers, it is not their first language.

A 2010 article in the *West Cape News* claimed that an estimated 1 700 of South Africa's science teachers were not qualified and that an estimated 39% of all science teachers in the Free State lacked the credentials to teach science (Silva, 2010:s.p.). This statistic was also reflected three years later in the results of the 2015 Trends In International Mathematics and Science Study (TIMSS), which found that only an estimated 61% of Grade 9 science learners in South Africa were taught by a teacher with the correct qualifications (suggesting that 39% of learners were not) (Reddy *et al*., 2016:13). These figures suggest that more than a third of science teachers are not adequately prepared to teach science, and that more than a third of science learners in South Africa do not receive an adequate science education. It is reasonable to assume that these teachers are not confident in the information they have to present to learners, resulting in a lack of clarity, which then shifts from the teachers to the learners (this is discussed in detail in Section 2.3).

Given South Africa's history, the inequities of differentiated education under apartheid and the country's multilingualism, many teachers and learners struggle with English as the *lingua franca* of science. One of the reasons for South Africa's poor results compared to those of other countries is a lack of access to and proficiency in the language of learning and teaching, namely English, in impoverished communities, where performance is lowest (Reddy *et al*., 2016:12).

In addition, many learners and teachers may experience difficulty in interpreting information due to their different cultural and language backgrounds. According to Pienaar (2002:150), this misinterpretation may occur in the following ways, the third of which is the focus of this study:

- Messages may be transmitted in a way that cannot be understood by others.
- The communication rules of the countries (or in the South African scenario, different cultures) from which the communicants come may differ and influence how messages are interpreted.
- *A communicant may not be able to speak or use another's language competently.*

- A communicant may not understand how to accomplish a certain task or interpret a specific utterance within a particular social context.
- A communicant may make errors in attribution because of her/his group identity.
- Communicants may not be familiar with the topic being discussed.

For these reasons, it is important to consider the ways in which information is textually and visually communicated to teachers as primary recipients of the information they need to communicate to the learners as secondary recipients of the information.

One way to ensure clearer communication is to adopt plain language as a strategy to communicate complex information in a clear way (Cutts, 2013:xi). Thus, I argue that although the problems with the education system are manifold, the way in which information is presented in the *CAPS* for Natural Science teachers in the Senior Phase and teachers' guides can be improved with the implementation of plain language strategies, and more specifically Plain English strategies (as defined and discussed fully in Chapter 2). Throughout the remainder of the study, except where stated otherwise, I use the terms 'plain language' and 'Plain English' interchangeably,[1] because for the purposes of South African science education, the medium of instruction and communication, especially with teachers, who are the intended readers of the texts I discuss, is primarily English.

1.2 PROBLEM STATEMENT

Ideally, all South Africans should be proficient in the language of learning and teaching, or all eleven official languages should be developed and promoted enough as media of academic instruction and communication for learners to attain a good education in any language/s they choose. This is not currently possible for practical reasons, and, realistically, the situation is unlikely to improve within the foreseeable future (Titlestad, 1996:172). Although this was argued many years ago, this argument still rings true.

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[1] *Internationally, most work on plain language has been done in Anglophone countries, or where large numbers of English second language speakers can benefit from its use. Hence, the terms are largely seen as synonymous. However, there is a growing movement in countries such as South Africa for 'gewone Afrikaans' (Cornelius, 2012) and in France, Germany, etc. (discussed further in Section 2.5) (Asprey, 2003:7-28).

Black communities, especially in rural areas, have had uneven exposure to competent English-medium instruction. Consequently, many people in our country lack English proficiency but are either being educated in English or having to educate people in English (a language in which teachers might not be proficient). In addition, the technical and scientific vocabularies of many of South Africa’s indigenous languages have not been developed enough for teachers to teach subjects such as Natural Science in these languages (Wright, 2015:172). The problem is compounded by parents’ choices for their children regarding the language of instruction. For example, many Afrikaans communities are moving away from Afrikaans instruction to English instruction, because ‘English has become the chosen language of professional and academic communication in global higher education’ (Day Translations, 2013:s.p.). Parents believe that English has higher international and local prestige value – it has elite status (Wright, 2015:177). These choices are mirrored in other language communities, both in South Africa and in neighbouring countries such as Namibia (Smit, 2012).[2]

One of the cornerstones of democracy is the right to education. Although South Africa is a long way away from resolving the problems in its basic education system, if any improvements can be made, they should be. In this respect, Aitcheson (2001:147) argues that government and private institutions need to work together to improve literacy and make information more accessible to anyone who requires access to that information. This study is based on the assumption that learners and teachers should have access to information from user-friendly science resources. I therefore investigate how using Plain English to communicate subject matter to Senior Phase Natural Science teachers who lack English language proficiency can help them to understand the curriculum and subject content.

1.3 AIM, OBJECTIVES AND RESEARCH QUESTIONS

The aim of this research is to show how using Plain English to communicate subject matter to Senior Phase Natural Science teachers who lack solid English language proficiency can help them to understand the curriculum and subject content.

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[2] In Namibia, English has been adopted as the language of instruction in all government schools (Smit, 2012:82), and sadly, the number of students studying African languages at university level has dropped (Smit, 2012:84).

In order to meet this aim, I address the following objectives:

- to select plain language writing criteria that can improve the presentation of content in Natural Science resources for Senior Phase teachers;
- to assess whether these criteria have been successfully implemented in selected education guides for Senior Phase Natural Science teachers; and
- to apply these criteria to selected guides and gauge whether this improves readability.

These objectives are pursued by attempting to answer the following research questions:

- Which plain language writing principles can improve the presentation of information in Natural Science teacher resources?
- How do teachers feel about the resources available to them?
- How do teachers respond to the proposed Plain English criteria?
- To what extent are plain language writing criteria already implemented in selected existing science guides for teachers in the Senior Phase?
- How can these principles be applied better for teachers to understand complex scientific concepts?

1.4 RATIONALE FOR THE STUDY

Science is a language-intensive subject (Hazen & Trefil, 2009:4), so it is important to ensure that teachers grasp difficult and often complex scientific jargon in order for them to be able to impart important scientific knowledge to learners.

English is the primary medium of education in South Africa and the *lingua franca* of science. Many science teachers are not necessarily fluent in English, and nor are the learners in their classrooms able to speak, read and write English well. Low reading proficiency makes it difficult for such teachers to digest the subject matter they must teach. If teachers are not comfortable with their subject matter, the unintended outcome is learners who are inadequately prepared for further science education.

In line with the Constructivist approach discussed below (see Section 1.5.2), Anderson and Mitchener (1994:14) comment:

> The importance of teachers knowing their subject is at the centre of teacher education. Teachers' knowledge of their subject is critical in shaping their

> curriculum and pedagogical decisions. A teacher's own knowledge of a subject will enhance or limit the opportunities a student has to learn that subject.

One of the biggest challenges facing both teachers and the schoolchildren they teach in the South African education system is the limitations imposed by individuals' access to the language of learning and teaching. This problem applies not only to learners, but to teachers who have had limited exposure to English as a *lingua franca* and medium of instruction (the language on which this study focuses). South Africa wants to compete on a global stage in terms of its contributions to science and technology, but it has a young democratic society that is still suffering from the legacy of the past. Thus, there are many South Africans who have had limited access to English – the global language of science and technology (Bickel, 2015:s.p.) – making it difficult for these citizens of the global republic of learning to understand complex scientific jargon, and for teachers to pass on this knowledge to learners.

There are eleven official languages in South Africa, and this in effect means that 90% of the population are not first language English speakers (Statistics South Africa, 2012:24). This is problematic, because for South Africa's education system to be effective, teachers and learners need to understand what is being taught. Thus, if science teaching in particular is *de facto* in English, ways have to be found to enhance access to the material offered to learners and teachers in English. I argue that implementing plain language principles is a proactive way to achieve this, so that meaning is not lost and the content is clear to someone with a narrower vocabulary and understanding of English – in the words of Albert Einstein (s.a.), '[i]f you can't explain it simply, you don't understand it well enough'. Hence, this study explores the possibility of applying plain language writing techniques to science resources for teachers so that the content is easier to understand and convey to learners.

Plain language in general (and Plain English in particular) is difficult to define (see Chapter 2), because it is a broad term with a broad range of applications. However, there is consensus in the definitions that plain language texts offer easy (or at least easier) access to essential information to readers so that they are able to understand the information they wish to retrieve. This concept is useful to consider when reviewing problems such as language in education.

This study starts from the widely acknowledged inadequacy of science teaching and communication in South Africa and proposes a proactive solution: if the central notions of plain language for providing access to information were adequately applied to the *CAPS* document and selected Natural Science education guides, it may create a stepping stone which teachers can use to understand significant information more clearly and convey it to learners in a more comprehensible manner. As far as I could ascertain from a comprehensive search of library databases, this study is the first to test these ideas by means of a mixed methodology, combining a literature review and document analysis with interviews with the intended users of such documents – teachers in the field. In order for plain language writing principles to be applied to these documents effectively, it is essential to ascertain the viewpoints and needs of practising Natural Science teachers.

1.5 THEORETICAL ASSUMPTIONS

This study draws on the principles of plain language and it was developed broadly in line with the precepts of Vygotsky's 'Activity Theory' and a Constructivist approach to learning. I also applied the reasoning behind reader-response theory. These form the underlying theoretical underpinning of the study. I discuss plain language in detail in Chapter 2, so I only briefly discuss the remaining three theoretical underpinnings of the study here.

1.5.1 Activity theory

Vygotsky's Activity Theory (1978) elucidates the relationship between individuals, their social environment and subject content/knowledge. In the classroom, learners internalize information through their interactions with teachers and other aids to learning. This process of internalization takes place in the teacher as well. To enhance this process, it is important for information to be as clear and as accurate as possible for teachers to internalize the content to deliver it to the learners (Vygotsky, 1978:34-35).

1.5.2 Constructivist approaches

Activity theory corresponds to a Constructivist approach to learning, which states that teachers should understand learners' pre-existing conceptions and guide the learning activities inside and outside the classroom to address, build upon and sometimes challenge these conceptions. This aligns with Vygotsky's (1978:36) proposition that '[l]earning is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things'. In this particular study, one has to consider the *teacher* as a primary learner who needs to acquire the necessary scientific knowledge base to be able to deliver content to schoolchildren (as secondary learners in this case) in a way that ensures that this process takes place within those secondary learners as well. This is particularly pertinent in the Natural Sciences, because the field is broad and constantly changing, with many new discoveries and inventions. This implies that the foundations laid in the Senior Phase are crucial to giving children the specialized abilities they need to think about a variety of things without language's becoming an impediment to the acquisition of these abilities. One might look at the learning process as a spiral in which every teacher acquires her/his knowledge base which is then passed on to the learners. The Educational Broadcasting Corporation (2004:s.p.) explains this principle as follows:

> When [learners] continuously reflect on their experiences, [they] find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information. One of the teacher's main roles becomes to encourage this learning and reflection process.

Thus, the teacher is integral to the development of schoolchildren's capacity to think and develop complex reasoning capabilities. In the Natural Sciences, this complex thinking is often left undeveloped due to teachers' inadequate content knowledge.

This reasoning led to my study, in which I explore Plain English writing principles and their application to science education guides for teachers so that these primary learners are better equipped to lay the foundations of science in the Senior Phase. (Please refer to Chapter 2 for details on plain language.)

1.5.3 Reader-response theory

This study is further underpinned by reader-response criticism. According to Stanley Fish, an acclaimed American reader-response criticism theorist,

> …interpretative strategies are not put into execution *after* reading… they are the *shape* of reading, and because they are the shape of reading, they give texts their shape, *making* them[,] rather than, as it is usually assumed, arising from them. (Fish, 1976:218, my emphases).

In other words, reader-response criticism assumes that the reader is the person who gives meaning to the text. Once a text has been written, it is up to the reader to interpret and give meaning to that text. Theorists such as Fish generally apply this reasoning to the interpretation of literary texts, but it can also apply to non-fiction and instructional texts, such as textbooks and teacher materials. Content is often misunderstood or not understood at all by a reader because of the language that has been used. Although the writer usually has a definite intention in developing a text, the meaning springs from the reader's ability to make sense of the text. For this reason, strategies such as the use of plain language can help to mesh the writer's intention with the reader's interpretation, so that there is as little room for misinterpretation as possible.

1.6 OUTLINE OF THE STUDY

The study is divided into six chapters, as set out below.

Chapter 1: Introduction

The main aim of the introductory chapter is to provide the background to the study, the aims, objectives and research questions that are addressed in the study. This chapter also provides the rationale and theoretical underpinnings for the study.

Chapter 2: Literature Review on Plain Language

In order to apply plain language to science guides for teachers, it is essential to gain a clear idea of the educational context in South Africa, the role of language in education, and what science education in South Africa is like. Furthermore, since the focus of this study is plain language/Plain English, it is important to define this term and identify its historical context and the ways it has been or can be applied to education, science and science education.

The chapter begins by providing insight into the context of education in South Africa. Following this, the science education landscape is discussed. After I have established the educational context, I unpack plain language definitions and review the prior literature on the global and local history of plain language and its role in science in general. In the context of South Africa's multilingualism, I propose a working definition of plain language for the purposes of the study. This definition maintains the principles of plain language while providing for our unique situation.

Chapter 3: Methodology

In the third chapter, I discuss the research process in detail. I begin by explaining why this study may be classified as an exploratory study by providing an overview of the research design, and show the various steps of the iterative process of data gathering, from the literature review stage to the interviews and document analysis and application of the plain language criteria in revising sample texts.

I discuss the selection of the plain language criteria which I applied as a preliminary set (in the interview stage) and then as a final set (in the document analysis and sample revision stages). Then I explain how I selected the preliminary and final set of documents for analysis. I also discuss the qualitative research in the form of interviews in detail, considering the sample, the interviews, data management and ethical aspects. The process that was undertaken when it came to analysing the data that were accumulated is then unpacked. Finally, I clarify the role of readability tests as a quantitative analysis tool in this study.

Chapter 4: Discussion of Results – Interviews

The interviews that were conducted with ten science teachers in the South African schooling system are unpacked and analysed in this chapter. The chapter is divided into four sections based on the structure of the interviews. These are demographics, general awareness of the problem area, teachers' responses to *CAPS*, and responses to teacher guides. A questionnaire served as an interview schedule, so, in each of these sections, the closed-ended questionnaire data is unpacked in a table, followed by an analysis of the data, and a discussion of significant findings for each section, based on these results.

Chapter 5: Document Analysis

The documents that were analysed are the *CAPS* document for Senior Phase Natural Science, *Spot On Natural Sciences* for Grade 8 (teacher and learner guides), and *Platinum Natural Sciences* for Grade 9 (teacher and learner guides). Thus, this chapter is structured according to these divisions. Prior to the analysis of these documents, the final plain language criteria selected for the study are outlined. Then four text samples from the CAPS document are analysed quantitatively, by using a readability checker, and qualitatively against the selected plain language criteria. Revised samples of the text are then included to show how the plain language criteria can be implemented more effectively. These samples are then again quantitatively analysed using the readability checker to see how the results compare to the readability of the original. The same procedure is followed with the *Spot On* and *Platinum* guides. Final comments on the findings are included at the end of the chapter.

Chapter 6: Conclusion

Chapter 6 presents a summary of the key findings and recommendations with regard to the application of plain language writing techniques to science education guides. It also reflects on the strengths, contributions and limitations of the study and suggests avenues for further research, before making some concluding remarks.

CHAPTER 2:
LITERATURE REVIEW ON PLAIN LANGUAGE

2.1 INTRODUCTION

The literature on the various language, science, and education elements considered in this study is explored in this chapter. In a broad sense, plain language is an approach to writing that adapts several aspects of a text – such as sentence length, word choice, structure, and layout/visual elements – in such a way that readers are able to understand the content presented to them as fully and as clearly as possible. This is not a new approach to writing, but it is not an approach that is generally associated with science, which is seen as a complex field, or with science education. This arguably because people in that field are afraid that the material may be diluted, but plain language is not a dilution or 'dumbing down': it addresses the presentation of material, including complex ideas, in accessible language. In the chapter, I unpack plain language.

For the purposes of this study, it is also important to establish the impact of the South African education system on language acquisition, as well as the impact of language on the science education context before exploring plain language definitions and providing a historical context for plain language in general, and plain language in science in particular.

The discussion of all of these elements helps to identify why there is a need for plain language in South Africa's education system, particularly in the sciences, and what definitions can be best applied to a study of this nature. Based on the literature review in this chapter, I was able to establish a working definition of my own for plain language which I used as a basis upon which to select plain language criteria as a step towards meeting the objectives of the study.

2.2 LANGUAGE AND THE SOUTH AFRICAN EDUCATION CONTEXT

Through the various political transitions in South Africa, the basic education system has changed. These changes resulted in language challenges that still affect many South Africans. Race and language have been dividing factors throughout South Africa's political and educational history.

Education provided to white South Africans has seen some language challenges over the years. The outcome of the South African War (1899-1902) led to the imposition of English in schools, but also to the rise of Afrikaans. ‘When the Union of South Africa was created in 1910, it was a bilingual state, and thus both English-speaking and Afrikaans-speaking schools were established for white Europeans’ (*Encyclopaedia Britannica*, 2018b:s.p.). The trend toward separate schools for different language and racial groups became a practice that still exists in South Africa today (Afrikaans and English schools still continue to exist, although more and more schools are now bilingual).

In his article ‘A History of English in South Africa’ (1996), Lanham provides a history of English in South Africa. He acknowledges that language has been a contentious issue in South Africa since the colonial period when ‘Standard Southern BrE [British English became] the mark of high social status’ (Lanham, 1996:23) and Dutch-English was regarded as a mark of the unsophisticated and uneducated (Lanham, 1996:24) due to its variants. Standard English remains the preferred variant in South Africa, largely because of its international status (Titlestad, 1996:168-169).

Arguably the most divisive and controversial aspect of education in South Africa’s history over the last century and a half is the ‘Bantu education’ introduced by the Apartheid government, which sought to segregate education according to different language and racial profiles (Jansen, 1990:2). In his article ‘Black English in South Africa’, Gough (1996) argues that Bantu education led to a language learning environment that became impoverished through its policies. In the ‘black’ Department of Education and Training (DET) schools, classrooms were overcrowded, facilities were limited, and teachers were undertrained and often conservative in their teaching methods (Gough, 1996:54). These factors resulted in poor English language acquisition amongst many black South Africans. Gough argues that today’s teachers ‘are overwhelmingly non-native [English] speakers and products of Bantu education themselves, and the classroom input the children receive thus bears the hallmarks of black English’ (Gough, 1996:54). His article was written 22 years ago, but many black South Africans are still stuck in this vicious language cycle.

Lanham (1996) explains that various policies, despite Apartheid and the introduction of Bantu education (mentioned earlier), have cemented the status of English as the primary language of economic power in the country. Under the Bantu Education Act, native tongue, English, and Afrikaans teaching was implemented (*Encyclopaedia Britannica*, 2018a:s.p.), which led to resistance from the African community, culminating in the Soweto uprising in 1976. These factors along with the international standing of English have cemented English as the language of education in South Africa. Furthermore, English has become the language associated with opportunities in South Africa and abroad (Wright, 1996:155).

The 1996 *Constitution of the Republic of South Africa* stipulates that none of the eleven official languages spoken in South Africa should be singled out as superior to another – '[n]o one superordinate language is here singled out' (Branford, 1996:37). Section 29 of the *Bill of Rights* acknowledges multilingualism in South Africa and the need for language inclusion (RSA, 1996c):

> Everyone has the right to *receive education in the official language or languages of their choice in public educational institutions* where that education is reasonably practicable. In order to ensure the effective access to, and implementation of, this right, the state must consider all reasonable educational alternatives, including single medium institutions, taking into account—
> (a) Equity;
> (b) Practicability; and
> (c) The need to redress the results of past racially discriminatory laws and practices. (my emphases)

The *South African Schools Act, 84 of 1996*, the *National Education Policy Act, 27 of 1996*, and the *Language in Education Policy of 1997* mirror this idealism regarding the right to language inclusion. Section 6 of the *South African Schools Act, 84 of 1996* (RSA, 1996b) states:

> (1) Subject to the *Constitution* and *this Act*, the *Minister* may by notice in the Government Gazette, after consultation with the *Council of Education Ministers*, determine norms and standards for language policy *in public schools*.
> (2) The *governing body* of a *public school* may determine the Language policy of the *school* subject to *the Constitution*, *this Act* and any applicable provincial law.
> (3) No form of racial discrimination may be practised in implementing policy determined under this section.
> (4) A recognised Sign Language has the status of an official language for purposes of learning at a *public school*. (emphases in the Act)

Section 4 of the *National Education Policy Act, 27 of 1996* (RSA, 1996a), declares that

> …every person [has the right] to establish, where practicable, education institutions based on a common language, culture or religion, as long as there is no discrimination on the ground of race, and; for every person to use the language and participate in the cultural life of his or her choice within an education institution.

Furthermore, section 6 of the *Language in Education Policy of 1997* (RSA, 1997) asserts:

> The right to choose the language of learning and teaching is vested in the individual. This right has, however, to be exercised within the overall framework of the obligation on the education system to promote multilingualism… [And] subject to any law dealing with language in education and the Constitutional rights of the learners, in determining the language policy of the school, the governing body must stipulate how the school will promote multilingualism through using more than one language of learning and teaching, and/or by offering additional languages as fully-fledged subjects, and/or applying special immersion or language maintenance programmes, or through other means approved by the head of the provincial education department.

While each of these policies reiterates the need for language inclusion, there is little evidence to suggest that these policies have been developed further to determine how this should be done. Although each language is perceived as equal and the *Bill of Rights* acknowledges that each individual has the right to education in the language of her/his choice, in practice this is unrealistic. Given that there are eleven official languages, the government does not have the resources to translate all documents into all of these languages, and certainly not enough to train all teachers to be fluent in more than two to three of these. Moreover, the development of these languages is not viewed as a priority, compared to issues such as the provision of services, housing and employment. These policies merely provide lip service to language equality without considering the implications of this for the education system, which is under-resourced. There is still a lack of qualified teachers; language communication is undervalued, and the onus has been placed on the governing bodies of government schools to decide on the language of learning and teaching which means that no language standard is provided – according to Titlestad (1996:164), referring to the Transitional Constitution’s recognition of eleven official languages (this became part of the official Constitution after the publication of his article), ‘an untidy situation has produced an untidy Act’.

Provincial language education policy is slightly more detailed than the National policy; however, it is equally unrealistic in terms of its actual implementation. Section 5 of the Gauteng Department of *Education Policy Act, 12 of 1998* (RSA, 1998), says:

> All education policy made in terms of this Act must contribute to the development of an education system which respects religious, cultural and language rights by –
> (i) promoting respect for the country's diverse communities and traditions;

(ii) encouraging participation of persons in the cultural life of their choice within an education institution;
(iii) promoting the status and use of official languages that have previously been neglected or discriminated against;
(iv) teaching learners in the language of their choice where reasonably practicable;
(v) recognising sign language as an official language of communication;
(vi) enabling learners to become competent in the languages of learning in their education institution;
(vii) allowing learners, where reasonably practicable, to use their language of choice where it differs from the language of learning in their education institution;
(viii) ensuring that, on completion of the ninth level of learning, learners have acquired satisfactory levels of competence in at least two official languages; and
(ix) encouraging education and training practitioners to acquire the skills necessary for rendering education services in a multilingual environment

The details outlined in this policy are fair, but, in practice, this policy is not being fulfilled.

In reality, English has become the dominant language (the language of education and much of the media) and people want access to its perceived benefits. Thus, even though the first language English community in South Africa is small – only 9.6% of the population, according to the 2011 Census (Statistics South Africa, 2012:24) – English has become the *lingua franca* and the language of education for historical and political reasons and because of the promise of international communication and prestige that it offers. According to Wright (2015:169-170), the shift away from English dominance will occur only when economic value is applied to other African languages. Until this happens, English will remain the predominant language of education. In addition to this, modernity has resulted in many learners' lacking the desire to develop their home languages, which are perceived as holding little social weight.

In 1999 an education crisis was declared by the Minister of Education at the time, Kadar Asmal: 'He believed that the state was not upholding their rights to education' (quoted in Aitcheson, 2001:149). The languages of education remain English and Afrikaans and there has been very little done to improve upon resources in indigenous languages. The reality is that parents want their children to learn in English because they see it as the 'key to the child's future' (Mostert *et al.*, 2012:172). Many South African children are not able to read properly in their home language in the foundation phase, and have limited proficiency in the language in which they are taught from

Grade 4 – English. Less than half of all students are being taught to read for meaning in this critical period. The weak foundations provided in Grades 1 to 3 constitute one of the main factors leading to poor learning outcomes in later grades and to functionally illiterate learners. Furthermore, these language challenges often result in subtractive bilingualism, where a second language is learned at the expense of a first language and, as a result, both remain underdeveloped (Plüddemann, 2013:21). Thus, the central objective for teaching in early primary school must be to develop funding and teacher training – specifically with regard to teaching reading – and to establish reading norms and a language standard, so that children can acquire basic learning skills (specifically reading skills) in this critical period, enabling them to cope with content knowledge in the later grades (Spaull *et al*., 2016:11).

Although English is the *lingua franca* in South Africa, difficulties still arise from the fact that only a small portion of the population are first language English speakers, and many teachers are not first language English speakers. Thus, children in underprivileged communities and those in Afrikaans schools are often not exposed to mother-tongue English speakers. ‘Even though English is *de jure* the medium of instruction, *de facto* there is extensive use of the vernacular with English’ (Gough, 1996:54) because many teachers themselves are unable to communicate fluently in the language.

‘Education is a process of engagement between two groups of people, learners and teachers. If either is not equipped to engage effectively, it is unlikely to succeed’ (Butcher, 2001:83). As discussed above, teachers are often ill equipped to provide adequate language skills, and the education budget has increased relatively little over the years, which means that the education system is not equipped to manage the language crisis (Aitcheson, 2001:145). Teachers need to be furnished with the necessary language skills to teach content to learners, so that there can be an effective transfer of knowledge. The situation is aggravated by the fact that there are not enough qualified teachers in the country. A projection by Simkins (2015:17) stated that only 78.7% of teachers in South Africa would be qualified in 2018 and the percentage is set to decline. This means that not only are many teachers ill equipped from a language point of view, but over 20% of teachers also lack an adequate knowledge base for the subject/s they are teaching. In this regard, as long as two decades ago, Lanham (1996:32) warned:

> For teachers and pupils who for several generations now have been deprived of an adequate English-language education, the English Medium for learning subjects such as mathematics, science, geography, etc. makes such learning a language problem far more than a conceptual learning problem.

The shift to democracy in South Africa and equal education for all has been difficult to enact due to pre-existing language barriers and socio-economic factors. This has led to a new generation of learners who are unable to grasp relevant content in English.

In her 2005 conference paper, ‘Language development in South Africa: past and present’, De Kadt (2005:3) outlines some of the problems with language development in South Africa, claiming that ‘policy development in [language development has been slow] – a slowness which appears to be due to lack of political interest, rather than deeper political difficulties’. Her comment suggests that until language development across the board is viewed as a priority, language issues will continue to pervade South Africa and its education system. Moreover, the language in education policy remains vague and attempts to acknowledge mother-tongue equality and fill the gap in English proficiency have come to nothing despite the policies put in place after 1994 and the constitutional changes in 1996. A lack of political and social will to develop the indigenous languages has resulted in the failure of the education system to fulfil the right of educational and language equality. Many South Africans are currently stuck in a cycle in which ‘[s]tudents are regularly examined in languages other than those in which they are taught, and in which they generally have low proficiency [and] teachers are attempting to teach in a language they barely know’ (De Kadt, 2005:4).

According to Nel and Müller (2010:636), South Africa’s poor performance in the 2006 Progress in International Reading Literacy Study (PIRLS) was the result of ‘lack of access to newspapers, magazines, TV and radio; lack of opportunity to hear or to speak English; lack of English reading material at home and at school; and poor language teaching by teachers whose own English proficiency is limited’, particularly in rural communities. We can assume that this lack of exposure to English continues to influence performance, given that the 2016 PIRLS study reported similar results (Howie *et al*., 2017:7-10). Furthermore, the English syllabus focuses on literary rather than colloquial English (Gough, 1996:54). Academic English is geared to assist in content-based subjects, such as Natural Science, which means that learners are not learning to speak, read or write English adequately.

Home language proficiency is essential to a learner's development, but, given the situation on the ground, more 'high quality resources' (Butcher, 2001:73) for teachers and learners need to be considered by the Department of Education. While communication in English is a problem, performance when an African language is used is often worse: '[I]n poor rural areas, should inadequate tuition in an African language be compounded by weak performance in English, the result will be a burgeoning reservoir of the unemployed and unemployable, subsisting on state benefits – a recipe for political disaster' (Wright, 2015:177). Language policy in South African education is an area that requires further development, but, given the lack of adequate development thus far, it is practical to consider alternatives, such as plain language resources to aid with teachers' grasp of the material.

2.3 SCIENCE EDUCATION IN SOUTH AFRICA

The South African education system has struggled to adjust to the language demands of the new South Africa. Multiple issues have developed such as poor performance in mathematics and science education and a shortage of qualified teachers, and these issues affect the quality of education available to South African learners.

As I indicated at the start of my study, according to the Trends in International Mathematics and Science Study (TIMSS) conducted on Grade 9 learners in 2015, South Africa had the lowest performance in science out the 39 countries that participated in the study (Reddy *et al*., 2016:3-16). Even though there has been an improvement from the 'very low' standard achieved in 2003 to a 'low' standard in 2015, the improvement is not sufficient to raise our international standing. An analysis of these results reveals that there are several factors that contribute to our poor performance, such as bullying, the teaching environment, teacher qualifications, teacher job satisfaction and, most crucially, access to and proficiency in the language of learning and teaching.

The lowest performing schools were non-fee paying public schools – primarily of learners from impoverished backgrounds who are generally not first language English speakers. Statistics revealed that there was a significant difference between learners whose home language is the language of learning and teaching and those whose language is not. Since science is a language-intensive subject, this is a crucial factor to consider in learner performance. Moreover, only 61% of Grade 9 science learners are being taught by a teacher with a qualification (Reddy, *et al*., 2016:13), meaning that we know that 39% of learners are being taught by a teacher without an adequate qualification – most of these learners attend non-fee paying public schools.

The most recent education statistical survey – conducted in 2013 and released in 2015 – revealed that the results in Matric Physical Science were the second worst after Mathematics (RSA, 2015:27). In 2012, only 39.1% of learners who wrote Physical Science in Matric achieved above 40%. This increased slightly to 42.7% in 2013. The fact that 61.3% of learners achieved above 30% in 2012, and 67.4% of learners achieved above 30% in 2013 means that many learners fall into the 30% to 40% bracket (indicative of a poor comprehension of fundamental scientific concepts). These results are poor and representative of the issues identified above.

The South African Department of Education is not addressing its accountability for these shortcomings and little is being done to remedy the situation, as is suggested by the fact that there have been only minor improvements in learner results. Concerns about learner performance in Mathematics and Science are dealt with in a defensive manner, rather than a reactive manner. When the 2015 and 2016 *World Economic Forum* released its education statistics, which revealed that South Africa had the worst performance in Mathematics and Science education out of the 139 countries ranked (My Broadband, 2016:s.p.), the Department claimed that these statistics were 'bizarre' and 'lack credibility' (Mhlanga, 2015:s.p.), rather than suggesting solutions to the problem. These statistics may indeed lack validity, as the rankings are determined by business executives who are asked to rate their country on a seven-point scale. However, the fact remains that there is a justifiable perception that mathematics and science education in South Africa is poor, and adjustments to the system need to be made.

As mentioned earlier, there is a shortage of qualified science teachers in South Africa, which leads to unqualified teachers teaching science. An article published in the *West Cape News* stated that 'more than 1700 South African science teachers are not qualified to teach science – meaning that at least 50 000 learners are not receiving teaching from qualified teachers' (Silva, 2010:s.p.). This is extremely problematic, as there is a 'link between teacher content knowledge and student learning' (Spaull *et al.*, 2016:8). Moreover, the KwaZulu-Natal legislature has expressed concerns that 'thousands of teachers employed by the Education Department could be teaching with fraudulent qualifications' (Magubane, 2018:s.p.). These may not all be science teachers, and it is unknown how many learners are receiving an inadequate science education. Science is a jargon-heavy subject, and if the teacher is struggling to grapple with the information, it is more difficult for learners to make sense of the content.

Therefore, if one considers learner performance, teachers' and learners' limited proficiency in the language of learning and teaching, and the issues with teacher qualifications, it seems that a plausible place to start is to look carefully at the materials made available to teachers and learners, in order to ensure that the teachers are able to grasp the concepts that they are teaching learners, and that learners are able to understand these concepts. This is where plain language can play a role. Plain language takes various aspects of a text into consideration, going beyond just the language used, and considering visual elements of the text as well – from charts and diagrams to the layout of the text. Plain language techniques could therefore go a long way toward making science concepts accessible. The most important thing to consider when it comes to science education at a school level is that the goal is to lay the groundwork for science – this does not need to be advanced, but at a functional level for learners. Plain language strategies could assist especially less qualified teachers in comprehending complex concepts, and may also minimise the language barrier for both teachers and learners. While there are other issues contributing to the problem, this is one that can be addressed at a language level.

Two years after the advent of the 'new South Africa', De Klerk (1996:17) predicted that realistically 'linguistic schizophrenia is likely to prevail for some time yet in South Africa, with people perceiving English simultaneously as the language of oppression and of access to elite educational, scientific and political domains', and Wright's (2015) article, nearly two decades later, bears out this prediction. The Department of Education, along with the education system as a whole, needs to get on board by ensuring that teachers are resourced enough to lay the groundwork for science education in South Africa, so that it is accessible to every learner in the country.

2.4 PLAIN LANGUAGE DEFINITIONS

Martin Cutts[3] has earned his place as figurehead of the plain English movement with four editions of his book *Oxford Guide to Plain English*. Cutts acknowledges that he was inspired by George Orwell (see Section 2.5), and has advocated for plain language in all spheres of life for decades. His definitions serve as a useful starting point for any discussion of plain language, which in his book is used interchangeably with Plain English, as it is in most of this dissertation.

In the definition used in the first three editions of the *Oxford Guide to Plain English*, Cutts states that Plain English is the

> …writing and setting out of *essential information* in a way that gives a *co-operative, motivated person* a good chance of understanding it at *first reading*, and in the same sense that the *writer meant it to be understood*. (Cutts, 1995:3; my emphases)

However, in the fourth edition of the *Oxford Guide to Plain English*, Cutts adopts the definition provided by the International Plain Language Federation (there have been subsequent minor alterations to this definition), which states that

> …[a] written communication is in plain language if its *wording, structure, and design* are so clear that the *intended readers* can easily find *what they need*, understand it, and use it. (Cutts, 2013:xii; my emphases)

In her thesis, 'Widening Readership – A Case Study of the Translation of Indigenous Law', Noomé (2015:135-136) dissects these definitions, showing that both stress the purpose of plain language, but that there is a shift in focus. In the initial definition, the responsibility of the writer is placed at the centre of the text, but the reader also has an active role to play. The obligation to present information in a manner that ensures that a 'motivated person' will clearly understand the message that the writer wishes to convey is central to the definition. The call for clarity 'at first reading' highlights the need for clarity of information. However, in the later definition a 'motivated person' is altered to 'intended readers'. This shift in focus emphasises the idea that a target audience (rather than a general reader who may not necessarily have been the target of the text) should have easy access to the information. Again, the onus is on the writer to ensure that the text is understandable to the intended audience before this shift

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[3] Martin Cutts has been a member of Plain Language Association International for 12 years, and he has been the director of the British Plain Language Commission for 24 years.

occurs, although the writer as agent is somewhat elided from the definition. Furthermore, in the newer definition the idea that a text needs to be understood upon first reading is no longer stressed. Rather, the effect on readers, who should be able to find what they need 'easily' and *use* it, is emphasised. In the new definition the shift between writer and reader is identified, and the understanding that the reader uses a text for her/his purposes is acknowledged. Both of these definitions provide a clear and sound purpose for plain language, but the earlier definition provides a broader outline for the purpose of a plain language text. It must also be noted that both definitions imply that the reader should be functionally literate in order to make sense of the text.

The newest International Plain Language Federation definition states:

> A *communication* is in plain language if its wording, structure, and design are so clear that the intended *audience* can easily find what they need, understand what they find, and use that information. (International Plain Language Federation, 2017:s.p.; my emphasis)

Many proponents of plain language make use of this definition. One of these is the Plain Language Association International (PLAIN), which recommends that the following areas be taken into consideration when drafting a plain language text:

1. Audience and purpose
2. Structure
3. Design
4. Expression
5. Evaluation. (PLAIN, 2017:s.p.)

In the Plain Language Federation definition that Cutts (2013) provides in the fourth edition of his guide, a 'written communication' is stressed, while the new definition used by the Plain Language Federation simply states 'communication'. Furthermore, the initial definition by the Plain Language Federation identifies 'intended readers' while the new definition mentions 'intended audience'. Thus, the communication mentioned in the new definition is broader than that of the earlier definition. It is not simply written communication, but has an implied visual and verbal communication element as well. This is a broader definition, although the limitations mentioned earlier are still relevant.

The definitions discussed thus far have been developed mainly by first language English speakers who are working in a first language English context, such as the

United States of America or the United Kingdom. Although they are useful in providing a sense of what plain language is, it is important to look at local definitions that may take the South African context into consideration.

The following policy is included in section 22 of the *Consumer Protection Act, 68 of 2008* (RSA, 2008) and article 64 of the *National Credit Act, 34 of 2005* (RSA, 2005:94):

> … a notice, document or visual representation is in plain language if it is reasonable to conclude that an ordinary consumer of the class of persons for whom the notice, document or visual representation is intended, with average literacy skills and minimal experience as a consumer of the relevant goods or services, could be expected to understand the content, significance and import of the notice, document or visual representation without undue effort, having regard to –
>
> *(a)* the context, comprehensiveness and consistency of the notice, document or visual representation;
> *(b)* the organisation, form and style of the notice, document or visual representation;
> *(c)* the vocabulary, usage and sentence structure of the notice, document or visual representation; and
> *(d)* the use of any illustrations, examples, headings or other aids to reading and understanding.

Although this is not an English-specific language policy, the criteria outlined in this definition make it a sound like a plain English definition, because it covers various facets of plain language. The onus is placed on both the writer and the reader, as it is the writer's duty to use a variety of methods to make a text understandable – including visual literacy and effective visual representations – and describes the reader as a person with 'average literacy skills'.

However, it is when the definition gets to this point that it becomes problematic to implement – there are many South Africans who do not possess average literacy skills, which means that a large portion of the population is effectively excluded and not accounted for. Although this policy acknowledges people with 'minimal experience as a consumer', which one can assume would include people from more impoverished circumstances, the people whom this policy is meant to include may not benefit from the implementation of it, because they may not possess the required literacy skills. Having said this, it is important to acknowledge that the use of a definition of this quality may be beneficial to the education system as the current regulations are vague and the implementation of this policy to teaching resources may help teachers and learners to grasp information more clearly in schools. Moreover, the policy specifies that the relevant *context* for understanding a text must be provided – this is an important point because it implies that there is not a universal context for all South Africa's citizens, and that this is important to consider in the delivery of information to the correct target audience. Moreover, this must be coupled with the necessary organisational aspects, grammar, and visual literacy aspects, all of which contribute to a coherent understanding. Visual literacy and visual representation are often left unacknowledged in plain language definitions, but these are essential requirements in texts as they contribute to comprehension. Noomé (2015:142) argues that, if a text is in plain language, 'access to content can allow readers to make up their own minds on the basis of the information more effectively', so it is important to consider various means of achieving such understanding.

As stated previously, this definition is sound for both plain language (as a broad term, inclusive of any language) and Plain English. These terms are referred to interchangeably in the study because English is the *lingua franca* in South Africa and the primary language of science and education (the focus of this study). Although this should not be the case in South Africa, given our history and the theoretical equality of the eleven official languages, the assumption that plain and language are interchangeable terms in this study is justified. It should, however, also be noted that different cultural and linguistic backgrounds in South Africa can lead to difficulty when it comes to the practical implementation of plain language criteria due to different frames of reference and literacy skills, as was suggested by Pienaar's (2002:150) list of obstacles to communication, which I quoted in Section 1.1.

There are a few individuals and groups that have made an attempt to effect the implementation in South Africa, notably Eleanor Cornelius.[4] In her article 'Defining "plain language" in contemporary South Africa', Cornelius (2015:9-12) notes that the following principles need to be considered in developing a plain language text: cohesion, coherence, acceptability, intentionality, informativity, contextuality, and intertextuality. She rightly suggests that, given both the popularity of plain language and the difficulties of formulating a formal definition of the term, these three broad

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[4] Prof. Eleanor Cornelius is head of the Department of Linguistics at the University of Johannesburg. She is a former member of PanSALB, serves on the council of the *Fédération Internationale des Traducteurs* (the International Federation of Translators) and is the vice-chairperson of the South African Translators Institute (SATI).

issues relating to plain language listed by the International Plain Language Working Group (2010) should be acknowledged:

- It is possible to use numerical and formula-based definitions that focus on particular elements in order to determine whether a text is readable or not, and apply mathematical formulas to a text to determine readability and comprehensibility.
- Elements-focused definitions do not provide a ‘definition’ for plain language, but outline elements that plain language practitioners should work with – these definitions focus on issues such as structure, vocabulary, design, and content.
- Outcomes-focused definitions focus on both the linguistic and the visual aspects of a text, as well as on how well a text can be understood and used.

A definition that is both elements-focused and outcomes-focused can be considered when it comes to reconstructing documents into plain language texts. These two foci emphasise issues of content, structure, design, and vocabulary, as well as the readability and reception of plain language texts (this includes visual elements) to ensure comprehensibility.

Numerical or formula-based definitions can initially be applied to texts to get a sense of the readability of the documents in terms of sentence length and vocabulary, and to establish whether they need revision (which is time-consuming, and thus costly). This can be done in the form of readability tests. According to Cutts (2013:235), ‘testing is key’ because it is the only tool that gives a writer a sense of the readability of a document.

By drawing various elements of these definitions together, I developed a working definition for the purposes of this study. This definition is presented in the conclusion to this chapter.

2.5 A HISTORY OF PLAIN LANGUAGE

Plain language is not a new concept. As far back as the 14th century, when Chaucer wrote the lines ‘Speketh so pleyn at this tyme, we yow preye/That we may understonde what ye say' (ll. 19-20),[5] people have urged for its inception in various sectors of society.

One of the earliest proponents for plain language in the modern world was the British essayist and novelist, George Orwell, who wrote the essay 'Politics and the English Language' in 1946. He explores the relationship between what we say and how we think and act. Orwell (1946:109) claims that '[i]f thought corrupts language, language can also corrupt thought'. He proposes using plain language, arguing that avoiding Latinate and abstract words could rescue the English language from 'collapse' under a political language that he believed was designed to cloud thought and disguise lies. Therefore, he called for a language that is free of ambiguity and untruthfulness. He later states that language should be 'an instrument for expressing and not for concealing or preventing thought' (Orwell, 1946:112). He illustrates the reality that a lack of clarity in language leads to a lack of mental clarity, which can affect multiple facets of one's life.

These ideas have been brought forward into Cutts's work. He openly acknowledges Orwell's influence on his work in plain language, which is evident in his definition of plain language and the list of elements he believes one should consider when writing a plain language text. Cutts claims that plain language can eliminate ambiguous and unclear information and, like Orwell, he believes that 'Plain English should be an accepted part of plain dealing…between citizens and the state' (Cutts, 2013:xii), and by extension, between academe and those who have to convey information to learners, and between teachers and learners.

Orwell and Cutts are both British, but it is important to recognise that the plain language movement is a global movement which extends far beyond this region and even beyond the English language. Several countries have implemented policies that recommend the use of plain language or even make it mandatory in some situations. In the 1970s, the then US president Richard Nixon declared that the federal register should be written in 'layman's terms' (Lutz, 1987:10). Later, President Jimmy Carter stated that 'regulations should be as simple and clear as possible' (Asprey, 2003:2), which led to the introduction of a plain language law in New York State requiring

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[5] Chaucer is mentioned in Cutts (2013:xxvii), but the line has been corrected by Noomé (2015:141).

residential leases and contracts to be written in plain language (Asprey, 2003:2). Since then, various plain language policies have been implemented across various states in the United States. Other countries besides the United Kingdom and the United States that are on board with the movement include Australia, Canada, Denmark, the European Union, France, Germany, Hong Kong, India, Ireland, Italy, New Zealand, Papua New Guinea, Singapore, South Africa, and Sweden (Asprey, 2003:7-28).

One of the challenges facing the plain language movement is highly heterogeneous societies, such as that in New York, where language exclusion has the potential to alienate people. South Africa is a good example of a heterogeneous society, where the majority of citizens are not first language English speakers, but the *lingua franca* is English. When people like Orwell and Cutts seek potential solutions for the lack of clarity in language, it must be borne in mind that their work is written from the perspective of a first language English speaker for use primarily by fellow first language English speakers, and assumes a level of functional literacy. According to Thrush (2001:295), it is important to acknowledge this, and to recognise that English idioms and colloquialisms that may simplify the language to first language speakers may in fact be completely obscure to non-first language English speakers.

South Africa has made attempts to be part of the plain language movement in its own right. In 1995, the then Minister of Justice, Mr Dullah Omar, said:

> Simplicity of language reflects a commitment to democracy. The use of language above the heads of the average citizen may swell the heads of its users, but it does little else. (quoted in Asprey, 2001:27)

As already indicated, South Africa has eleven official languages and a large functionally illiterate population. These challenges have resulted in difficulty implementing plain language across the board. In 2001, an attempt to train parliamentary staff in the use of plain language for official documentation in English and the ten other official languages was undertaken. Practical training workbooks were used to train staff. Following the training, the following areas of need were identified for the future (Asprey, 2001:28):

- institutional support for plain language principles, both in policy and implementation;
- customised training workbooks and programmes for other sections of South Africa’s Parliament and its nine provincial legislatures;

- refresher training and a mentoring system;
- an electronic plain language definition glossary; and
- plain language editing packages in all South African languages.

Given that we know that a lot of work still needs to be done in the development of the indigenous languages in South Africa (with the possible exception of Afrikaans), it is clear that South Africa still has a long way to go in addressing these areas of need. Furthermore, there is still a lot of official documentation that does not subscribe to plain language writing principles (one of which is the *CAPS* document that I analyse later in this study). Nevertheless, South Africa is not completely failing in its attempts to encourage the use of plain language. Academic support at a tertiary level for the movement is also increasing: Cornelius's work on *gewone Afrikaans* (2012) in legal documents and Noomé's work on the translation of indigenous Nkuna law first from Afrikaans to English and then into Plain English (for accessibility) both suggest that there is forward trajectory in the plain language movement in South Africa.

The idea behind my study is to see whether and how plain language is used in educational resources for science in South Africa, because this is an area where the country is facing an educational crisis. Three decades ago, an article by Dorney (1988:49) stressed that 'organisations that embrace plain English benefit from better internal communication and improved public relations'. He includes the education system as one of the institutions that can be improved by using plain language texts. Plain English has therefore been in use in the American education system for many years, but this is less explicit in South Africa. For many years South African publishers have been applying plain language to educational resources, but it is not very clear how effectively this has been done, especially for science education (ascertaining this is one of the objectives of this study). It is something that requires close consideration, as these resources influence the understandability and accessibility of important content. Elmore (2008:22) stresses the following:

> In its simplest terms, the instructional core is composed of the teacher and the student in the presence of content… a focus on the instructional core grounds school improvement in the actual interactions between teachers, students, and content in the classroom.

Thus, if the resources that teachers use are developed by people who are knowledgeable in both content and plain language strategies, it would go a long way toward ensuring that teachers both understand and are able to communicate information to learners in a comprehensible manner.

As discussed in the previous sections, the South African language situation is a problem because many learners are being taught in English without an adequate comprehension of the language by either the teachers or the learners. Reading and writing influence learners' performance not only in their language subjects, but in all their subjects. Language proficiency 'provide[s] the foundation for further learning, whether that be in literature, mathematics, history or science – reading is central to almost all further formal learning' (Spaull *et al*., 2016:13).

By assuring that effective plain language resources are being used by teachers in the South African education system, particularly in subjects that are content-heavy, such as science, teachers, who lack comprehension in English, and learners will be better equipped to access essential information and this will 'limit cognitive processing by the reader' (Cornelius, 2010:171). In this way, learning will be aided, preparing readers for more complex texts that can otherwise often lead to the exclusion and marginalisation of learners who do not come from first language English homes. The purpose of plain language is to 'ensure intelligible texts' (Pienaar, 2002:147), so that successful communication takes place in the classroom environment:

> The language of face-to-face human interaction, the physical environment of the classrooms, and nonverbal human messages (such as gestures, body language) are crucial as well for the successful implementation of any language learning. (Mostert *et al*., 2012:176)

It is essential for teachers to be presented with easily understandable and accessible materials so that they are comfortable with the content and therefore able to communicate successfully with learners in the classroom. Oversimplification of information can be avoided if those who develop texts are knowledgeable in subject content and plain language strategies.

2.6 PLAIN LANGUAGE IN SCIENCE

English is the 'primary medium for twentieth century science and technology' (De Klerk, 1996:7) in a globalising world, and it is the responsibility of the scientific community to ensure that findings are universally accessible. However, this is not often the case, due to the extensive use of scientific jargon in scientific texts.

> We live in a world that operates according to a few general laws of nature. Everything you do from the moment you get up to the moment you go to bed happens because of the working of one of these laws. This exceedingly beautiful and elegant view of the world is the crowning achievement of centuries of work by scientists. There is intellectual and aesthetic satisfaction to be gained from seeing the unity between a pot of water on a stove and the slow march of the continents, between the colours of the rainbow and the behaviour of the fundamental constituents of matter. The scientifically illiterate person has been cut off from an enriching part of life, just as surely as a person who cannot read. (Hazen & Trefil, 2009:xvi)

As scientific fields have become more and more specialised, scientific texts have become less accessible to the general public. Furthermore, poor language teaching in schools has led to poor writing skills that filter into written scientific texts. Many people ‘have not been exposed to science sufficiently or in a way that communicates the knowledge they need to have to cope with the life they will have to lead in the twenty-first century’ (Hazen & Trefil, 2009:xv) and this has resulted in a society that has a poor understanding of science, due to limited scientific literacy.

In 1915, George Otis Smith, an American geologist, published an article titled ‘Plain writing’ in which he encouraged plain writing in science. His argument was that scientific research needs to be accessible to the public because research is conducted in order for us to understand the world we live in: ‘Science is simple [and] scientific thought is exact and direct, and scientific writing must therefore be accurate and to the point’ (Smith, 1915:630). But often scientists shut the reader out by aiming their work at the specialised and using long words to cover up uncertainty on some matters. Thus, it is essential to know when to use technical terms and when to use common words in order to transmit thought. Science should be written in the ‘language of the people’ (Smith, 1915:632).

Although it is necessary to be precise (and this sometimes to use scientific jargon), it is also important to make sure that the wording around this jargon is understandable to those who choose to access it. Moreover, if a scientist ‘expects someone to know something, [she/he] has to tell him or her what it is’ (Hazen & Trefil, 2009:xvii). Consequently, Guy Shakhar (s.a.) and Anne E. Greene (2013) have developed guides specifically for the use of plain language in science. Shakhar’s guide, *Writing science in Plain English* (s.a.), stresses the need for scientists to sound ‘serious, precise, authoritative, professional and objective’, but acknowledges that this can often come across as ‘pretentious, lengthy, vague, and dull’ (Shakhar, s.a.:6). To counter this, he provides an elements-based guideline for scientists to apply to their scientific work. Greene’s book, *Writing Science in Plain English* (2013), addresses the need for intelligible writing because scientific writing can often hinder the flow of information and affect the ‘cross-fertilization that has advanced scientific discovery in the past’ (Greene, 2013:2), which in turn can lead to a decline in scientific discoveries and scientific literacy. One reviewer of Greene’s book acknowledges that ‘writing in science has reached an all-time nadir and has become practically unintelligible to all but specialists in narrow fields’ (Heatwole, 2013:1014). Thus, scientists are also cutting themselves out of developing their knowledge base within scientific fields because of inaccessible language.

Plain language is yet to be adopted in scientific communication, but there are members of the community who acknowledge its importance and advocate a scientific base that is accessible to the general public through plain language.

2.7 CONCLUSION – A WORKING DEFINITION OF PLAIN LANGUAGE

In this chapter, I have considered plain language definitions, the history and the relevance of plain language in the global and local scientific and educational context. I have cited several specific and carefully worded definitions of plain language, but there are also many loose descriptions of the term and several misconceptions which could potentially lead to the misuse of strategies, incoherence and a *lack* of clarity in texts. For example, important information may be left out of a text in an effort to keep it ‘short and sweet’ – this would make the information unclear to the reader and the text would no longer fulfil its purpose. For this reason I have decided that Cutts (1995:3) definition is the most useful as a working definition for this study. I therefore repeat it here. It states that plain English is

> …the writing and setting out of *essential information* in a way that gives a *co-operative, motivated person* a good chance of understanding it at *first reading*, and in the same sense that the *writer meant it to be understood*. (my emphases)

My study focuses on how best to convey ‘essential information’ to teachers, whom I assume to be ‘co-operative, motivated’ readers. Teachers need to pick up on content easily and quickly in their preparation and in classroom, which means that understanding at ‘first reading’ is important. It is crucial that this information is also understood correctly. To expand this definition, I also apply the following four bullets from section 22 of the *Consumer Protection Act, 68 of 2008* (RSA, 2008) and article 64 of the *National Credit Act, 34 of 2005* (RSA, 2005):

- the context, comprehensiveness and consistency of the notice, document or visual representation;
- the organisation, form and style of the notice, document or visual representation;
- the vocabulary, usage and sentence structure of the notice, document or visual representation; and
- the use of any illustrations, examples, headings or other aids to reading and understanding.

I argue that these are the elements that would make the most difference to an understanding of scientific text. It is essential that the resources available to teachers pay attention to context, and that they are as comprehensive and consistent as possible. Macro elements such as organisation, form, style and visual presentation contribute to the effectiveness of a document, and micro elements such as vocabulary, sentence structure and illustrations aid the reading process.

Lastly, I apply Cornelius's advice that numerical and formula-based definitions, elements-focused definitions, and outcomes-focused definitions be used when it comes to the analysis of documents for this study. I therefore use readability tests to test the readability of each text, and then evaluate each text for content, structure, design, and vocabulary, as well as overall readability and reception.

There are many more definitions available, but the above mentioned are the most applicable to this study, as they are plain language definitions that can be usefully applied to the documents assessed in this study.

CHAPTER 3:

METHODOLOGY

3.1 INTRODUCTION

In this chapter, I provide detailed information on the research process, and the methods that I used to conduct the research.

The study is exploratory as it gathers and analyses information on the use/failure to use plain language in the South African education environment, specifically in materials made available to teachers, to gain more insight into whether or not plain language techniques can improve the delivery of content to Natural Science teachers. The study is also exploratory because it combines more traditional English studies methods such as detailed reading and an extensive literature review (in the preliminary and data application stages) with methods less commonly used in this field, namely qualitative data collection in the form of interviews.

The research design is complex, in that it required an iterative process of data gathering, application and analysis: I gathered data, applied them, and then gathered more information on the application, and again applied the data to explore the application. The flow diagram in Figure 1 (overleaf) represents this research process.

I began with a literature review to establish the need for plain language in the South African education context, and to identify preliminary plain language criteria that I applied to sample texts to use in the interviews conducted with a small sample of ten science teachers. Based on the data, I selected a final set of criteria to establish whether selected Natural Science resources adhere to them. The process was not linear, as I revisited each research component several times, but, for the sake of clarity, in this chapter I discuss the steps systematically, in the following order:

- research design and process;
- the selection of preliminary plain language criteria;
- the selection of documents for analysis
- the text samples for use in the interviews;
- the interviews; and
- the document analysis procedures
- the application of readability tests;
- the application of the final criteria to sample document analyses.

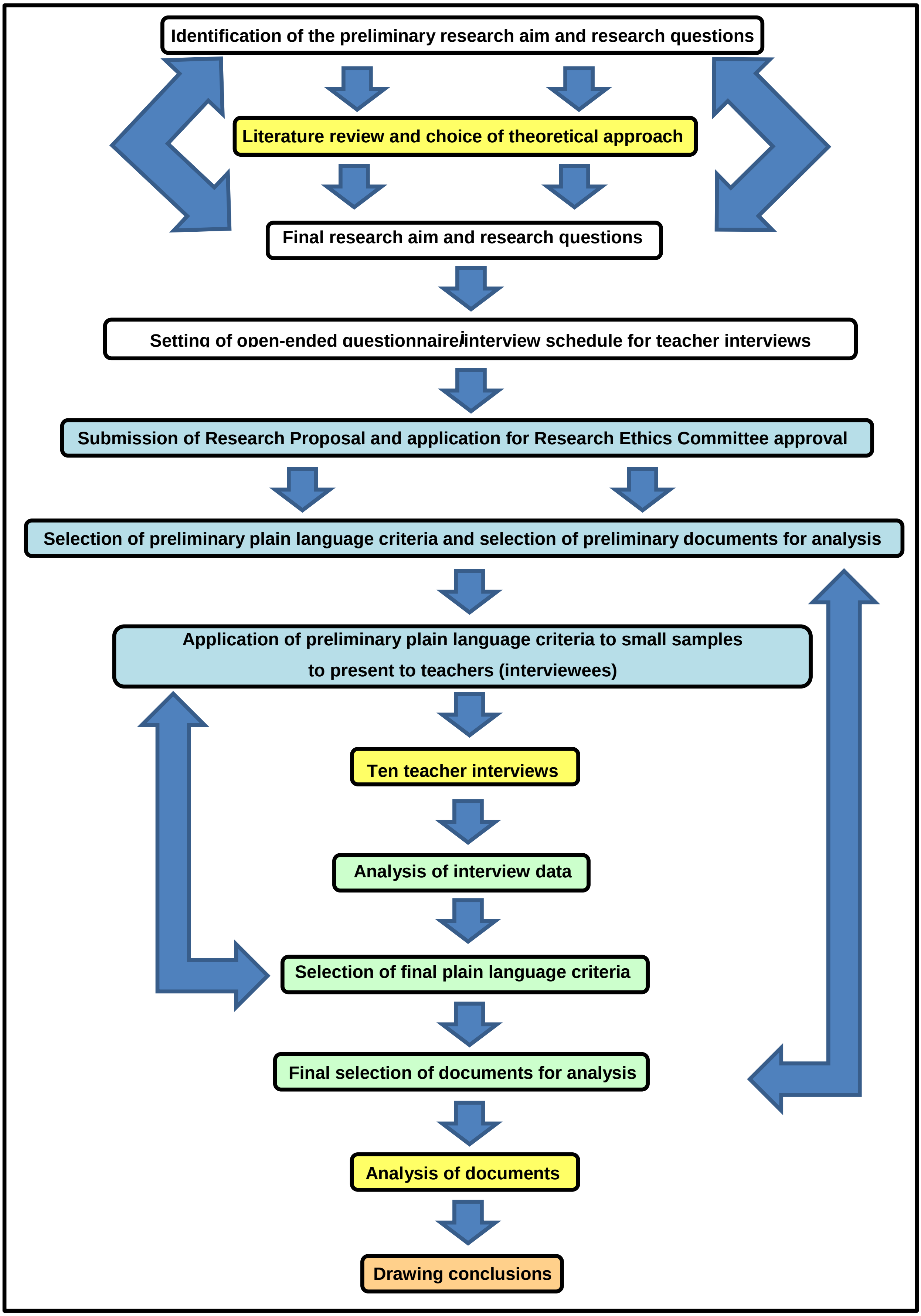

Figure 1: Research process

3.2 RESEARCH DESIGN AND PROCESS

As indicated at the start of this chapter, this is an exploratory study in which various means of data collection were implemented in the bigger research process outlined in Figure 1. The methods of data collection that I used are presented in Table 1.

Table 1: Data collection methods

Data collection method	Description
Literature review	The purpose of this method was the following: • identifying the theoretical underpinnings of the study; • identifying global and local definitions of plain language that could be applied in the study; • verifying the existence of a language problem in South Africa's education system and exploring the language debate in the country; • ascertaining that plain language is a useful tool for making science more accessible to the community; and • identifying preliminary plain language interventions that can help to clarify teacher resources toward improving science education in South Africa.
Teacher interviews	Based on approval by the ethics committee, teachers were selected for open-ended interviews through the process of snowball convenience sampling, and these interviews were used to: • establish teachers' thoughts on existing Natural Science teacher resources; • find out which resources are the most commonly used; • gauge which options teachers prefer out of samples of original texts and plain language versions of the same texts to ascertain whether plain language can potentially help teachers to make better sense of challenging content.
Readability tests	Readability tests were used to provide • an objective quantifiable measure to the readability and comprehensibility of the selected original texts; and • an objective quantifiable measure to the readability and comprehensibility of the plain language texts.
Researcher's input	Based on the findings, the researcher had to • select the preliminary and final plain language criteria; • select the resources for analysis. • study the sample texts to see how they have/have not applied the selected plain language criteria; • implement the selected plain language criteria to the sample texts, where necessary; and • assess the success of the application of these criteria using readability tests as a starting point.

Thus, a mixed methods design was used, combining an extensive literature review, qualitative data collection in the form of the interviews, and quantified assessments of document readability in the form of the readability tests to augment analysis of the texts.

The literature review was essential in order to establish the context and relevance of plain language and to develop a working definition (see Chapter 2), and to work towards the plain language criteria identified as most relevant for use in science resources for teachers (see Section 3.3). The literature review established the role that the teacher plays in student learning. It was also useful in clarifying that it is the writer's responsibility when developing a text to ensure that there is as little room as possible for miscommunication and misunderstanding, assisting the readers (in this case, teachers, who then have to transmit the information to learners).

Following this desktop research, qualitative research was undertaken in the form of teacher interviews to gather information on the challenges in the field of using the *CAPS* document and teacher resources available, to verify the applicability of my preliminary selection of plain language criteria from the literature and identify which teacher guides were most commonly used by the sample to select the texts from which I would take samples for the subsequent document analysis in the next stage of the study. Each of the ten teachers was asked to sign a consent form (see Appendix A and Section 3.6.3) prior to being interviewed for the study. Questionnaires were developed to simplify the collation and processing of the interview data, as each response was ticked or marked by the participant and then elaborated on in the discussion, which was audio-recorded. A sample of the questionnaire is attached as Appendix B. Teachers were asked a variety of questions to elicit general demographic information on the participants, the *CAPS* document, and teacher resources (see the detailed discussion of this in Section 3.6.2).

Once the interviews had been conducted and the interview data had been collated, the data were used to finalise the plain language criteria and which resources to draw the document analysis samples from for the next stage of the research.

Following this process, the originals of the sample selections were run through a readability checker (readability tests are discussed in Section 3.8) to quantify their readability, and I did a qualitative analysis to see how well they complied with the selected final plain language criteria. If the samples did not comply with these criteria, the texts were revised and again run through the readability checker to establish a new readability score and assess the comprehensibility of the revised texts. I used my discretion as a trained editor (I completed a rigorous editing module at Honours level at the University of Pretoria) and user of text in my observation and implementation of the plain language criteria, in line with the findings of the literature review and of the interviews.

3.3 PLAIN LANGUAGE CRITERIA

In Chapter 2, I outlined the origins of plain language and various definitions applicable to this study (see Sections 2.4 to 2.7). at the end of the literature review (see Section 2.7), I provided a working definition for plain language that draws on Cutts's 1995 definition and the criteria listed in section 22 of the *Consumer Protection Act, 68 of 2008* and article 64 of the *National Credit Act, 34 of 2005.* As I explained, I first applied a numerical or formula-based definition to the selected text samples to test for readability in the form of quantifiable readability tests. Then, I applied elements-focused and outcomes-focused criteria to the content, because they stress content, structure, design, and vocabulary, as well as the readability and reception of plain language texts (this includes visual elements as well) so as to ensure comprehensibility – qualitative means of analysis are employed here. But these criteria are broad and do not specify the exact principles applied to the selected teacher guides. Hence, I used the fourth edition of Cutts's *Oxford Guide to Plain English* (2013), Shakhar's *Writing science in plain English* (s.a.), and Greene's *Writing Science in Plain English* (2013) to establish a preliminary specific set of criteria that were applied to samples from the texts selected for analysis. These were presented alongside the original version so that the teachers who took part in the study could select their preferred option. The participants were asked to explain their selection. After an analysis of these results, a final set of criteria was established (see Section 5.2) and applied to the documents analysed in Chapter 5.

The preliminary selection of criteria was the following:

- **An average sentence length of 15-25 words:**
  Shakhar (s.a.:7) promotes the KISS principle (Keep It Short and Simple) when it comes to sentence length, which suggests that the shorter the sentence, the better. This broad principle is useful but vague. Greene (2013:63) argues that the sentences should vary in length, because a 'string of long sentences (30 words or more) is difficult to get through; a string of short sentences (10 words or less) is choppy, and a string of medium-length sentences (15-25 words) is monotonous'. Cutts recommends an average maximum sentence length of about 15 to 20 words (Cutts, 2013:1), which allows for some variability. Bearing in mind these diverging views on sentence length, I opted for medium-length sentences in the initial revisions to present to the participants, because the aim is for teachers to be able to digest information in small amounts, rather than in large chunks via lengthy explanations.
- **Focused paragraphs and lists:**
  Cutts (2013:8) recommends that paragraphs represent a '*unit of thought*' (Cutts's emphasis). Greene explains that each paragraph should have an issue, development and conclusion. Furthermore, a paragraph should not be more than approximately 150 to 200 words long (Greene, 2013:67).[6] It is also recommended that large chunks of information be divided into vertical lists (bulleted or numbered) in order to make it easier for the reader to digest information (Cutts, 2013:5).
- **Word choice:**
  Cutts (2013:11) recommends using 'words your reader is likely to understand'. Although science is a discipline that relies on complex constructs and terms, these terms are often overused or used unnecessarily. As a result, I favoured shorter words over longer words (where possible), kept terms consistent, and broke up noun strings. I bore the following in mind when reading the text the call to prefer the 'common word to the rare word, the short to the long, the single to the multiple, the standard to the off-beat, the specific to the general, the definite to the vague, the concrete to the abstract, the Anglo-Saxon to the Latinate' (Shakhar, s.a.:16).
- **Favour the active voice:**
  The active voice is more direct than the passive voice, and is often shorter than the

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[6] To give a sense of how long this is – the bullet point above is 145 words long.

passive option. Moreover, active sentences are easier to understand as they reflect the way we speak every day (Greene, 2013:22), and it is clear who the agent is. However, there are times when the passive voice is useful and can make a text more understandable, for example, when the process is more important than the agent. For this reason, I did not omit the passive entirely but used it only when necessary.

- **Audience, register, and tone:**
  According to Cutts (2013:118), the average reading age in Britain is 13 – one can assume that the reading age is lower in South Africa, where English is not the first language of the majority of the population. Hence, it is important for writing to be pitched at the correct level. This should be done in such a way that the audience does not feel spoken down to, as if they are incapable of understanding what is being said. Hence, the register should remain primarily formal but with carefully crafted informal elements (Greene, 2013:7). In addition, the tone should project confidence in the knowledge that is being presented (Greene, 2013:10).
- **Non-sexist/biased language:**
  It is important to make sure that language is not sexist (Cutts, 2013:34), especially when it comes to the natural sciences, which are often dominated by men. Language should also not present racial or political biases.
- **Reader-centred structure:**
  When readers are placed at the centre of the text, they are better able to grasp important information early (Cutts, 2013:165). What Cutts means by this is that the reader is placed at the centre of the text by addressing her/him directly in the second person. For example, ‘You can…’ or ‘When you…’. Imperatives work in the same way, because the implied subject in a command is ‘you’. Neither Shakhar nor Greene discusses this point, perhaps because scientific writing is generally geared toward a more academic audience, where using the impersonal third person has long been the norm (although this is changing). However, the idea behind textbooks and the teacher guides that accompany them is to help the readers to learn information quickly, which is why a reader-centred structure is promoted in this instance.
- **Clear layout:**
  Layout has an influence on readers’ ability to absorb information, so the layout

needs to help them to access the information. Elements such as a legible font and font size (the font should be easy on the eye and the font size should not be difficult to read), line spacing (leaving enough white space to allow readers to see each word clearly), colour (for example, contrasting the foreground and background and adding colour to headings, to make the document more navigable), and a hierarchy of headings (bold, upper and lower case, italics to help the reader to navigate the document). These elements should be considered as the absence of such elements can influence the reader's experience negatively (Cutts, 2013:246).

- **Use alternatives to words:**
  According to Cutts (2013:178), '[t]he written word alone is not always the best way of communicating a message. Graphic devices such as tables, illustrations, pie charts, diagrams, maps, strip cartoons, mathematical formulas and photographs can all help'. There are no set rules, but it is useful to experiment with these alternatives.

There are multiple criteria to consider when writing a plain language document – the preliminary criteria identified above were deemed the most applicable to the selected documents. Once the interviews had been conducted and the data had been collated, these criteria were revisited. These criteria and an explanation of any changes appears in Section 5.2 – a fold-out of the final criteria can be referred to in the hard copy of this document when reading Chapter 5 (attached as Appendix C).

3.4 SELECTION OF DOCUMENTS

The documents that were analysed prior to the interviews to select samples to use in the interviews were the *CAPS* document (Department of Education, 2011) and the *Spot On Natural Sciences* teacher guide for Grade 8 (Vermaak *et al*., 2017). After the interviews, another section of the *CAPS* document was analysed, based on the interview findings. I then looked at the same *Spot On* teacher guide (2017) and the 2013 learner guide that the teacher guide was meant to match.[7] I also analysed the learner and teacher guides for the *Platinum Natural Sciences* for Grade 9 (Bester *et al*., 2018a, 2018b). The reasons for each of these selections are discussed below.

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[7] The *Spot On* guides were added to the University of Pretoria's collection in 2017. The teacher guide (2017) is a revised edition, but the learner guide (2013) is not because it has not been revised.

3.4.1 CAPS for Senior Phase Natural Science

The *CAPS* document[8] serves as a uniform national point of departure for teachers, because it provides an overview of the content, term plans, weekly plans, and assessment schedule for each grade. The purpose of the document is to ensure that teachers throughout the country know what they have to cover in the classroom and assess in tests and assignments in a given grade. The document was developed to ensure that teachers stay on track with the content as they prepare learners moving towards a matriculation certificate. Because learners' future depends on their passing that final examination, the document needs to be as clear and accessible as possible, and there should be no room for misinterpretation.

The *CAPS* document for Senior Phase Natural Science states that teachers need to promote an understanding of

- science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena.
- the history of Science and the relationship between Natural Sciences and other subjects.
- the different cultural contexts in which indigenous knowledge systems have developed.
- the contribution of Science to social justice and societal development.
- the need for using scientific knowledge responsibly in the interest of. ourselves, of society and the environment.
- the practical and ethical consequences of decisions based on Science. (Department of Education, 2011:8-9; original punctuation).

These are all useful but broad and therefore somewhat vague aims for a teacher. These aims can be achieved only if teachers have a clear understanding of the content, which is often not the case (as stated in Section 2.3). The *CAPS* document acknowledges the role of language in science: 'The ability to read well is central to successful learning across the curriculum' (Department of Education, 2011). This applies to anyone involved in the learning process. Based on the understanding that teachers are involved in the learning process, the curriculum, its aims and objectives, need to be clearly stated. The *CAPS Document* for Natural Science in the Senior Phase was therefore selected for analysis for its importance to the teaching and

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[8] The full name is the *National Curriculum Statement Curriculum Assessment Policy Statement Natural Science Senior Phase (Grades 7 – 9).*

learning process, with a specific focus on Grade 7, which is the foundational year for the Senior Phase.

The goal was to see whether and how plain language criteria could be applied and an evaluation of the Grade 7 section gave a good idea of how this was done across the board. My initial analysis showed that the layout of the information was very similar for each of the three grades (Grades 7 to 9). Analysis of one grade's material would therefore suffice to identify the layout and principles governing the organisation of the material, so that it was not necessary to evaluate each grade in full, as I was not undertaking a full revision of the document.

Prior to the interviews I selected text samples from three different places in the text, because I was not certain of which sections of the document the teachers used most. From the start, I intended to analyse the *CAPS Document*, but I wanted to establish which section/s were the most used and most/least understandable to teachers before I could make my text selection for the final document analysis (see Section 3.7 and Chapter 5). The interviews revealed that the Natural Science content and concepts (pp. 17-84) were by far the most used section in the document, so that section formed the focus of the final analysis.

3.4.2 Learner and teacher Guides

I chose the *Spot On Natural Sciences* Teacher Guide for Grade 8 for the sample analysis prior to the interviews because a librarian on the teaching campus at the University of Pretoria (Groenkloof) indicated it as the most recent addition to the library's resource collection, stating that it had been acquired because it is a popular teaching resource.

There are several CAPS-compliant Natural Science textbooks available and in use in South Africa. The process around Natural Science textbook selection for the Senior Phase in South Africa is somewhat opaque. No information on this process could be found online, suggesting that this information is also not freely available to teachers. In the interviews, the participants stated that they were told which textbook to use by their respective Heads of Department (HoDs) for Natural, Physical and Life Science. Two HoDs who spoke to me on an informal basis explained that the Department of Education faxes textbook lists to schools every three to five years. Neither of the HoDs could find the latest copies of these lists, nor could they remember what was on the list. They admitted that they had selected their textbooks based on word-of-mouth.

According to the participants, each set of textbooks has good and bad points. It may be argued that it is preferable for teachers to refer to more than one textbook (this view was shared by most of the teachers interviewed in the study). Some textbooks seemed to be slightly more popular and easier to access than others, based on internet searches and conversations with the librarians at Groenkloof, but the results of the interviews were inconclusive. Based on the limited information available, I finally decided to focus on the *Spot On Natural Sciences* learner and teacher guides for Grade 8, which I had already looked at for the samples for the interviews, and the *Platinum Natural Sciences* learner and teacher guides for Grade 9. The reasons for these selections are discussed more fully below.

3.4.2.1 Spot On Natural Sciences

This textbook was selected based on my initial conversation with the librarian at Groenkloof. Only one of the respondents in the study (P2) indicated using the *Spot On Natural Sciences* learner and teacher guides. Another respondent (P4) claimed that it is a popular textbook in township schools. Thus, this textbook was selected based on these reasons and its accessibility.

The Grade 8 learner and teacher guides were chosen for the study because the teacher guide was updated more recently than the other grades' (it was updated in 2017). Close analysis of the documents revealed that the learner and teacher guides function as a set and had to be evaluated together. Due to the limitations of a Master's study and time constraints, only selected sections of these guides could be evaluated.

3.4.2.2 Platinum Natural Sciences

Although only the first respondent (P1) uses of the *Platinum* textbooks in her class, several of the other respondents stated that they referred to this series as an additional resource. The bestseller lists on Takealot.com (2017 and 2018) showed that the *Platinum* series is the most popular series of science textbooks in South Africa (even though P4 claimed that there are errors in the teacher guide). Hence, the Grade 9 learner and teacher Guides were selected for analysis in the study.

As with the *Spot On* textbooks, both the learner and teacher guides were selected because they function as a set. I chose the Grade 9 set, because I wanted to get a sense of how the Grade 9 syllabus is presented in the resources.[9] Again, due to time constraints, only selected sections of these guides were evaluated.

3.5 PLAIN LANGUAGE SAMPLE REVISION PRIOR TO THE INTERVIEWS

Three short examples from the *CAPS* document and three from the *Spot On Natural Sciences* teacher guide for Grade 8 were presented to the teachers interviewed for the study (see Chapter 4). These examples appear below in order to demonstrate how each sample was evaluated and then adapted to meet plain language criteria.

3.5.1 Examples from *CAPS* for Senior Phase Science

The first example was taken from page 8 of the *CAPS* document (Department of Education, 2011), under the heading 'Indigenous Knowledge Systems and Natural Sciences'. This is an important section, because it explains that indigenous knowledge has to be taught in all schools in South Africa, and what is classified as indigenous knowledge. Table 2 (overleaf) shows the original text, problem areas (written aspects that do not comply with the selected plain language criteria), the Plain English text, and an indication of the changes made to the text.

The information in the first column of Table 3 (overleaf) appears on page 12 of the *CAPS* document (Department of Education, 2011), under the heading 'Resources'. This is also important information, because it acknowledges that teachers lack resources, but foregrounds the need to engage learners in active investigation, clarifying why resources may be needed. Table 3 presents the original text, problem areas, the Plain English version, and a description of the changes made.

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[9] This meant that I had some sense of the syllabus covered in all three Senior Phase grades – Grade 7 from the *CAPS* document, Grade 8 from the *Spot On* guides and Grade 9 from the *Platinum* books.

Table 2: *CAPS* – Example 1

Original	Problem areas	Plain English version	Changes
Indigenous knowledge includes knowledge about agriculture and food production, pastoral practices and animal production, forestry, plant classification, medicinal plants, management of biodiversity, food preservation, management of soil and water, iron smelting, brewing, making dwellings and understanding astronomy.	• The sentence is far too long – 37 words. • It is difficult to maintain focus, because this horizontal list is long and has not been broken up. • The connections between items in the list sometimes group more than one item, for example, grouping 'pastoral practices' with animal production. [10]	Indigenous knowledge includes knowledge about: • Agriculture • Food production • Pastoral practices • Animal production • Forestry • Plant classification • Medicinal plants • Biodiversity • Food preservation • Soil management • Water management • Iron smelting • Brewing • Building dwellings • Astronomy	• The sentence is easier to access, because there is a platform statement and each item has been bulleted for the reader. • The horizontal list has been broken down into a vertical list (bulleted items), making it easier for the reader to absorb the information and use it as a checklist.

Table 3: *CAPS* – Example 2

Original	Problem areas	Plain English version	Changes
While it is acknowledged that it is not ideal to have to improvise equipment, teachers should remember that it is more important for learners to have the experience of carrying out a variety of investigations than to depend on the availability of equipment.	• Sentence length – 43 words. • Problematic word choice – improvise (context and meaning?). • The reader is not addressed. • Starts with a subordinate clause, which is unnecessary in this instance.	It is important for learners to carry out a variety of investigations so, when possible, you must be creative and conduct experiments with the learners.	• Medium length sentence has been chosen. • 'Not ideal', which is negative, replaced with the more constructive 'when possible'. • Addresses the reader – you. • Active voice is preferred, showing the agent/doer immediately. • Main clause information presented first, allowing the reader to get to the point faster.

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[10] The term 'pastoral practices' may be confusing. Here, the term refers to animal herding and grazing practices, but it could be misread as relating to (missionary and later adopted Christian) religious practices. In retrospect, I realised that the term may therefore also require glossing, although I did not make that change in the interview sample.

The term plan depicted in Table 4 (overleaf) appears on page 13 of the *CAPS* document (Department of Education, 2011). It provides an outline of the work that must be covered in each term and grade (the example below is of Grade 7, Term 1). This is the teacher’s first glimpse at the yearly plan, so the information needs to be clear and precise. The tabular form complies with the plain language criterion of easy-to-access layout, and avoids chunky text (it does not eliminate words, but provides an alternative to blocks of text). This table is also very useful to the reader because there are clear differentiations between the topics and sub-topics, but the layout can be enhanced.

Table 4 presents the original text with a description of the problem areas, the Plain English version of the text, and a description of the changes made.

Table 4: CAPS – Example 3

<table>
<tr><th>Original</th><th>Problem areas</th></tr>
<tr><td>
<table>
<tr><td rowspan="2">GRADE</td><td colspan="2">TERM 1:
LIFE & LIVING</td></tr>
<tr><td>TOPIC</td><td>WKS</td></tr>
<tr><td>7</td><td>• The biosphere
- The concept of the biosphere
- Requirements for sustaining life’
• Biodiversity
- Classification of living things
- Diversity of animals
- Diversity of plants
• Sexual Reproduction
- Sexual reproduction of angiosperms
- Human reproduction
• Variation
- Variations exists within a species</td><td>1
3 ½
3 ½
1
9 wks</td></tr>
</table>
</td><td>• Layout of the table.
• Information unnecessarily spread out in the table.
• Heading does not appear in bold.
• Grade is not immediately clear.
• ‘The biosphere’ appears in sentence case, whereas ‘Sexual Reproduction’ appears in title case – inconsistency
• Hours do not appear in line with the headings.
• Ambiguous/broad phrasing of concepts.</td></tr>
<tr><th>Plain English version</th><th>Changes</th></tr>
<tr><td>
<table>
<tr><td>Grade 7
Term 1: Life and Living</td><td>9 weeks</td></tr>
<tr><td>The biosphere
• What is the biosphere?
• What are the requirements for sustaining life?</td><td>Week 1</td></tr>
<tr><td>Biodiversity
• How do we classify living things?
• The diversity of animals
• The diversity of plants</td><td>Weeks 2 - 5</td></tr>
<tr><td>Sexual reproduction
• Sexual reproduction in angiosperms (seed bearing plants)
• Human reproduction</td><td>Weeks 5 – 8</td></tr>
<tr><td>Species variation
• What is a species?
• What is species variation?</td><td>Week 9</td></tr>
</table>
</td><td>• Grade indicated first – first thing teacher will look for.
• Topic stated in bold rather than all capitals – easier to read.
• ‘Weeks’ written in full – the abbreviation ‘wks’ is unnecessary
• Weeks have been clearly indicated in line with headings with clear dividing lines in the table.
• I show which week the teacher will be on rather than the amount of time it will take – clearer to say where in the schedule the teacher should be.
• Sentence case is used for all four subheadings.
• ‘Variation’ is changed to ‘Species variation’ to be more specific.
• Topics are phrased as questions whenever possible, as these are the questions that teachers need to answer for the learners.
• The total number of weeks is indicated at the beginning rather than at the end, as teachers need to know up front how long this will take.</td></tr>
</table>

3.5.2 Examples from *Spot On Natural Sciences* Teacher Guide for Grade 8

The information in Table 5 (overleaf) appears on page 42 of the *Spot On Natural Sciences* (Vermaak *et al*., 2017) teacher guide for Grade 8. The goal is for the teacher to explain what photosynthesis is to learners by referring to a word equation. Learners should be able to understand word equations in order to progress to symbol equations at a later stage. Table 5 depicts the original text, a description of the problem areas with regard to the application of plain language, the Plain English version of the text, and the changes made.

The example in Table 6 (overleaf) appears on page 45 of the *Spot On Natural Sciences* (Vermaak, *et al*., 2017) teacher guide for Grade 8. The goal of this component of work is for the teacher to explain the scientific method to learners. This is an essential component of the work, as this method is followed through to Grade 12; thus, there should be no room for confusion. Table 6 presents the original text, alongside a description of the problems pertaining to the application of plain language principles. An example of a Plain English version of the text is included, with a description of the changes made.

The third teacher guide example (in Table 7, page after next) also appears on page 45 of the *Spot On Natural Sciences* (Vermaak, *et al*., 2017) teacher guide for Grade 8. This is a representation of the specific steps one should follow when writing an experimental report. Again, this is essential information that should be carried through to Grade 12. The flow diagram is a good idea in terms of the criterion of avoiding chunky text only, but experimentation with the layout can be considered. Table 7 depicts the original text, a description of the problem areas, a Plain English version of the text, and an explanation of the changes made.

Table 5: Teacher guide – Example 1

Original	Problem areas
Learners must be able to understand and reproduce the chemical word equation for photosynthesis. Write it down on the board (or use the poster) so that you can talk them through it slowly and carefully. Ensure that learners understand the positioning of the chlorophyll and sunlight in the equation – these are not directly involved in the chemical reaction, but the chemical reaction would not happen if not for them.	• Teachers are not directly addressed. • The equation is not provided. • The final sentence contains 34 words – too lengthy.
Plain language English version	**Changes**
Photosynthesis In this session you need to ensure that learners understand what photosynthesis is. You can do this by reproducing the following equation on the board: Carbon dioxide + Water $\xrightarrow[\text{Sunlight}]{\text{Chlorophyll}}$ Glucose + Oxygen **NB!** Make sure that the learners understand the position of chlorophyll and sunlight in the equation. Even though these are not directly involved in the chemical reaction, the chemical reaction would not happen without them.	• A heading is provided to orient readers. • Readers are directly addressed. • The word equation is provided. • Important information is identified as important by being marked with 'NB'. • The information is broken up. • The last sentence is broken up.

Table 6: Teacher guide – Example 2

Original	Problem areas	Plain English	Changes
The scientific method **The scientific method for writing an experimental report** When we are faced with a scientific problem, there is a specific sequence of steps that we need to follow, in order to come to a reasonable explanation for our problem.	• The article in the heading is unnecessary. • The sub-heading is unnecessarily lengthy. • The reader is referred to in the plural form – we. • The sentence starts with a subordinate clause. • The sentence contains 31 words – too lengthy.	**Scientific method** **How to write an experimental report:** There is a specific sequence of steps that you need to follow when faced with a scientific problem. You need to follow these steps in order to come up with a reasonable explanation for the problem.	• The article in the heading can be omitted. • The sub-heading is more direct and specific. • The main clause is written as a sentence on its own and moves forward. • 'We' has been replaced with 'you' – directly addressing readers. • The subordinate clause has been rephrased as a sentence on its own.

Table 7: Teacher guide – Example 3

Original	Problem areas
The flow diagram below outlines the sequence of steps that the scientific method follows: Observation made ↓ A question is formulated ↓ Hypothesis formulated ↓ An experiment is designed ↓ Conduct the experiment ↓ Obtain results ↓ Analyse results ↓ Draw conclusions ↓ Accept or reject hypothesis	• The introductory sentence does not make it clear that these are the steps that one must follow when writing an experimental report. • The reader is not addressed. • There is a lack of parallel structure. The writer has switched between passive phrases, passive clauses and imperatives. • Steps are not numbered – flow diagram used instead.
Plain English version	**Changes**
You must follow the sequence of steps outlined below when you write an experimental report: 1. Make an observation 2. Formulate a question 3. Formulate an hypothesis 4. Design an experiment 5. Conduct the experiment 6. Obtain your results 7. Analyse your results 8. Draw a conclusion 9. Either accept or reject the hypothesis	• The introductory sentence (platform statement) makes it clear that these are the steps that need to be followed when writing an experimental report. • Readers are addressed. • The imperative form is used for each step. • Steps are numbered.

3.6 INTERVIEWS

Interviews were conducted with a sample of ten teachers (the results are set out in Chapter 4). The main purpose of the interviews was to draw on the experiences of teachers who are actually using the *CAPS* document and teacher resources available to them in preparing their classes and their interactions with learners. The second purpose was to verify the applicability of my preliminary selection of plain language criteria from the literature. The third purpose was to identify which teacher guides were most commonly used by the sample to focus the document analysis in that stage of the study (see Chapter 5).

Nine of the ten teachers were interviewed face to face in Pretoria and Johannesburg between January 2018 and October 2018. Each interview was conducted individually (with the exception of P7 and P8, who were interviewed together). One participant, Respondent 5, was not available to be interviewed in person because this participant lives in a town in another province. This respondent did not have the time for an interview and preferred to answer the questionnaire at her/his convenience, so this respondent received the questionnaire via email and responded via email. For this reason, this participant's answers are less detailed than those of the other participants. Nevertheless, I opted to include the information, because it was difficult to recruit participants, and I hoped to gain some insight from a respondent who was not in a large city environment.

The ten teachers were interviewed using a typed questionnaire with some closed-ended and some open-ended questions (see Appendix B for the questionnaire and Section 3.6.2 for a discussion of it). It served as an interview schedule to structure the interviews and make the data easier to compile and compare (see Section 3.6.4 for a discussion of how the data were processed). Prior to the interview, each participant received a copy of the informed consent form and questionnaire via email, but the participants were informed that this was just for their interest and preparation, as I took hard copies of both documents to the interviews so that the participants could sign and fill them in there. Each participant filled in her/his own questionnaire during the interview. The interviews were audio-recorded with the permission of the participants (see the ethical considerations in Section 3.6.3). All of the participants stated beforehand that they had limited time and this interview format (hard copies filled in during the interview) was deemed to be the format that would take the least amount of time, while still ensuring that all the important information was covered.

For the sake of the recording, I would read each question aloud from my copy of the questionnaire (I had my own copy on which I made separate notes during the course of the interview) and the participant would respond by filling in the appropriate section on her/his questionnaire and responding verbally. When the participants chose to elaborate on their responses, they did so verbally and indicated key points on the questionnaire.

After each interview, I collated the information from the closed-ended questions on an Excel document and transcribed the key points from the recorded interview (the open-ended questions) on a separate Excel sheet for each participant. These recordings were then stored on a computer for safe keeping (see Section 3.6.3). The audio-recordings were useful in attaining fuller, more detailed descriptions of each participant's views. Each interview took between 30 minutes and an hour and a quarter, depending on the amount of detail the participant was willing to offer.

These teachers were able to identify the most problematic sections of work and these formed the focus of the study analysis. This study was approached from a language perspective, but it is important to remember that the goal is to improve the teacher's understanding of scientific content. Thus, teachers' perspectives added value to the study.

More information on the process of selecting a sample, the questionnaire/interview schedule, ethical considerations and the data analysis are offered below.

3.6.1 Sample

A sample of ten teachers was used. This small sample is one of the limitations of this study, because it cannot be considered a statistically significant sample. The number was dictated by practical considerations relating to time and financial resources (Mouton, 2005:100), because I had a limited amount of time to collate the data before making my selection of samples for textual analysis and plain language criteria, and I was restricted to the Gauteng region, due to travel costs.

A sample of ten is considered appropriate and adequate for qualitative research of this nature (O'Reilly & Parker, 2012:191), because a very specific target group was required to discuss a targeted subject. The aim of these interviews was not to come to any final conclusions about the *CAPS* document and teacher resources, but to gain an understanding of what teachers *think* about these resources. Crouch and McKenzie (2006:496) argue that small sample groups are not just acceptable but best for exploratory research of this nature. As the results (set out in Chapter 4) show, there was some data saturation, which further suggests that this sample size was acceptable for the study.

A purposive convenience sample is recommended for qualitative research because it helps one to get the necessary sample size for research in a ‘relatively fast and inexpensive way’ (Lund Research, 2012:s.p.), and it guarantees access to relevant data (Lund Research, 2012:s.p.). A purposive convenience sample was also used because this study required a select group of participants who needed to respond to specific details related to their field. Such varied information was sought that of necessity the interviews were long, and not many teachers were able or willing to voluntarily spend the time required to answer all the questions. Each of my participants had to meet the criteria of

- currently teaching or having recently taught science (Natural, Physical or Life Science and preferably in the Senior Phase),; and
- teaching or having taught at an English-medium school.

These criteria had to be met because the teacher had to have been exposed to *CAPS* and other teaching resources, and the teacher had to have an understanding of the quality of the available resources in English because this is the language that I am focusing on in this study.

Teachers were approached via Sci-Enza at the University of Pretoria with permission from Sci-Enza and the University’s Ethics Committee (see Section 3.6.3), and from there snowball sampling was used. Sci-Enza is an interactive science institute on the University of Pretoria’s main (Hatfield) campus. Throughout the year, primary school and high school science teachers visit the institute with their learners to expose them to practical hands-on science experiences (University of Pretoria, 2018:s.p.). This served as a good starting point to begin the process of snowball sampling. Snowball sampling refers to a method of research in which ‘each person interviewed may be asked to suggest additional people for interviewing’ (Babbie, 2008:205). This was useful because it was difficult to locate teachers willing to participate.

3.6.2 Interview schedule/questionnaire

As indicated above, an interview schedule/questionnaire approved by the Research Ethics Committee was used to structure the interviews. The information elicited by the questionnaire can be divided into four sections.

The first is demographic information. Specific information relating to each participant's teaching background, qualifications, and language background was asked in this section. The participants ticked their answers in boxed lists that laid out the options for the teachers. For example, when asked what type of school the participant works at, the participant simply ticked the box indicating the relevant school type. This demographic information gave me an indication of whether or not the teacher had experience with Senior Phase teaching, the teacher had easy access to resources, was qualified, is proficient in English (the language focus of this study), and provided an indication of whether or not the participant reverts to code-switching in the classroom – code-switching refers to the shift between languages in the classroom and is often used in classrooms where the learners lack proficiency in the language of learning and teaching. These demographics confirmed that the participants did indeed meet the selection criteria for the sample.

The second section asked for teachers to provide information pertaining to the problem areas they encounter in the field. Here the teachers were asked for information relating to whether or not they found it easy to convey scientific content to learners in the language of learning and teaching, and then they were given different reasons for why this might be an issue. The teachers were asked to indicate their responses on a 5-point Likert scale, ranging from 'Strongly agree' to 'Strongly disagree'. Because this is a plain language study, the teachers were also asked to indicate whether or not they are familiar with plain language. They simply had to tick a yes or no box – a definition was provided to them.

The last two sections pertained to information on resources. Since the *CAPS* document was one of the documents selected for analysis, teachers were asked questions about their access to the document, how regularly they used the document, whether or not they found the document easy to use and understand, and which section/s of the document they found most useful. Again, these responses could be ticked off alongside the options provided. Toward the end of this section, the teachers were asked to indicate whether or not they thought the information in the document was well communicated to them. Aspects pertaining to macro structure (such as how easy it was to find information), and micro structure (such as the clarity of words and phrases), were indicated on the questionnaire and the participants were again asked to indicate their responses on a 5-point Likert scale ranging from ‘Strongly agree’ to ‘Strongly disagree’. At the end of the section, examples of original text samples and plain language text samples were provided alongside each other. These were randomly sequenced so that the participant would not know which option was the original and which the revised sample, and each participant was asked to indicate the option s/he preferred. This helped to establish whether or not plain language makes texts more easily readable and understandable, whether the teachers liked this style of writing, and whether the preliminary criteria that had been chosen were effective in producing a text that worked well for these participants.

The final section of the questionnaire sought information on the teacher resources that each participant used. Respondents were asked to indicate whether they used a teacher guide and whether the learners used the corresponding learner guide. The teachers were asked whether they felt that the guides corresponded well with each other, whether the guides are well communicated, whether the guides can communicate challenging concepts to learners by using only these guides, and if they (the teachers) have had to develop a lot of their own resources. These responses could be ticked. Each term is divided into topics for the teachers, so the teachers were also asked to indicate which topics they felt are the most challenging to communicate to learners by ranking them from ‘Most problematic’ (1) to ‘Least problematic’ (4). Toward the end of this section, the teachers were asked to indicate whether or not there were areas that require improvement in the teacher resource/s they used. As with the *CAPS* document, aspects pertaining to macro structure and micro structure were indicated on the questionnaire and the participants were again asked to indicate their responses on a 5-point Likert scale ranging from ‘Strongly agree’ to ‘Strongly disagree’. Again, at the end of the section, examples of original text samples and plain language text samples were provided alongside each other, randomly sequenced so that the participant would not know which option was which. Participants were asked to indicate the options they preferred. Again, this helped to establish whether or not plain language makes texts more easily readable and understandable, whether the teachers liked this style of writing, and whether the preliminary criteria that had been chosen were effective in producing a text that worked well for these participants.

As many options for answers as possible were provided beneath each section because I wanted the data to be as detailed as possible. When a simple yes or no answer was required, the teachers were asked to expand on their answers in the interview. The Likert scale allowed the teachers to give more nuanced responses to the questions because it provides a scale to measure attitudes, rather than a fixed response that can be restricting to an interviewee (McLeod, 2008:s.p.), and this added to the qualitative depth of the responses. Furthermore, these options helped to enhance the comparability of the answers.

3.6.3 Ethical considerations

The Research Ethics Committee of the Faculty of Humanities at the University of Pretoria considered the research proposal and samples of the letters of permission, and approved the ethics application on 30 November 2017 (reference number 28141640/GW20171111HS).

Sci-Enza at the University of Pretoria gave permission for teachers visiting the centre to be approached to participate in the study (the original letter of permission was submitted with the Research Ethics application). The institute shared a copy of its school visit schedule with me, so that I could be there to approach teachers for the study on the relevant days. Because participation was voluntary, the teachers who agreed to participate left their contact details with me so that a time and date for the interview could be arranged, and the relevant documentation (informed consent form and questionnaire) could be sent to them beforehand.

Every participant signed a letter of informed consent (see Appendix A) which stated who I was and what my research entailed. The reason for the interviews and the procedure of the interviews was unpacked for participants, so that they were prepared for the process. It was stressed that participation in the study is voluntary and that the anonymity of each participant was guaranteed. It was clarified that only I and my supervisor would have access to the questionnaires and the interviews, and that the interview data would be stored on a private computer for safekeeping. Furthermore, the participant was informed that s/he was under no obligation to answer all of the questions if s/he was not comfortable doing so.

3.6.4 Data analysis

The analysis of the interview data took place in two parts, focusing on the closed-ended questions and the open-ended questions. The closed-ended questions were recorded on an Excel document. Each subsection was presented on a sheet with columns for the relevant questions and answer boxes. Each participant was given a colour code, and the responses were then indicated using this colour code. Once all of the interviews were complete, I removed the colour codes and tallied the responses for each question so that I could compare the data more clearly.

The same colour codes as those used for the questionnaire data were applied to the recording of the open-ended responses. Each participant was given her/his own Excel spreadsheet. I divided the sheet into columns that indicated the teacher’s name, school, qualification/s, and resource list – this helped me to navigate the information. Alongside these columns were separate columns that were titled ‘General Awareness of the Problem Area’, ‘CAPS’, and ‘Teacher Resources’. The interviews were recorded in the column relevant to the discussion.

The open-ended data were then compared to the closed-ended data for each participant to ensure that the responses matched. The colour codes helped to draw this comparison.

3.7 DOCUMENT ANALYSIS

One of the objectives of the study was to see whether plain language criteria had already been applied to selected material by their authors and publishers and to apply these criteria where this had not already been done. In order to do this, feedback from the ten participants who took part in the study was used to gain insight into Natural Science teachers’ perceptions of the clarity of the language used in the resources available to them. Once I had collated the data from the interviews, I used this information to select my final plain language criteria. Readability tests (see Section 3.8) were also conducted on further sections of the documents selected for analysis to quantify the readability as a verification of the teachers’ and my own impressions. These tests use the average number of words per sentence, and the average number of long words in order to establish the difficulty of a text (Bond, s.a.:s.p.). This served as a starting point to identify verbosity and difficult words. Once I had done this, I evaluated the selected extracts against the adjusted final plain language criteria, revised the texts, and again tested for readability.

The document analyses are set out in Chapter 5. The presentation of the data appears as detailed in Table 8.

Table 8: Presentation of analyses

Text	Presentation of data	Section
CAPS: Natural sciences content and concepts for Grade 7	• Original samples • Readability test results • Application of plain language criteria • Plain English samples • Readability test results	5.3
Spot On Natural Sciences learner and teacher guides for Grade 8	• Original samples • Readability test results • Application of plain language criteria • Plain English samples • Readability test results	5.4.1
Platinum Natural Sciences learner and teacher guides for Grade 9	• Original samples • Readability test results • Application of plain language criteria • Plain English samples • Readability test results	5.4.2

3.8 READABILITY TESTS

As a starting point for my document analysis of the selected texts, I used readability tests, because I approach the study from a language perspective and not the perspective of a science teacher. Science teachers are the people who use the documents and because I am not trained in sciences, there is no way for me to know whether a text is well geared toward this group or not without testing the document in some way. Cutts (2013:235) advocates testing plain language revisions because it is the only way to ascertain what the target audience may understand. Furthermore, tests 'encourage the idea that a clear document is one that scores well on the formula' (Cutts, 2013:123), which may be more convincing to science authors, who are often resistant to plain language. There are drawbacks to these tests (discussed in detail below), because they cannot 'read' a text in the same way that a human can.

Nevertheless, they provide a yardstick for measurement and a quantifiable result that can usefully inform the analysis process.

Ten extracts from each of the documents were run through an online program that provided the results for seven readability tests and a consensus rating. The seven tests are the following well-known tests:

- Flesch Reading Ease score
- Gunning Fog
- Flesch-Kincaid Grade Level
- The Coleman-Liau Index
- The SMOG Index
- Automated Readability Index
- Linsear Write Formula

These tests all follow a similar principle and work by ascertaining the average sentence length and the average number of syllables or characters (depending on the test) per word, applying these results to a formula and establishing the reading level of the text.

In order to provide the most accurate result, the results of these tests were averaged to establish a 'readability consensus' according to the US schooling system. For example, based on an average for all of these scores, the consensus might read 'Grade level: 20; Reading level: Impossible to comprehend; Reader's age: College graduate'. I used this readability consensus as the result that I refer to when gauging the readability of each text, because it provides an objective average score. A detailed explanation of each test has been included as Appendix D.

While these analyses are useful, because they help to identify long sentences and challenging words, they have their limitations. All of the tests are based on the US schooling system, which is not only different to ours but also functions on the assumption that the majority of the population are first language English speakers; thus, one can assume that the average reader in the US would have a better understanding of English than the average South African reader. Moreover, '[t]he formulas are blunt tools. They ignore the way the text is organised, how it looks on the page, and the reader's motivation and level of prior knowledge' (Cutts, 2013:122). Thus, these tests only served as a starting point because the content was then evaluated more closely against the selected criteria, demonstrating detailed reading to be a less ‘blunt tool’ for the purposes of this exploratory qualitative analysis.

As stated earlier, ‘testing is key, as people who read and write fluently can only guess what these groups understand’ (Cutts, 2013:235). So, these tests were used appropriately and the scores were noted, but the researcher’s discretion had to be used when it came to the analysis of the texts. Taking the limitations into consideration, I identified an acceptable grade level. Based on the assumption that teachers have completed Matric and have had exposure to tertiary education at some level, I determined that the texts should be geared toward a minimum grade level of 8 and a maximum grade level of 11.

These methodological processes provided a sound platform for me to build upon. By using this methodology I was able to establish the best results I could for an exploratory study of this nature.

CHAPTER 4:

DISCUSSION OF RESULTS – INTERVIEWS

4.1 INTRODUCTION

This chapter presents the findings of the interviews, which provided insight into science teachers' thoughts and perceptions about the resources available to them. The interviews informed the choice of documents selected for analysis and the selection of the most applicable final plain language criteria.

The information that was gathered in the interviews was analysed and compared. For each of the four subsections (demographic information, general awareness of the problem area, *CAPS* document, and teacher guide), the closed-ended questionnaire data are summarised in the form of a table, followed by a full discussion of this data in conjunction with the interview responses to the open-ended questions and teachers' elaborations on their responses to the closed-ended questions, and a discussion of the main findings. An outline of the discussion is presented in Table 9.

Table 9: Interview structure

Topic	Presentation of data	Topic
Demographics	• Closed-ended questionnaire data • Data analysis • Discussion of main findings	• Years of teaching experience as a science teacher • Type of school (past and present) • Senior Phase grade(s) taught • Subjects and grades currently taught • Science and teaching qualification • Home language and Language proficiency • Language used in teaching
General awareness of the problem area	• Closed-ended questionnaire data • Data analysis • Discussion of main findings	• Conveying content and concepts • The role of subject matter • Learner proficiency in English • Teacher proficiency in English • Complex terminology • Clarity of explanations • Availability of resources • Plain language
CAPS document	• Closed-ended questionnaire data • Data analysis • Discussion of main findings	• Copy of the *CAPS* document • Referring to the CAPS document • Ease of use and clarity

Topic	Presentation of data	Topic
		• Most understandable and least understandable elements • Communication of information • Ability to find information • Amount of information • Headings • Repetition and redundancy • Clarity of words and sentences • Length of sentences and paragraphs • Addressing the reader • Clarity of explanations • Usefulness of lists and tables • Use of visual aids • Specific examples and definitions • Original vs. plain language samples
Teacher guides	• Closed-ended questionnaire data • Data analysis and explanation	• Teacher guide used • Learner guide used • Teacher and learner guides as a set • Communication of information • Explaining concepts • Most problematic and least problematic topics • Challenging concepts • Development of own resources • Communication of challenging concepts • Finding information • Quantity of information • Headings • Teacher and learners guides as a set (question repeated and explained) • Vagueness of information • Clarity of words and sentences • Length of sentences and paragraphs • Addressing the reader • Clarity of explanations • Usefulness of lists and tables • Use of visual aids • Specific examples and definitions • Original vs. plain language examples

4.2 DEMOGRAPHICS

Some demographic information is pertinent to this study. The aim is to work towards materials suitable for all teachers, but geared toward teachers who are not necessarily proficient in the language of learning and teaching (English in this context), and to make scientific material accessible to teachers who lack a science background, but are required to teach it. These demographics and participants teaching and language background were identified. Results are presented in Table 10. Then individual demographics are discussed in detail. In some cases more than one answer could be given (marked as n≥10, otherwise, where only one answer could be given, marked as n=10). In the discussion, participants are referred to as P1, P2, etc. to retain participants' anonymity.

4.2.1 Closed-ended questionnaire data

The data gathered using the closed-ended questions are set out in Table 10, and are discussed in the next section.

Table 10: Demographics

Question	**Response**					
Years of teaching experience as a science teacher	0–3	3–5	5–10	10–15	15+	
(n=10)	1	1	5	1	2	
Type of school (past and present)	Government school	Independent school	Semi-private school	Township school	Other	
(n≥10)	8	6	0	1	1	
Senior Phase grade(s) taught	7	8	9	None		
(n≥10)	1	5	6	2		
Subjects and grades currently taught	Intermediate Phase (Gr 4–6)	Natural Science	FET (Gr 10–12)	Life Science	Physical Science	
(n≥10)	3	3	8	4	6	
Science qualification	Yes	No				
(n=10)	5	5				
Teaching qualification	Yes	No				
(n=10)	10	0				
Home language	English	Afrikaans	isiZulu	Sepedi	Setswana	isiNdebele
(n=10)	5	3	-	1	1	-
Language proficiency (speak, read, write)	English	Afrikaans	isiZulu	Sepedi	Setswana	isiNdebele
(n≥10)	10	7	1	1	2	1
Language used in teaching	English	Afrikaans	Code-switching			
(n≥10)	10	3 (previous school/s)	1			

Key: Intermediate Phase (grouped with subject in green); FET – Further Education and Training (grouped with subjects in red); Code-switching refers to the transition between one or more languages

4.2.2 Data analysis

4.2.2.1 Years of teaching experience as a science teacher

Each participant was asked to specify for how long s/he had or has been a science teacher. The teachers' experience varied, ranging from less than a full year to more than 15 years. One participant (P1) has been teaching science only since the beginning of 2018, less than a year. One (P9) has been a science teacher for between 3 and 5 years. Five of the participants (P2, P6, P7, P8 and P10) have been teaching science for between 5 and 10 years. Three participants have vast experience – P3 has been a science teacher for 10 to 15 years, and P4 and P5 have taught science for more than 15 years. Thus, the majority of the teachers (eight of the ten) have been teaching science since before the introduction of the *CAPS* curriculum and materials in 2012, or started teaching during the transition to *CAPS*. Only two of the participants have not been teaching for long enough to have had exposure to the materials used previously as teachers.[11] This provided insight into the range of materials the teachers have been exposed to.

4.2.2.2 Type of school (past and present)

The participants then identified the schools at which they currently teach or have previously taught science in order to establish the teaching background of each participant.

I distinguished between township and government schools in this study, because schools with government funding differ widely in terms of their resources and additional funding. I used the term 'government schools' to refer to former Model C schools; these schools 'are government schools that are administrated and largely funded by a governing body of parents and alumni' (Power, 2018:s.p.), and some of these schools are very well resourced (although this is not always the case). For the purposes of the study, 'township schools' refer to government schools that are controlled by the provincial education department. The standards in these schools vary widely, as they 'depend entirely on the government for funding and supplies. Each province is responsible for ensuring its schools are equipped and have enough money

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[11] They may have been exposed to the pre-*CAPS* syllabus when they were learners.

to run properly. As a result, standards vary immensely, depending on the efficiency and wealth of the province' (Power, 2018:s.p.).

Some deductions as to the accessibility of resources and teaching conditions could be made based on this information. For example, a private school teacher may not be constrained to use a particular textbook or may have the freedom to select a specific textbook, whereas a government school teacher normally has no choice in the matter. The majority of the participants indicated that they have taught science at a government school – six participants (P3, P4, P6, P7, P8 and P10) currently teach at government schools, while P2 and P5 indicated that they had taught at government schools in the past. Two more (P1 and P5) currently teach at private schools, and four (P2, P6, P9 and P10) revealed that they had previously taught at private schools. However, P9 currently teaches at a township school and P2 is currently a science teacher at a Technical and Vocational (TVET) College and a science tutor after hours. P9 (who teaches at a township school) indicated that her school was well-resourced, but pointed out that many teachers lack the capability to use many of the modern resources that have been provided, such as interactive whiteboards. P9 also stated that her school has large class sizes and a problem with discipline as a result of class sizes and the learners' home circumstances. P9 said that this is a something that many teachers in the district have a problem with.

The particular mix of participants in respect of where they teach is both a strength and a limitation of the study. The mix reflects the heterogeneity of the South African teacher body, but is not representative of the larger population of teachers, because the vast majority of teachers in the country teach at what I have referred to as township schools. This must be borne in mind in interpreting the results.

4.2.2.3 Senior Phase grade(s) taught

Eight of the participants who took part in this study indicated that they currently teach Natural Science to Senior Phase learners. One (P1) teaches Natural Science in the Intermediate Phase, specifically Grade 4, and another (P10) teaches Physical Science to FET Phase learners, specifically Grades 11 and 12. Only one other teacher (P4) does not teach at a high school; however, s/he teaches Natural Science to Grade 6 and 7 learners. Five (P2, P3, P7, P8 and P9) currently teach Grade 8 Natural Science, and six (P2, P3, P5, P6, P7 and P8) currently teach Grade 9 Natural Science. Although two (P1 and P10) do not teach Senior Phase learners, it was useful to gain insight into

P1's perception of Intermediate Phase resources and P10's perception of the science knowledge base of learners who come from the Senior Phase to the FET Phase. P10 also provided valuable insight into the governmental resources available to FET Phase learners and the difference in quality and quantity between these and Senior Phase governmental resources (discussed in Section 4.3 and 4.4).

4.2.2.4 Subjects and grades currently taught

The teachers were asked to indicate the other subjects that they teach. This provided an understanding of whether or not the teachers view Natural Science as their primary focus. P1 indicated that s/he is a dance teacher at the school at which s/he teaches and has been asked to step in as a Grade 4 Natural Science teacher because the school could not find a replacement for a teacher who went on maternity leave. P4 teaches exclusively Grade 6 and 7 Natural Science. P2 currently tutors Intermediate Phase learners after hours, but also teaches FET Phase Life Science at a TVET College. Seven participants (P3, P5, P6, P7, P8, P9 and P10) also teach either Life Science or Physical Science to FET Phase learners. Both P7 and P8 stated that they prioritise their FET Phase teaching over the Senior Phase and indicated that they felt that schools should employ teachers specifically for the Senior Phase. P6 and P9 did not explicitly state that they prioritise the FET Phase, but these respondents continuously referred to their FET Phase resources and work, suggesting that this is in fact a priority for them.

4.2.2.5 Science and teaching qualification

All the teachers interviewed have a teaching qualification, and half have science qualifications, as set out in Table 11.

Table 11: Qualifications

Participant	Teaching qualification	Science qualification	Other qualification
P1	BMus Dance Education		
P2	PGCE	BSc Micobiology	
P3	PGCE		BA Human Movement Sciences
P4	BEd Hons		
P5	HDE		B-degree, details not provided
P6	PGCE	MSc	
P7	BEd Hons		
P8	PGCE	BSc Medical Sciences	
P9	PGCE; BEd Hons	BSc Applied Maths	
P10	PGCE	BSc Hons Electronic Engineering	
Total	10	5	1

Half of the interviewed teachers have specialised science knowledge. However, P9 indicated a background in mathematics and initially struggled to teach Natural and Physical Science. P1, who has has a BMus in Dance Education, is the only participant who stated that s/he does not have any science education background, but this participant has only been temporarily asked to teach Natural Science to Grade 4 learners. The teaching qualifications vary – seven hold a Post Graduate Certificate in Education (PGCE) or its precursor, a Higher Diploma in Education (HDE), two have a four-year education degree (BEd), and three have a BEd Honours.

4.2.2.6 Home language and language proficiency

Half of the participants (P1, P4, P5, P8 and P10) are home language English speakers, a percentage that does not reflect the country's language demographics. The home language of three (P2, P3 and P7) is Afrikaans. P6 is a home language Sepedi speaker, and P9 is a home language Setswana speaker.

All the participants in this study stated that they feel they are proficient in English. P7 admitted some difficulty reverting to English when returning to work after a recess, but felt that that s/he could get back into it quite quickly. The rest of the candidates indicated that they are comfortable with their ability to speak, read and write in English.

4.2.2.7 Language used in teaching

All the teachers interviewed teach in English and are comfortable with this. P9 stated that s/he sometimes resorts to code-switching (transitioning between two or more languages) in the classroom in order to assist the non-English home language learners with understanding the material. P6 code switches when non-English home language learners have one-on-one queries. P10 works at a dual medium school and revealed that s/he is comfortable teaching Physical Science in English, but struggles to express her/himself at times in the Afrikaans class. P10 also stated that many of the learners in the Afrikaans class have asked that they be taught in English because they feel that this will help them with their tertiary education, when they expect to have to write examinations in English.

4.2.3 Discussion of main demographic findings

The participants who were interviewed for this study clearly come from different school and language backgrounds, which was ideal for this study because different contextual factors influence teachers' experiences of resources. The responses reflected that various factors influence the learning environment.

P9's responses were particularly fruitful in this section because s/he works at a township school. Although this participant is proficient in English and is well-educated, s/he stated that s/he struggled to teach science when s/he became a science teacher. This suggests that plain language resources may be beneficial to a broader range of teachers. P9 also indicated that many township schools struggle with more than a language issue; the home life of learners has a negative effect on discipline, which becomes a hindrance to teaching. This participant also stated that s/he reverts to code-switching as a way to convey information to learners in this environment (P6 stated that s/he does the same thing when s/he provides one-on-one tuition). This reflects a problem with English literacy, which justifies the need for accessible resources.

P10 stated that s/he has noticed that more learners are switching over to English education at the school at which s/he teaches. Again, this is potential justification for accessible resources.

Furthermore, a few of the teacher's answers suggest that the Senior Phase might be a slightly neglected phase. Some of the teachers interviewed do not prioritise this phase in their teaching and it appears that governmental resources for the FET Phase are better than those for the Senior Phase (discussed in more detail in Section 4.3 and 4.4).

4.3 GENERAL AWARENESS OF THE PROBLEM AREA

The problem area that has been identified pertains to teachers' ability to convey pertinent scientific concepts to learners in the language of learning and teaching. Thus, I propose that it is important to develop content for teachers that is easy to understand and to convey to learners. The participants in the study were asked to assess their ability to convey scientific content and concepts to learners in the language of learning and teaching. The participants were then presented with reasons as to why it may be challenging to convey these concepts to learners. The participants answered these questions on a 5-point Likert scale ranging from ‘Strongly agree’ to ‘Strongly disagree’. The results of these questions are combined in Table 12.

4.3.1 Closed-ended questionnaire data

The data gathered using the closed-ended questions are set out in Table 12, and are discussed in the next section.

Table 12: Problem area

Question	Response				
Easy to convey scientific content and concepts to learners in the language of learning and teaching (English)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n=10	3	4	1	2	-
Ease of ability to convey scientific content and concepts to learners depends on the subject matter**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	-	5	-	-	-
Learners are not proficient in English**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	5	4	-	-	-
I am proficient in English**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	8	1	-	-	-
Complex terminology is difficult to explain to learners**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	5	3	-	1	-
Clear explanation of concepts in resources**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	1	4	-	4	-
Not many resources available**	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
n≥10	-	1	-	5	3
Familiar with plain language	Yes			No	
n=10	9			1	

4.3.2 Data analysis

4.3.2.1 Conveying content and concepts

P3, P5 and P8 strongly agreed that it is easy to convey content and concepts to learners in English (the language of learning and teaching in this case). However, P3 admitted that explaining abstract concepts can pose a challenge. P5 did not respond to the rest of the questions (this participant's home language is English and s/he teaches at a private school – one can assume that learners in this type of school may have a better command of English, suggesting that communication may not be a challenge in this environment). P8 stated that it is difficult to see where learners come unstuck and whether learners' difficulties should be ascribed to language, laziness, a lack of foundation, or a combination of factors.

P1, P6, P7, and P10 agreed that they found it easy to convey scientific content and concepts to learners in English, but did not elaborate further. P9 felt that s/he was not sure because the learners in township schools tend to suffer from socioeconomic factors that lead to behavioural problems in the classroom in addition to the fact that classrooms are overcrowded. However, P9 previously stated that s/he feels that the learners struggle to understand the questions posed to them in tests because they lack a command of English.

P2 and P4 disagreed with the statement, claiming that it is a challenge to convey concepts in the language of learning and teaching. P2 feels strongly that abstract concepts, such as those in chemistry, are difficult to explain to learners, while P4 stated that the learners struggle to comprehend information and have a limited vocabulary.

4.3.2.2 The role of subject matter

Five participants (P1, P2, P4, P6 and P9) agreed that the ability to convey information to the learners depends on the difficulty of the subject matter. There was consensus that it is more difficult to convey abstract concepts, such as those in chemistry, than concrete concepts, such as life and living. P4 felt quite strongly about this. The remainder of the participants did not respond to this question.

4.3.2.3 Learner proficiency in English

All nine respondents who answered this question (P5, from a private school, did not respond to the question) either agreed or strongly agreed that learners are not proficient in English. Five participants (P1, P4, P7, P8 and P9) strongly agreed with this claim, while four (P2, P3, P6 and P10) agreed with it. P6 had strong views on this subject and stated that s/he feels that learners are able to understand the concepts, but cannot transfer the knowledge onto paper. P9 explained that the learners often do not understand what is being asked of them because their English vocabulary is limited.

4.3.2.4 Teacher proficiency in English

Eight participants (P1, P2, P3, P4, P7, P8, P9 and P10) all strongly agreed that they are proficient in English – although P7 previously stated that s/he finds it a challenge to switch to English after recess. P6 chose to agree rather than strongly agree because s/he feels that s/he is very proficient in scientific concepts, but her/his language is lacking in other areas. P5 did not respond to the question but previously indicated that s/he is a home language English speaker.

4.3.2.5 Complex terminology

Half of the participants (P2, P3, P4, P9 and P10) strongly agreed that it is a challenge to convey complex terminology to the learners – four of whom (P10 is the exception) reiterated the challenge of explaining abstract concepts to learners. P4 indicated that it is essential to use concrete examples to explain these concepts to learners. P9 made the point that scientific language needs to be very precise, so the learners have to use the correct vocabulary, which is something that they lack. P10 suggested that the challenge relates to time – content cannot be reiterated, so the minimum amount of time and information are used to convey the essence of the topic/s. P1, P7, and P8 agreed with this suggestion. However, P6 disagreed, stating that it is always possible to convey the information in a more understandable way. P5 did not respond to the question.

4.3.2.6 Clarity of explanations

The respondents were divided when it came to whether they feel that the concepts are clearly explained in the learner and/or teacher guides. P3 strongly agreed that the concepts are clearly explained, but acknowledges that the teacher is core to the transfer of knowledge (the learners would not understand the work without the teacher). Four participants (P1, P4, P9 and P10) agreed that the concepts are clearly explained, but P4 and P10 stated that they drew information from multiple sources and not only one guide. However, another four (P2, P6, P7 and P8) disagreed. P7 and P8 both said that the guide that they use only gives an outline of the information, and does not offer clear explanations. Furthermore, they indicated that there are errors in the guides. P5 did not respond to the question, but later indicated that s/he does not make use of a teacher and/or learner guide – s/he prefers to make her/his own notes. (This may be a source of concern, as this participant did not indicate whether or not s/he has a science qualification and has an HDE, which is an older qualification, but teaches at a private school, where s/he can decide on the teaching material at her/his discretion). It is worth noting the divergent responses possible to the same guide – P3 (who strongly agreed with this claim) and P6, P7, and P8 (who disagreed with this claim) all used the same teacher and learner guides.

4.3.2.7 Availability of resources

Half of the participants (P2, P3, P4, P6 and P8) disagreed that there are not many resources available, and this finding was supported by three more (P1, P7 and P10) who strongly disagreed that there are many available resources. However, P9 agreed with this statement, and explained that s/he felt there are a lot of resources available to FET Phase learners, but not to Senior Phase learners. This coincides with P10's response, because s/he only teaches the FET Phase. P1 responded to the question from the perspective of Intermediate Phase resources. The rest of the respondents teach grades outside of the Senior Phase, so it is was unclear from the responses whether there are many *Senior* Phase resources available. Again, P5 did not respond to the question, as s/he develops her/his own resources and did not appear interested in investigating the resources available.

4.3.2.8 Plain language

Following the previous line of questioning, the participants were asked whether they had ever heard of the concept of plain language and were presented with a definition of it. Nine of the candidates indicated that they were familiar with the concept (P1, P2, P4, P5, P6, P7, P8, P9 and P10) and one respondent (P8) even stated that it is something that all teachers should know, as they have to simplify complex information in the classroom. P3 stated that s/he was not familiar with the concept beforehand but that she understands the basic idea.

4.3.3 Discussion of main findings on teachers' awareness of the problem area

Based on the results of these findings, it is clear that these participants generally agree that there is a problem with the transfer of knowledge to learners. The responses suggest that many of the learners lack the literacy and proficiency to transfer their knowledge into the written form and the vocabulary to express or analyse their thought processes. It is also evident that abstract scientific terms are a challenge for some teachers to convey to learners, as the learners are unable to observe abstract phenomena and make sense of the concepts. Moreover, P10 indicated that the limited time available to the teachers makes it difficult to reiterate these already challenging concepts to the learners. Not surprisingly, P9 indicated that illiteracy is clouded by socioeconomic factors in the teaching environment in which s/he works, which suggests that there might be bigger challenges at play in more rural environments.

Teachers' English proficiency was more difficult to gauge, as none of the teachers indicated that they struggled with proficiency. P6 agreed and P7 strongly agreed that they were proficient in English, but still admitted that they did encounter language difficulties at times. Although all of these teachers may indeed be proficient in English, such responses suggested that it might be difficult for teachers to admit their own limitations. This is concerning because there was consensus amongst the interviewed teachers that the teacher is central to the delivery of content to learners, especially complex content. Furthermore, the teachers' responses did not conclusively indicate that the Senior Phase is well resourced.

These factors indicate that there is a need for this research, as teachers may struggle with the transfer of knowledge to learners, which means that those who are not proficient in English and who lack a strong scientific knowledge base will find this task even more challenging. Furthermore, the potential problem with the availability of resources for the Senior Phase indicates that those resources that are available should be as complete, accessible, and comprehensible as possible.

4.4 TEACHERS' RESPONSES TO THE *CAPS* DOCUMENT

The *CAPS* document provides information pertaining to the curriculum and assessment of learners in the South African schooling system, and there is one for every subject. Thus, these documents need to be available to all teachers and they need to be understandable. The participants were asked a series of questions about the *CAPS* document in order to establish their thoughts on the usefulness and usability of the document.

4.4.1 Closed-ended questionnaire data

The data gathered regarding *CAPS* document using the closed-ended questions are set out in Table 13, and are discussed in the next section. In some sections, one or more participants did not answer the question (n<10).

Table 13: Responses to *CAPS*-related questions

<table>
<tr><th>Question</th><th colspan="10">Response</th></tr>
<tr><td>Access to copy of <i>CAPS</i> document for Senior Phase Natural Science</td><td colspan="5">Yes</td><td colspan="5">No</td></tr>
<tr><td>Hard copy (n=10)</td><td colspan="5">8</td><td colspan="5">2</td></tr>
<tr><td>- Received a hard copy from school (n<10)</td><td colspan="5">5</td><td colspan="5">2</td></tr>
<tr><td>- Hard copy has gone missing (n<10)</td><td colspan="5">1</td><td colspan="5">2</td></tr>
<tr><td>Electronic copy (n=10)</td><td colspan="5">10</td><td colspan="5">-</td></tr>
<tr><td>- Has access to the internet (n=10)</td><td colspan="5">10</td><td colspan="5">-</td></tr>
<tr><td>- Has a computer or tablet (n<10)</td><td colspan="5">8</td><td colspan="5">-</td></tr>
<tr><td>Regularity of referring to CAPS (n=10)</td><td colspan="2">Daily</td><td colspan="2">Weekly</td><td colspan="2">Monthly</td><td colspan="2">Termly</td><td colspan="2">Never</td></tr>
<tr><td></td><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">1</td><td colspan="2">3</td><td colspan="2">2</td></tr>
<tr><td>CAPS is easy to use and understand (n=10)</td><td colspan="5">Yes</td><td colspan="5">No</td></tr>
<tr><td></td><td colspan="5">8</td><td colspan="5">2</td></tr>
<tr><td>- Difficult to find information (n<10)</td><td colspan="5">3</td><td colspan="5">4</td></tr>
<tr><td>- Explanations clear (n<10)</td><td colspan="5">6</td><td colspan="5">2</td></tr>
<tr><td>- Too much unnecessary information (n<10)</td><td colspan="5">2</td><td colspan="5">5</td></tr>
<tr><td>Elements of document (most understandable (1) – least understandable (5) (n≥10)</td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td></tr>
<tr><td>- Indigenous knowledge systems</td><td colspan="2">1</td><td colspan="2">-</td><td colspan="2">1</td><td colspan="2">1</td><td colspan="2">5</td></tr>
<tr><td>- Resources</td><td colspan="2">-</td><td colspan="2">2</td><td colspan="2">-</td><td colspan="2">3</td><td colspan="2">3</td></tr>
<tr><td>- Natural Sciences content, concepts and time allocations</td><td colspan="2">4</td><td colspan="2">2</td><td colspan="2">4</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>- Natural Sciences content and concepts</td><td colspan="2">8</td><td colspan="2">2</td><td colspan="2">-</td><td colspan="2">-</td><td colspan="2">-</td></tr>
</table>

- Assessment schedule	4	4	2		
CAPS information adequately communicated (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	5	1	4	-
Easy to find information (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	2	5	1	2	-
Unnecessary information (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	2	3	1	4	-
Headings unclear (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	1	1	7	1
Repetition and redundancy of information (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	3	3	4	-
Words and sentences are clear (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	6	3	1	-
Sentences and paragraphs too long (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	1	1	3	5	-
Document addresses the reader (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	5	3	1	1
Explanations are unclear (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	4	2	4	-
Lists or tables are not useful (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	6	1	3	
Visual aids provided (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	-	3	-	3	4
Specific examples and definitions (n=10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	2	5	2	1	-
Original vs. Plain language examples (see Section 3.5.1)	Original			Plain language	
- Example A (n<10)	-			9	
- Example B (n<10)	2			7	
- Example C (n<10)	3			6	

4.4.2 Data analysis

4.4.2.1 Copy of the CAPS *Document*

To begin this conversation, the participants were asked if they had a copy of the relevant *CAPS* document. Only two participants (P1 and P9) indicated that they did not have a hard copy of the document (P1 works at a private school, but the curriculum is still based on the *CAPS* curriculum, so s/he should have the document). These two participants indicated that they did not think they needed to have a hard copy because they refer to an electronic copy of the document. All the participants have access to an electronic copy of the document, as they all have access to the internet. Most of the participants did not answer this selection of questions in their entirety, but it is clear that all of the participants have easy access to this document, whether or not they use it.

4.4.2.2 Referring to the CAPS *document*

When asked how *frequently* they refer to the document, the participants' responses were mixed. Three (P2, P6 and P9) indicated that they refer to the document on a daily basis. P6 went so far as to state that s/he feels that the document is essentially a 'teaching Bible'. P9 said that it is important to remain on track with the guidelines laid out in the document. P4 indicated that s/he uses the document on a weekly basis even though s/he does her/his preparation a term in advance because s/he likes to make sure that her/his work is on track.

P10 revealed that if s/he were to work out an average, s/he refers to the document on a monthly basis, although it depends on the time of year (s/he refers to it more when preparing exams). P1, P3, and P5 indicated that they only refer to the document at the start of each term. P1 and P3 stated that the reason for this is that they do not find the document user friendly, so they only use it when absolutely necessary.

P7 and P8 indicated that they never use the document. P7 stated that s/he does not find it particularly useful and feels that the Senior Phase 'slips through the cracks' as the syllabus is unrealistic and it seems as though the department does not know what it wants from the teachers and learners. Similarly, P8 argued that the Senior Phase falls by the wayside because large portions of the document are irrelevant and the amount of content that has to be covered is unrealistic for the time allocated. Both P7 and P8 answered several of the questions discussed below, despite the fact that they claim not to use the *CAPS* document. (This means that either they used it at some point, or that they gave random answers to these questions.)

4.4.2.3 Ease of use and clarity

The respondents were then asked whether they find the document easy to use and understand. Eight participants (P2, P4, P5, P6, P7, P8, P9 and P10) felt that it is easy to use and understand the document, but most responded to the question in terms of the usefulness of the document rather than its clarity. P4 and P10 said that they had learnt to navigate the document fairly well, and P6 and P9 believed that things are well outlined and straightforward. However, P1 and P3 indicated that they did not find the *CAPS* document easy to use and understand. They both felt that it is difficult to find what they were looking for and that the explanations lack clarity – P1 said that what teachers should do is often implied rather than directly stated. Two (P2 and P3) felt that there is too much unnecessary information.

4.4.2.4 Most understandable and least understandable elements

Most participants responded to this question in terms of the parts of the document they used the most, rather than whether or not they found the information clear and understandable. Eight (P1, P2, P4, P5, P7, P8, P9 and P10) indicated that the Natural Sciences content and concepts (pp. 17–84) was the section they found most understandable (many simply said it is the section they referred to most). A detailed breakdown of everything that needs to be covered in class time is included in this section (it is almost like a lesson plan). Four participants (P3, P4, P5 and P9) indicated that the detailed summary of Natural Sciences concepts, content and time allocations (pp. 13–16) is the most understandable section, and four participants (P4, P5, P6 and P9) found the Assessment schedule (pp. 86–93) the most understandable part. P4 P5, and P9 indicated that these three sections are equally understandable, but when I probed a little more, they each said that these were the sections of the document they used. P3 stated that s/he would like these three sections of the *CAPS* document to be brought together because the rest of the information is unnecessary. By contrast, P6 indicated that s/he would prefer these to remain separate sections. The participants found the description of science and indigenous knowledge systems (pp. 8) and the list of resources (pp. 12) the least useful sections – P10 stated that these sections were not included in the FET document. As a side note, P4 argued that information on the country's 'past' is unnecessary and contentious (essentially, this teacher objected to this aspect of the curriculum itself, which is an issue beyond the scope of this study).

4.4.2.5 Communication of information

The respondents were then asked whether they felt that the information presented in the *CAPS* document is adequately communicated to them. The participants were asked to indicate their responses on a 5-point Likert scale with the options 'Strongly agree', 'Agree', 'Not sure', 'Disagree', and 'Strongly disagree'. The responses were varied: five participants agreed that the information is adequately communicated in the document (P4, P6, P8, P9 and 10), one participant was not sure (P7), and the other four participants disagreed (P1, P2, P3 and P5). P9 explained that the document is specific about what the learners need to know; however, P1 feels that it should be clearer about what the teacher should *teach* as opposed to what the learners should *know*. As the teacher is the person who has to deliver the content, there needs to be more clarity as to what s/he should teach. P7 did not know how to respond because s/he said s/he never refers to the document.

The participants were then asked more specific questions about the macro and micro structure of the document. These responses were also indicated on a 5-point Likert scale.

4.4.2.6 Ability to find information

P6 and P9 indicated that they strongly agree that it is easy to find what they are looking for because they are both comfortable with the document and frequently make use of it. Five of the participants (P2, P4, P5, P7 and P8) indicated that they agree that they can find what they are looking for. P2 did, however, complain that the page numbers on the hard copy do not correspond with the page numbers on the electronic copy, which one has to adjust for because it is not a searchable PDF. P4 stated that she had learnt to navigate the hard copy of the document well, but that s/he had had to develop her/his own strategies to do so. P10 indicated that s/he was unsure, as s/he had created an index on her/his hard copy in order to make it more navigable and finds it quite easy to use now; moreover, the FET Phase document, which s/he also uses, has been split into three separate documents, including Physical Science, Technical Science, and Exam Guidelines (Senior Phase Natural Science does not have a separate Technical Science and Exam Guidelines document). P1 and P3 indicated that they disagree with the statement, because both participants found it difficult to navigate the document.

4.4.2.7 Amount of information

The responses to the question whether participants' felt there is a lot of unnecessary information elicited contradictory opinions. P1 and P3 indicated that they strongly agree that there is too much unnecessary information and disliked having to go back and forth in the document. P2, P4, and P5 agreed that there is too much unnecessary information – P4 said that chunks of information are contrary to scientific thinking, so s/he would prefer more bulleted lists. P8 indicated that s/he is not sure if there is too much unnecessary information because s/he does not know the document well enough. However, P6, P7, P9, and P10 disagreed with this statement, as they felt that all the information in the document is essential.

4.4.2.8 Headings

Eight of the participants indicated that there is no problem with the headings in the *CAPS* document. P1 strongly disagreed that the headings are unclear, saying that they are navigable. P2, P4, P6, P7, P8, P9, and P10 all disagreed that the headings are unclear – not much further explanation was offered. P3 said that s/he was unsure because s/he has never taken note of the headings. P5 indicated that s/he agrees that the headings are unclear – no further explanation was offered.

4.4.2.9 Repetition and redundancy

The participants were first asked whether they felt that some of the information in the document is redundant or repeated unnecessarily. This question in part served as a control to the question on the amount of information. Three participants (P7, P8 and P9) were not sure. Three (P1, P3 and P5) did feel that information is repeated unnecessarily (they all found the document quite cumbersome). But four (P2, P4, P6 and P10) disagreed that there is redundancy in the document, all stating that most of the information in the document is important. P2 and P4's responses contradict their responses in 4.4.2.7, but they could have been responding to this question in terms of the repetition of concepts – they may have felt that there was too much information in the document, but the document is not repetitive.

4.4.2.10 Clarity of words and sentences

When asked if the meanings of words or sentences are clear, the participants were again divided in their responses. Six participants (P2, P4, P5, P6, P9 and P10) agreed that the meaning of words and sentences is clear because they had no trouble understanding the document. Three (P1, P7 and P8) were not sure because they had not referred to the document in a while and could not remember. P3 disagreed with this statement because s/he felt that the document is poorly communicated.

4.4.2.11 Length of sentences and paragraphs

Next, participants were asked whether the sentences and paragraphs are too long. P3 strongly agreed that they are too long, and reiterated that s/he finds communication in the document poor. P4 also agreed that the sentences and paragraphs are too long – s/he would prefer bulleted lists. Three (P2, P7 and P8) were not sure because they could not remember. Half (P1, P5, P6, P9 and P10) disagreed with this statement – however, P10 later stated that s/he would prefer more bulleted lists.

4.4.2.12 Addressing the reader

Participants were then asked if they felt that the document addresses the reader. Five participants (P5, P6, P7, P8 and P9) felt that it did. Three (P3, P4 and P10) were unsure because they had not referred to the document recently enough. P2 disagreed with this statement, and P1 strongly disagreed with this statement, saying that the document only says what learners need to know and not what teachers need to teach.

4.4.2.13 Clarity of explanations

Participants were asked whether they felt that the descriptions/explanations are unclear. Four (P1, P2, P3 and P10) agreed that these are unclear stating that they were sometimes uncertain about what they had to do and required more specific guidelines. P2 also said that some terms are often used too broadly, which can be confusing. P7 and P8 were not sure. Four (P4, P5, P6 and P9) disagreed with this statement and three of these (P4, P6 and P9) stated that they always knew what they had to teach.

4.4.2.14 Usefulness of lists and tables

When it was suggested that lists and tables are not useful,[12] six of the participants agreed with this statement (P3, P4, P6, P7, P8 and P9) – most explained that they feel these can be used more effectively. P2 was not sure, and P1, P5, and P10 disagreed – P1 felt that these are the most useful things in the document.

4.4.2.15 Use of visual aids

In response to the question whether visual aids are provided, three participants (P1, P3 and P6) indicated that they are – although P1 stated that s/he does not see how this question differs from the previous one. However, the rest of the respondents disagreed (P4, P7 and P8) or strongly disagreed with this statement (P2, P5, P9 and P10). P9 indicated that the document is far too ‘wordy’ and s/he would prefer alternative representations of information, but P10 did not feel that there is any need for visual aids.

4.4.2.16 Specific examples and definitions

With regard to the final question, which asked whether there is a need for more specific examples and definitions, the responses tended toward agreement. P2 and P9 strongly agreed that there need to be more examples and definitions, stating that these would help teachers to know exactly what they need to do. Half of the participants (P1, P3, P4, P5 and P10) agreed, but P4 stated that the document would need to be careful not to take away the teacher’s autonomy. P7 and P8 were not sure. But P6 disagreed, saying that more definitions would detract from the document’s purpose as a guide.

4.4.2.17 Original vs. plain language samples

At the end of this section, the participants were given three examples from the *CAPS* document that were presented in their original form and in their Plain English form (see Section 3.5.1 and Appendix B), randomly arranged. They then had to select the example they found more understandable. The examples were laid out in an irregular pattern so that the respondents would not be prompted to select a specific example, and they were not informed of which option was which. The responses to these

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[12] This question was stated in the negative to break the pattern and refocus the participants and avoid automatic ticking.

examples were overwhelmingly in support of the plain language options. (P5's responses had to be excluded, as this participant ticked all of the boxes.)

- *Example One*

The participants were unanimously in favour of the plain language option as the most clear and understandable. All nine participants said that a bulleted list is far easier to digest than a listed paragraph, as it cuts out the clutter.

- *Example Two*

Again, the responses were overwhelmingly in support of the plain language option. Seven participants (P1, P2, P3, P4, P7, P9 and P10) found it easier to digest the information in this example. However, P6 and P8 preferred the original and said that the original example has more information and is more specific. However, P7 disagreed with this and said that s/he feels that the plain language example suggests that the experiments will be of use to the learners, whereas the original does not.

- *Example Three*

The responses were once again overwhelmingly in support of the plain language format. Six participants (P1, P2, P3, P6, P8 and P9) indicated that they found it clearer than the original. They all indicated that the weekly layout is preferable, as one can lose track of the weeks. Furthermore, P9 stated that the question layout is better because it is more straightforward. However, P4, P7, and P10 preferred the original. P4 preferred the weekly countdown, P7 felt that the questions are more geared to learners than teachers, and P10 also did not like the question format and the repetition of the word 'weeks'.

4.4.3 Discussion of main findings on responses to the *CAPS* document

All the teachers interviewed stated that the *CAPS* document is fairly easy to access, suggesting that the Department of Education has indeed ensured that the document is readily available to teachers. All of the teachers also recognise the importance of the document, but there appeared to be a general sense that the document is not user-friendly. It does not come in a searchable PDF, and the page numbering in the PDF version differs from the page numbering on the hard copy of the document. Moreover, teachers indicated that they have had to come up with their own ways to navigate the hard copy document (colour tabs, etc.). P10 stated that the FET Phase documents have been divided up into three separate documents for teachers, and that these documents are detailed and navigable. Technical Science and Exam Guidelines are two of these documents, and P10 felt that these were indispensable to her/his teaching – the Senior Phase does not have these documents and they may be useful for teachers. P7 and P8 seemed to be particularly displeased with the document, because they indicated that they felt as though the department does not know what it wants from teachers and learners. This is important to note because it suggests that the document is not very clear to these teachers, who are both well-qualified and proficient in English – it is thus arguably potentially more of a challenge for teachers who lack subject knowledge and English proficiency.

The Natural Sciences content and concepts (weekly schedule) was largely recognised as the most important part of the document, hence it was selected for the analysis reported in Chapter 5.

The teachers were divided in response to the micro structure of the document, but there were some clear points of agreement. It appears that the teachers would prefer bulleted lists of information, a few visual aids (not many, but enough to break the monotony), and examples and definitions. P4 did state that it is important that the teacher maintains some autonomy, so one should be cautious not to overdo it with these elements.

The responses to the plain language alternatives to the text samples were positive. The teachers unanimously selected the bulleted list of information in the first example; most of the teachers liked the shorter, more concise plain language text presented in the second sample, and there was a strong preference for the clear divisions, gridlines and weekly layout in the final sample.

Overall, the teachers' responses to the questions on the *CAPS* document revealed differing perceptions of the document. While the information presented in the document is useful, it is possible to make it more accessible to the reader. Although some of the participants suggested that they do not feel the document is problematic, it is clear from the responses to the plain language examples that there are ways to improve the layout of the information for the reader.

4.5 TEACHER GUIDES

The draft of the National Policy for the Provision and Management of Learning and Teaching Support Material (RSA, 2014:4) describes a teacher guide as

> …a publication of systematically organised material, comprehensive enough to enable the teacher to cover the primary objectives outlined in the curriculum of a particular subject for the entire grade. It would include an exposition of the curriculum content in a pedagogically sound manner, which includes information and background on the content to be taught, learner activities and assessments.

A teacher should be able to teach core content to learners by using only a teacher guide. This is important in the South African context, where many schools lack the facilities and resources for teachers to be creative in their teaching. Moreover, these guides need to useful to teachers who lack an adequate knowledge base and/or language skills to teach their subject effectively. Based on this rationale, the teachers interviewed were asked about their perceptions of the material available to them. The responses to the questions were wide-ranging and brought to light the complexity of designing materials that all Senior Phase Natural Science teachers will find understandable, useful, and preferable to their teaching styles.

4.5.1 Closed-ended questionnaire data

The data gathered using the closed-ended questions are set out in Table 14, and are discussed in the next section. Again, in some sections, one or more participants did not answer the question (n<10).

Table 14: Teacher guide feedback

Question	Response	
Use of a teacher guide (n=10)	Yes	No
	9	1
Learners use corresponding learner guide (n=10)	Yes	No
	6	4
The two guides correspond (n<10)	Yes	No
	7	2
Information well communicated (n<10)	Yes	No
	9	-
Difficult to explain concepts using only prescribed guides (n=10)	Yes	No
	8	2

<table>
<tr><th>Question</th><th colspan="60">Response</th></tr>
<tr><td>Topics (most problematic (1) – least problematic (4) (n<10)</td><td colspan="15">1</td><td colspan="15">2</td><td colspan="15">3</td><td colspan="15">4</td></tr>
<tr><td>- Life and living</td><td colspan="15">2</td><td colspan="15">2</td><td colspan="15">2</td><td colspan="15">3</td></tr>
<tr><td>- Matter and materials</td><td colspan="15">2</td><td colspan="15">4</td><td colspan="15">-</td><td colspan="15">2</td></tr>
<tr><td>- Energy and change</td><td colspan="15">2</td><td colspan="15">1</td><td colspan="15">3</td><td colspan="15">2</td></tr>
<tr><td>- Planet Earth and beyond</td><td colspan="15">2</td><td colspan="15">1</td><td colspan="15">2</td><td colspan="15">3</td></tr>
<tr><td>Teacher guide helps to communicate challenging concepts (n=10)</td><td colspan="20">Yes</td><td colspan="20">No</td><td colspan="20">Sometimes</td></tr>
<tr><td></td><td colspan="20">3</td><td colspan="20">3</td><td colspan="20">4</td></tr>
<tr><td>Developed own resources to aid communication (n=10)</td><td colspan="30">Yes</td><td colspan="30">No</td></tr>
<tr><td></td><td colspan="30">8</td><td colspan="30">2</td></tr>
<tr><td>Areas of communication require improvement in teacher guide (n=10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">2</td><td colspan="12">6</td><td colspan="12">-</td><td colspan="12">2</td><td colspan="12">-</td></tr>
<tr><td>Difficult to find information (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">-</td><td colspan="12">-</td><td colspan="12">8</td><td colspan="12">1</td></tr>
<tr><td>Enough information (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">5</td><td colspan="12">1</td><td colspan="12">3</td><td colspan="12">-</td></tr>
<tr><td>Headings unclear (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">-</td><td colspan="12">1</td><td colspan="12">7</td><td colspan="12">1</td></tr>
<tr><td>Teacher and learner guides correspond (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">2</td><td colspan="12">5</td><td colspan="12">-</td><td colspan="12">1</td><td colspan="12">1</td></tr>
<tr><td>Information vague (n=10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">3</td><td colspan="12">-</td><td colspan="12">5</td><td colspan="12">2</td></tr>
<tr><td>Meaning of words and sentences unclear (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">3</td><td colspan="12">2</td><td colspan="12">3</td><td colspan="12">1</td></tr>
<tr><td>Sentences and paragraphs too long or incomplete (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">-</td><td colspan="12">5</td><td colspan="12">1</td><td colspan="12">2</td><td colspan="12">1</td></tr>
<tr><td>Document addresses the reader (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
<tr><td></td><td colspan="12">1</td><td colspan="12">5</td><td colspan="12">-</td><td colspan="12">3</td><td colspan="12">-</td></tr>
<tr><td>Explanations unclear (n<10)</td><td colspan="12">Strongly agree</td><td colspan="12">Agree</td><td colspan="12">Not sure</td><td colspan="12">Disagree</td><td colspan="12">Strongly disagree</td></tr>
</table>

Question	Response				
	-	1	1	6	1
Lists and tables useful (n<10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	1	7	-	1	-
Visual aids not well used (n<10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	1	1	3	2	2
More examples needed (n<10)	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
	1	4	2	-	2
Original vs. Plain language examples (see Section 3.5.2)	Original	Plain language			
- Example A (n=10)	1	9			
- Example B (n=10)	4	6			
- Example C (n=10)	6	4			

4.5.2 Data analysis

4.5.2.1 Teacher guide used

The teachers were first asked whether they have science teacher guides and, if so, to specify the guide/s they had. All the participants, with the exception of P5, used science teacher guides. P5 did not use one because s/he worked at an elite private school and was allowed the freedom to design her/his own resources. Most of the participants stated that they draw from a variety of sources, but that they had a primary set of teacher and learner guides that they used. Their responses are listed below:

- P1: *Platinum Natural Sciences* teacher and learner guides
- P2: *Spot On Natural Sciences* teacher and learner guides
- P3: *Doc Scientia* teacher and learner guides
- P4: *Top Class* teacher and learner guides (refers to *Solutions for All* and *Platinum* resources as well)
- P5: Own resources
- P6: *Doc Scientia* teacher and learner guides
- P7: *Doc Scientia* teacher and learner guides
- P8: *Doc Scientia* teacher and learner guides
- P9: *Solutions for All* teacher and learner guides (refers to *Platinum* and *Sasol Inzalo* resources as well)

- P10: *Doc Scientia* teacher and learner guides (Note that the teacher uses this in the FET Phase and not the Senior Phase. The teacher is uncertain of which guide is used in the Senior Phase.)

Although this list at first glance suggests that *Doc Scientia* is the most popular guide, it is important to acknowledge that P3, P6, P7, and P8 work at the same school. Thus, no conclusive findings on the most popular teacher and learner guides could be made.

4.5.2.2 Learner guide used

The respondents were then asked if the learners have the corresponding learner guide. Six (P3, P4, P6, P7, P8 and P10) stated that the learners do have the corresponding learner guide, while P2 and P9 indicated that they make photocopies of the relevant pages for the learners because the schools they work at are not resourced enough to cater for all the learners, and learners cannot afford the guides. P1 also indicated that the learners do not have the learner guide but that s/he prefers to make her/his own worksheets (like P5). P1 also has the freedom to do this because s/he works at an elite private school.

4.5.2.3 Teacher and learner guides as a set

Next, the teachers were asked if they felt the two guides correspond closely to each other. Seven participants (P1, P2, P3, P4, P6, P9 and P10) stated that they do believe that the two guides correspond closely with each other and function as a set. However, P7 and P8 indicated that they disagreed (although they use the same guides as P3 and P6). P7 stated that s/he felt there are gaps between the two and that the teacher guide assumes information has already been taught that has not yet been taught. P8 stated that there are gaps in content and that the questions do not always correlate. Neither of the participants feels that s/he can rely on the teacher guide to help them. P5 did not respond to the question.

4.5.2.4 Communication of information

When asked whether they feel that the information in the guides is well communicated to them, all the respondents agreed that it is. However, P4, P7, and P8 indicated that they have found mistakes in the answers to some of the activities in their respective teacher guides.[13] P5 did not respond to the question.

4.5.2.5 Explaining concepts

When asked whether they would find it difficult to teach or explain some of the prescribed topics to learners by using only the teacher/learner guide, eight of the participants (with the exception of P1 and P10) agreed that it would be. All the participants, again with exception of P1 and P10, indicated that they had to do a lot of their own research in order to teach the prescribed subject matter. P1 stated that s/he felt that the teacher and learner guides are complete enough to teach all content but that s/he did her/his own research because it would be boring for the learners to work exclusively from the one guide. P10 stated that s/he elaborated on the information presented to the learners in the class on overhead slides. The other participants stated that they had to do their own research because there are gaps in the content. (P1 and P10 did not teach learners in the Senior Phase, and their responses should therefore be treated with caution.)

4.5.2.6 Most problematic and least problematic topics

The respondents (with the exception of P10 because s/he did not teach Senior Phase learners) then ranked the topics that they found most problematic to least problematic to teach. P1 responded, even though s/he taught the Intermediate Phase, because the topics are the same in this phase. The topics are prescribed per term:

- Term 1: Life and living
- Term 2: Matter and materials
- Term 3: Energy and change
- Term 4: Planet Earth and beyond

There was no consistency in the respondents' selections and they did not make choices based on how the work is presented in the teacher guide. The participants all ranked their choices according to their own knowledge of the subject. As a result, no conclusions could be reached based on these findings. For example, P2, P4, and P5 found Life and living the easiest component to teach, but P1 and P9 found it the most

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[13] In my analysis of the guides, I came across some obvious errors, e.g. Lithium was reflected as 'Na', which is actually the symbol for sodium.

challenging, because they lacked a background in Life Science. However, six participants (P2, P3, P5, P6, P7 and P9) said that they found the abstract concepts in matter and materials a challenge to teach as the learners lack a frame of reference upon which to build.

4.5.2.7 Communication of challenging concepts

The participants were asked whether the teacher guide helps them to communicate more challenging concepts to the learners. P5, P6 and P10 agreed that it does. P5 drew from her/his experience at a government school at which s/he had to use a teacher guide, and P6 and P10 stated that they felt that the teacher guide functions as a gauge for what needs to be covered, but that nothing can replace a teacher's content knowledge. P1, P3, P4 and P9 indicated that they sometimes felt that the teacher guide does help to convey challenging concepts, but it depended on the subject matter. P2, P7 and P8 indicated that the teacher guide did not help with more challenging concepts and that they relied heavily on external sources for in-depth information.

4.5.2.8 Development of own resources

The participants were asked if they have had to do a lot of their own research and develop a lot of their own resources in order to explain more challenging concepts to the learners. All the participants, again with the exception of P1 and P10 (neither of whom teach Senior Phase Natural Science), indicated that they have had to do a lot of their own research and develop a lot of their own resources. P5 stated that s/he had developed a workbook of her/his own, and P6 and P9 stated that they felt that external sources and practical experience are essential in aiding learners to understand the content.

The participants were then asked more specific questions about communication in the teacher and learner guides. These responses were indicated on a 5-point Likert scale (Strongly agree; Agree; Not sure; Disagree; Strongly disagree).

4.5.2.9 Communication

In terms of the broad question ('Are there areas of communication that require improvement in the teacher guide?'), the majority of the respondents agreed that there are. P7 and P8 strongly agreed with the claim, and six participants (P1, P2, P4, P5, P6 and P9) all agreed with the claim. However, P3 and P10 disagreed with the statement and stated that they liked the guide they used – this is the same guide used by P7 and P8, who felt that it is a poor guide. P7 and P8 did, however, state that they feel *all* available guides have their limitations.

4.5.2.10 Finding information

The participants were asked whether it is difficult to find the information they are looking for. All of the participants disagreed with this statement – P1 strongly disagreed because s/he used an electronic version of the guide that is a searchable PDF. The rest of the participants all felt that the guides are straightforward in their layout. P5 did not respond to the question because s/he does not use a teacher and learner guide.

4.5.2.11 Quantity of information

The respondents were asked whether there is enough information in the guides. Half of the participants (P1, P4, P7, P9 and P10) agreed that there is. However, P1 claimed that it is not possible for a teacher guide to cover all scenarios, but that the one s/he used does a good job of giving as much information as possible. P6 indicated that s/he was not sure if there is enough information, and P2, P3, and P8 disagreed with the statement, as they did not think that there is enough information in the guides. P5 did not respond.

4.5.2.12 Headings

The participants were in agreement that the headings in the teacher guides are clear. P2 indicated that s/he was not sure as s/he could not recall what the headings were like, but the rest of the participants did not find this a problem. P5 did not respond.

4.5.2.13 Teacher and learner guides as a set

This was a repeat of an earlier question in which the participants were asked whether the information in the teacher guide corresponds with that in the learner guide – this was included in order to test if the interview had an impact on the teachers' feelings toward their guides. The responses remained the same.

4.5.2.14 Vagueness of information

When asked whether the information is vague, P2, P5, and P6 agreed that it is. P2 stated that the teacher guide is merely a compilation of answers to the activities in the learner guide, and that these responses sometimes require the discretion of the teacher. P5 indicated that this is why s/he has chosen to develop her/his own resources. P6 added that the teacher guide does not always explain things adequately. However, half (P3, P4, P8, P9 and P10) disagreed with the statement, and P1 and P7 strongly disagreed with the statement. These results were surprising as P7 and P8 had previously stated that they felt that there are gaps in the content.

4.5.2.15 Clarity of words and sentences

The participants were asked to indicate whether or not they found the meaning of words or sentences unclear. Three of the respondents (P6, P7 and P8) agreed that they did find the meaning of word and sentences unclear. P3 and P9 indicated that they were not sure. P2, P4 and P10 indicated that they disagreed with this statement, and P1 indicated that s/he strongly disagreed with the statement. None of the participants elaborated on their responses. P5 did not respond to the question.

4.5.2.16 Length of sentences and paragraphs

The participants were then asked whether they thought the sentences or paragraphs are too long or incomplete. The responses were divergent. Half (P2, P3, P6, P9 and P10) indicated that they did find this to be the case. All of them explained that they would prefer short, bulleted lists of information. P7 indicated that s/he was not sure because sometimes the sentences and paragraphs are too long, and at other times they are too short, but P4, P8 and P1 indicated that they disagreed with this claim (P1 strongly disagreed). P5 did not respond to the question.

4.5.2.17 Addressing the reader

Respondents had to identify whether or not the guide addresses them as readers. P1 strongly agreed that it does, and half (P3, P4, P7, P8 and P9) also agreed that theirs do. However, P2, P6 and P10 indicated that they did not feel that the document addresses the reader. Rather, the guide focuses on what the learner needs to know (P10 does not see this as problematic). P5 did not respond to the question.

4.5.2.18 Clarity of explanations

Participants tended to disagree with the claim that the descriptions and explanations are unclear. P8 was the only candidate who agreed with this statement as s/he reiterated her/his claim that there are gaps in the content. P7 indicated that s/he was not sure. P5 did not respond to the question.

4.5.2.19 Usefulness of lists and tables

When asked whether they found the lists and tables useful, all of the respondents, with the exception of P2, said that they are useful. P2 stated that s/he does not feel that there are enough lists or tables in the guide. P5 did not respond to the question.

4.5.2.20 Use of visual aids

When it came to whether or not visual aids have been well used, the responses were varied. P2 strongly agreed that they have not been well used, and P1 also agreed that they could be improved. P3, P8 and P9 indicated that they were not sure because they could not recall. P4 and P6 disagreed, claiming that the use of visuals is fair, and P7 and P10 strongly disagreed. P10 said that the guides do not use a lot of visual aids, but that she does not think that a guide should include these because they are unnecessary distractions. P5 did not respond to the question.

4.5.2.21 Specific examples and definitions

The participants were asked whether there need to be more specific examples and definitions. Half (P2, P3, P6, P8 and P9) agreed that there should be, as the guides can be unclear at times (P2 strongly agreed). P4 and P7 indicated that they were not sure as they did not use the guides for additional information. P1 and P10 strongly disagreed as they are happy with the level of information in the guides (again, these are the two participants who are not Senior Phase teachers).

4.5.2.22 Original vs. plain language samples

The participants were then asked to select the options they found more clear of the samples provided. Originals from the *Spot On Natural Sciences* Grade 8 Teacher Guide (2017) were provided alongside a Plain English example of the same information (see Section 3.5.2 and Appendix B). The participants were given no indication of which was which and had to select an option based on the example they found clearer.

- *Example One*

All the participants selected the Plain English option, stating that it was clearer than the other option and that they liked the equation, with the exception of P7. S/he stated that s/he would like to just read through what s/he needs to do without the equation. However, s/he did admit that s/he had not seen the information before the equation and if s/he had, s/he would have responded differently.

- *Example Two*

Six of the participants (P1, P3, P4, P5, P6 and P8) preferred the Plain English example. All of them stated that it was more straightforward than the original. However, P2, P7, P9, and P10 indicated that they preferred the original, stating that it is shorter and gets to the point faster than the Plain English version.

- *Example Three*

The results on this example were in favour of the original. Six participants (P2, P4, P5, P7, P9 and P10) indicated that they prefer the flow diagram to the numbered list. P9 stated that the flow diagram shows that there is a relationship between each component, which is something that the learners need to understand. However, P1, P3, P6, and P8 preferred the plain language option. P1 stated that s/he prefers the wording (the use of active verbs), and P6 and P8 like the numbered list because this is how the learners are expected to write the report. This finding suggests that a combination (a numbered list with imperatives in a flow chart) might work best.

4.5.3 Discussion of main findings

It was clear based on the teachers' responses that there are a number of *CAPS*-compliant teacher and learner guides available to teachers. Even so, the participant who had the freedom to develop her/his own resources (P5) opted to do so because s/he felt these guides are lacking. This was not the consensus amongst the teachers though, because some of participants were happy with the resources that they use and felt that the matching teacher and learner guides correspond well. P7 and P8 were adamant that they cannot rely on the resources available to them and that the matching guides do not correspond well with each other. Even though they are in the minority, there should not be room for teachers to feel this way. It was also noted that a few mistakes appear in the guides; this is a problem because important concepts could be missed because of this. All of the participants did agree that there is no replacement for the teacher’s input.

P2 and P9 both stated that they had to make photocopies of the guides for the learners because their schools cannot afford the guides. This shows that the government does not subsidise these resources for all learners, even though these guides are compulsory.

Amongst the Senior Phase teachers (eight of the participants), there was consensus that it would be difficult to teach challenging concepts using only the teacher and learner guides, and that they had to do a lot of their own research and develop a lot of their own resources. The only participants who did not face these challenges were P1 and P10, who do not teach in the Senior Phase. Again, this suggests that the Senior Phase might be more neglected than the other phases.

When looking at specific elements in the guides, the general feeling was that communication in the guides could improve through the use of more visual aids and definitions and explanations. However, it was generally felt that the documents are navigable, the headings are clear, the reader is addressed, explanations are clear, and lists and tables have been used well.

When it came to the Plain English samples, there were mixed results. A majority of the participants liked the added visual element (equation) in the first example, but the other two examples received mixed reviews. It appeared that using plain language had neither a definitively positive nor a definitively negative impact on these texts.

4.6 CONCLUSION

The aim of these interviews was threefold. Firstly, I aimed to establish what teachers thought of the resources available to them in terms of their usefulness, navigability, and comprehensibility. The interviews proved fruitful in establishing that these teachers found the *CAPS* document useful, but there were mixed feelings about its navigability and comprehensibility. All in all, it was clear that plain language criteria can be applied to the document to make it a more user-friendly and comprehensible resource. The *CAPS* is an important resource, so if improvements to the presentation and delivery of content can be made, they should be considered. In terms of the teachers' thoughts on the teacher and learner guides that they use, the results were mixed. Some teachers were very happy with their resources and others were very unhappy with their resources. When the questions started to focus on more specific elements of these resources, it became clear that the presentation of information is not problematic (only minor details) and that plain language criteria were already being applied to these resources. The more problematic concern was the quality of content. Most of the teachers felt that explanations and definitions, as well as visual aids, could enhance these documents (this suggests a content issue across the board in these resources).

Secondly, I aimed to verify the applicability of the preliminary plain language criteria. The teachers' responses to the plain language samples from *CAPS* indicated that the plain language criteria enhanced the delivery of content. There was overwhelming support for the plain language revisions. However, with the exception of the first sample, where a visual aid was used to aid the delivery of content, the responses to the plain language samples did not show that these strategies had enhanced the text. This aligns with the interview feedback which pointed to a problem with the quality of the content, rather than the presentation of information. For these reasons, I kept the original plain language criteria with only minor details added (refer to Chapter 5 and Appendix C) when it came to the *CAPS* revisions. But I reconsidered how I would approach the teacher resources. Part of my plain language working definition states that plain language is

> …the writing and setting out of *essential information* in a way that gives a *co-operative, motivated person* a good chance of understanding it at *first reading*, and in the same sense that the *writer meant it to be understood*. (Cutts, 1995:3; my emphases)

This definition suggests that the quality of *content* (essential information) is part of plain language. Even though these resources apply plain language criteria, the interview results suggest that this content is sometimes lacking. For this reason, I sought to enhance the teacher guides, amongst other things, and by bringing the teacher and learner guides together to make a more complete resource. The original plain language criteria were still considered, but an additional criterion (Quality of content) was added to this list for these samples.

Lastly, the interviews were used to identify the most popular/used teacher guides so that legitimate sources could be selected. The results were not conclusive, because there are a number of *CAPS*-compliant resources. Therefore, I had to select resources via other means (discussed in Section 3.4). Although the last aim was not met through the interviews, the information that was gathered was illuminating and shone a light on Senior Phase science education in South Africa. These responses suggest that the texts may not have a problem when it comes to the presentation of information. The problems might involve the quality of content more so than its presentation. The analyses in the next chapter explore this issue further.

CHAPTER 5:

DOCUMENT ANALYSIS

5.1 INTRODUCTION

Various extracts from the *CAPS* document for Grade 7 Natural Science, *Spot On Natural Sciences* for Grade 8, and *Platinum Natural Sciences* for Grade 9 were selected for analysis in this section. Specific sections from these documents were selected based on feedback from the teacher interviews (see Sections 4.4 and 4.5) so as to cover the different units of work and potential differences in structure (this is discussed in more detail at the start of each section). This chapter looks at the analysis for samples from the following documents:

- the *CAPS* document for Grade 7 Natural Science
- teacher and learner guides for analysis:
    - *Spot On Natural Sciences* for Grade 8; and
    - *Platinum Natural Sciences* for Grade 9.

As I explained in Chapter 3, the samples were run through a battery of readability tests. The results of these tests were averaged in order to establish a 'readability consensus'. After this was established, the texts were then analysed to see whether they comply with the selected plain language criteria for the study, and if so, how. According to these results, the texts were revised to comply with the final plain language criteria and then run through the readability tests again to establish a new readability consensus.

5.2 FINAL PLAIN LANGUAGE CRITERIA

Based on the results of the teacher interviews, a final set of plain language criteria were established. The criteria have been adjusted to address the documents specifically selected for analysis in this section. The criteria appear in Table 15 (overleaf). The criteria that have been highlighted in orange have remained the same, and those that have been highlighted in blue have been altered or added. A foldout of these criteria has been included in the hard copy of this document (Appendix C).

Table 15: Final plain language criteria

Criteria	Explanation
An average sentence length of 15-25 words	Shakhar (s.a.:7) promotes the KISS principle (Keep It Short and Simple) when it comes to sentence length, which suggests that the shorter the sentence, the better. This broad principle is useful but vague. Greene (2013:63) argues that the sentences should vary in length, because a 'string of long sentences (30 words or more) is difficult to get through; a string of short sentences (10 words or less) is choppy, and a string of medium-length sentences (15-25 words) is monotonous'. Cutts recommends an average maximum sentence length of about 15 to 20 words (Cutts, 2013:1), which allows for some variability. Bearing in mind these diverging views on sentence length, I opted for medium-length sentences in the initial revisions to present to the participants, because the aim is for teachers to be able to digest information in small amounts, rather than in large chunks via lengthy explanations.
Focused paragraphs and lists	Cutts (2013:8) recommends that paragraphs represent a '*unit of thought*' (Cutts's emphasis). Greene explains that each paragraph should have an issue, development and conclusion. Furthermore, a paragraph should not be more than approximately 150 to 200 words long (Greene, 2013:67). It is also recommended that large chunks of information be divided into vertical lists (bulleted or numbered) in order to make it easier for the reader to digest information (Cutts, 2013:5). This criterion is one that the participants mentioned most – they prefer the format of bulleted lists. Parallel structure must be implemented when working with lists.
Word choice	Cutts (2013:11) recommends using 'words your reader is likely to understand'. Although science is a discipline that relies on complex constructs and terms, these terms are often overused or used unnecessarily. As a result, I favoured shorter words over longer words (where possible), kept terms consistent, and broke up noun strings. I bore the following in mind when reading the text the call to prefer the 'common word to the rare word, the short to the long, the single to the multiple, the standard to the off-beat, the specific to the general, the definite to the vague, the concrete to the abstract, the Anglo-Saxon to the Latinate' (Shakhar, s.a.:16). Where accurate scientific terms must be used, it is important to gloss such words or add a dedicated glossary. This may add to a text's length, but ensures clarity, which is the aim of plain language. Once a term has been defined, it can be used consistently.
Favour the active voice	The active voice is more direct than the passive voice, and is often shorter than the passive option. Moreover,

Criteria	Explanation
	active sentences are easier to understand as they reflect the way we speak every day (Greene, 2013:22), and it is clear who the agent is. However, there are times when the passive voice is useful and can make a text more understandable, for example, when the process is more important than the agent. For this reason, I did not omit the passive entirely but used it only when necessary. In science, where the focus is often on the process rather than the agent, the passive voice is useful and can make a text shorter and more understandable. Hence, this criterion was applied with caution.
Audience, register, and tone	According to Cutts (2013:118), the average reading age in Britain is 13 – one can assume that the reading age is lower in South Africa, where English is not the first language of the majority of the population. Hence, it is important for writing to be pitched at the correct level. This should be done in such a way that the audience does not feel spoken down to, as if they are incapable of understanding what is being said. Hence, the register should remain primarily formal but with carefully crafted informal elements (Greene, 2013:7). In addition, the tone should project confidence in the knowledge that is being presented (Greene, 2013:10).
Non-sexist/biased language	It is important to make sure that language is not sexist (Cutts, 2013:34), especially when it comes to the sciences that are often dominated by men. Language should also not present any racial or political biases. One of the strategies Cutts (2013:139) recommends to avoid this issue is using plurals, like 'they', as singulars, 'they' in place of 'he/she' or 's/he', e.g. 'the teacher is…they…'. This should be avoided in the South African language context because it could lead to additional confusion and alienation for non-first language English speakers due to the already confusing issue of gendered pronouns in English – in isiZulu, for example, pronouns are not gendered (Noomé, 2015:158). Using the plural is a good idea, but then plural pronouns should be used with plural nouns, e.g. 'teachers are…. they…'.
Reader-centred structure	When readers are placed at the centre of the text, they are better able to grasp important information early (Cutts, 2013:165). What Cutts means by this is that the reader is placed at the centre of the text by addressing her/him directly in the second person. For example, 'You can…' or 'When you…'. Imperatives work in the same way, because the implied subject in a command is 'you'. Neither Shakhar nor Greene discusses this point, perhaps because scientific writing is generally geared toward a more academic audience, where using the impersonal third person has long been the norm (although this is changing). However, the idea behind textbooks and the teacher guides that accompany them is to help the readers to

Criteria	Explanation
	learn information quickly, which is why a reader-centred structure is promoted in this instance.
Clear layout	Layout has an influence on readers' ability to absorb information, so the layout needs to help them to access the information. Elements such as a legible font and font size (the font should be easy on the eye and the font size should not be difficult to read), line spacing (leaving enough white space to allow readers to see each word clearly), colour (for example, contrasting the foreground and background and adding colour to headings, to make the document more navigable), and a hierarchy of headings (bold, upper and lower case, italics to help the reader to navigate the document). These elements should be considered as the absence of such elements can influence the reader's experience negatively (Cutts, 2013:246). With regard to headings, all capitals should be left out. A title case heading in bold font provides enough emphasis. There must be clear markers for the division of information.
Use alternatives to words	According to Cutts (2013:178), '[t]he written word alone is not always the best way of communicating a message. Graphic devices such as tables, illustrations, pie charts, diagrams, maps, strip cartoons, mathematical formulas and photographs can all help'. There are no set rules, but it is useful to experiment with these alternatives. The teacher can easily feel spoken down to if the wrong graphics are used, so these should be used with care.
Quality of content	There should be careful consideration for the quality of content, because comprehension of 'essential information' (Cutts, 1995:3) is one of the principles of plain language. There should be no gaps in content, explanations should be full and complete, and the reader should not have to draw from two sources to gain a complete understanding (i.e. having to use both the teacher and learner get an idea of what will be covered in class).

It was clear from the interviews that there is a preference for bulleted lists of information. The teachers felt that this made it easy to pick up on important information quickly. For this reason, as many bulleted lists as possible have been used. There has also been careful attention to parallel structure in these lists.

Initially I had not considered that glossing and/or glossaries could be a good way of explaining potentially complex terms to teachers, but I realised that this alternative is a good way of ensuring that teachers have any important information at their disposal.

With regard to sexism in language, Cutts (2013:139) recommends using plural pronouns as singular pronouns. While this may be a politically correct way of resolving gender issues, it is both grammatically incorrect and in the case of South Africa, very problematic, adding to language complexity. As indicated in the table, gendered singular pronouns do not exist in languages such as isiZulu, leading to ungrammatical constructions by second language speakers such as 'the man she is tall'. Adding the plural/singular layer to the mix is potentially alienating and confusing for South African readers who might already struggle with English pronouns. For this reason, this strategy has to be actively avoided and corrected if necessary. Simple plurals (nouns and the matching pronouns) are clearer and evade the gender issue.

Clear layout is a concern in the *CAPS* document, particularly in the section the teachers indicated they most use, so close attention has to be paid to headings (hierarchies of headings and consistent use of title and sentence case) and the division of information. The teachers indicated that there could be more visual aids in both the *CAPS* and teacher guides, but stressed that this should be done with caution. Teachers do not want to feel as though they are the learners, or that they are being spoken down to. Thus, I had to be careful when it came to these considerations.

A new criterion was added to the list once it became clear that quality, rather than the presentation of information, was a factor to consider in teacher and learner guides. This became the primary point of focus in these resources, so I paid careful attention to gaps in content, full and complete explanations, and having all necessary information in one source (as opposed to referring to two). Here I must acknowledge that I do not have a background in science education, so I cannot judge the accuracy of information but I can judge the completeness of information from a language perspective.

5.3 *CAPS* DOCUMENT FOR GRADE 7 NATURAL SCIENCE

Based on the results of the participant feedback, I chose sections from the *CAPS* Natural Sciences content and concepts (Department of Education, 2011:17-84) for analysis. Eight of the participants stated that this was the section of the document that they found most useful; the remaining participants indicated that this was the second most useful section for them. I therefore focused only on sections from each term of the Natural Sciences content and concepts section of the document. This section of the document offers information about what a teacher should teach each week, and it is essential that all teachers find this content clear and easy to understand.

There was no consensus in the participant feedback about what the teachers found the most challenging term to teach, so I selected random samples of text from each term’s schedule for analysis, as discussed below.

5.3.1 *CAPS*: Examples Term 1 to Term 4

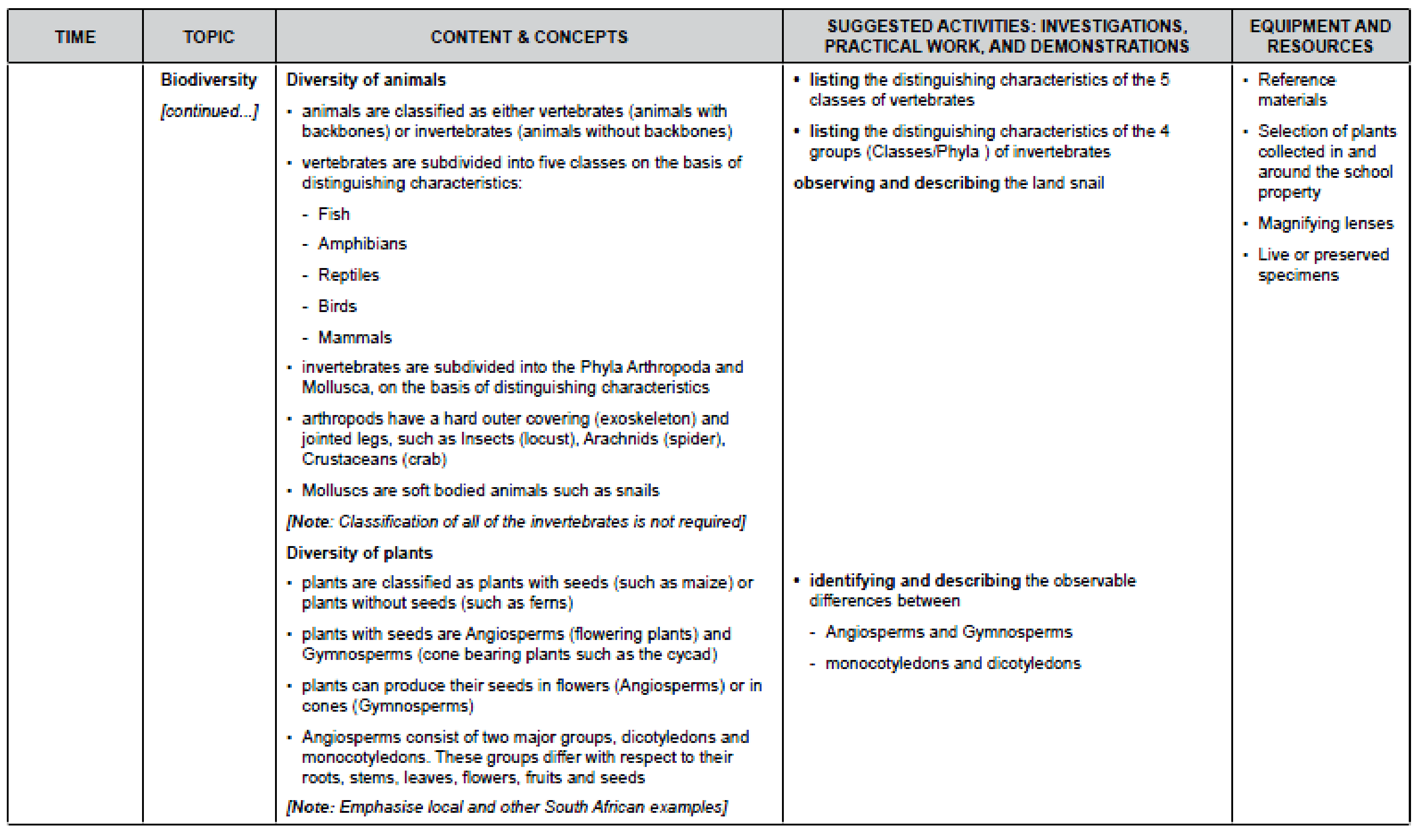
Each of the selected text samples (along with a variety of samples from the *CAPS* document) was put through the readability checker on ReadabilityFormulas.com (2018), analysed and revised to ascertain whether or not

- the samples comply with plain language writing criteria;
- there are similarities in the way the information is presented in each section of the document; and
- this has resulted in a communication gap in the text.

The text samples are tables with five columns containing different information. Because the text is divided into these different columns, I decided to send only the information from the column containing ‘Content & Concepts’ through the readability checker. This decision was made because this column includes the most information and sending the entire table through the readability checker would unfairly influence the results. Table 16 (overleaf) depicts the text sample from Term 1 as it appears in the Natural Sciences content and concepts for Grade 7. The results of the readability tests and the readability consensus (descriptions attached as Appendix D) appear below each sample. Table 17 (on pp. 108-109 depicts the text sample from Term 2, followed by its readability test results and the readability consensus. Table 18 (on pp. 110-111) shows the text sample from Term 3, followed by its readability test results and the readability consensus. Finally, Table 19 (on pp. 112-113) depicts the text sample from Term 4, followed by its readability test results and the readability consensus.

Table 16: *CAPS* sample – Term 1

Original text



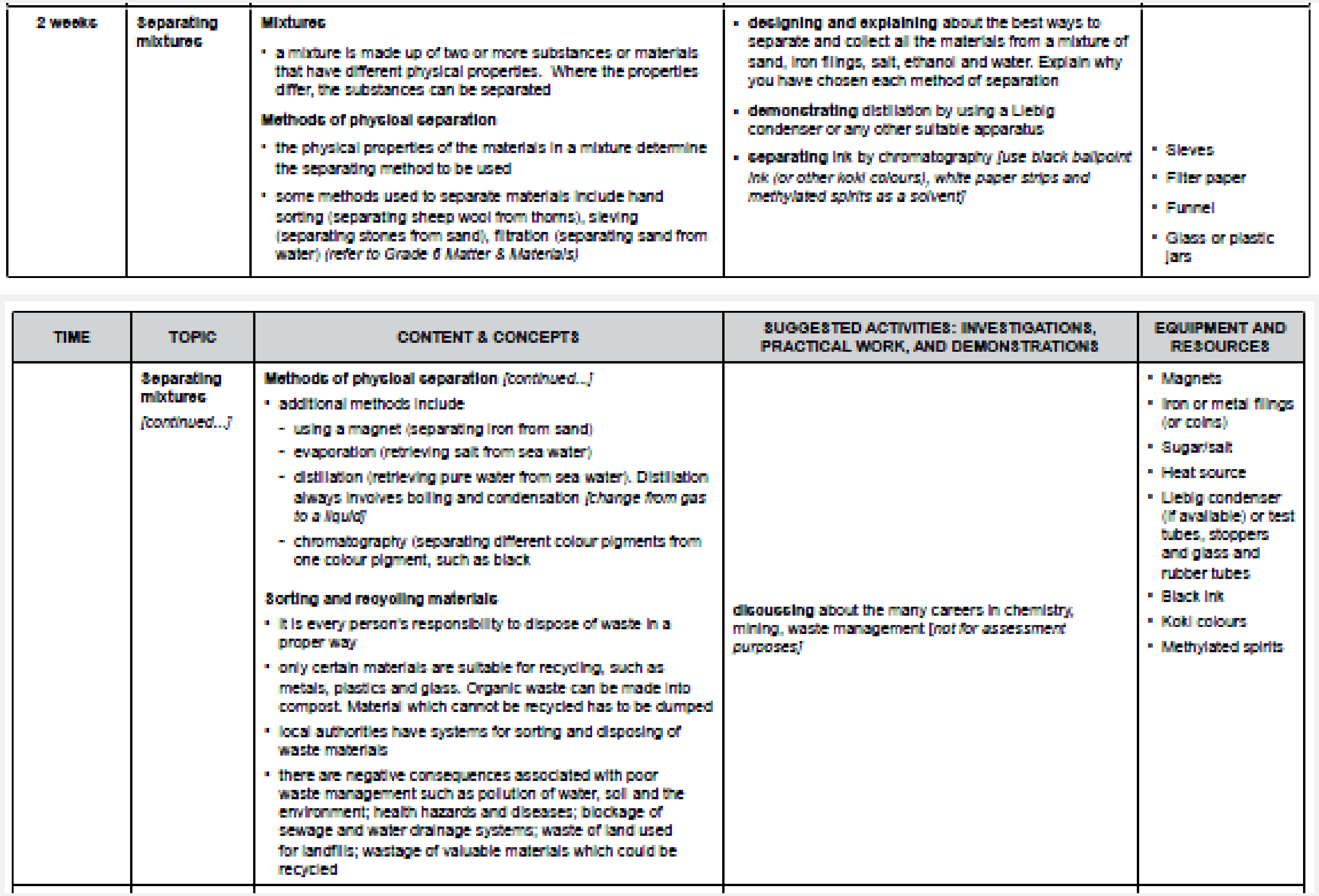
TIME	TOPIC	CONTENT & CONCEPTS	SUGGESTED ACTIVITIES: INVESTIGATIONS, PRACTICAL WORK, AND DEMONSTRATIONS	EQUIPMENT AND RESOURCES
	Biodiversity *[continued...]*	**Diversity of animals** ▪ animals are classified as either vertebrates (animals with backbones) or invertebrates (animals without backbones) ▪ vertebrates are subdivided into five classes on the basis of distinguishing characteristics: - Fish - Amphibians - Reptiles - Birds - Mammals ▪ invertebrates are subdivided into the Phyla Arthropoda and Mollusca, on the basis of distinguishing characteristics ▪ arthropods have a hard outer covering (exoskeleton) and jointed legs, such as Insects (locust), Arachnids (spider), Crustaceans (crab) ▪ Molluscs are soft bodied animals such as snails *[Note: Classification of all of the invertebrates is not required]* **Diversity of plants** ▪ plants are classified as plants with seeds (such as maize) or plants without seeds (such as ferns) ▪ plants with seeds are Angiosperms (flowering plants) and Gymnosperms (cone bearing plants such as the cycad) ▪ plants can produce their seeds in flowers (Angiosperms) or in cones (Gymnosperms) ▪ Angiosperms consist of two major groups, dicotyledons and monocotyledons. These groups differ with respect to their roots, stems, leaves, flowers, fruits and seeds *[Note: Emphasise local and other South African examples]*	▪ **listing** the distinguishing characteristics of the 5 classes of vertebrates ▪ **listing** the distinguishing characteristics of the 4 groups (Classes/Phyla) of invertebrates **observing and describing** the land snail ▪ **identifying and describing** the observable differences between - Angiosperms and Gymnosperms - monocotyledons and dicotyledons	▪ Reference materials ▪ Selection of plants collected in and around the school property ▪ Magnifying lenses ▪ Live or preserved specimens

(Department of Education, 2011:18)

Readability test results
Flesch Reading Ease score: -113.9 (impossible to comprehend)
Gunning Fog: 70.2 (EXTREMELY difficult to read)
Flesch-Kincaid Grade Level: 69.9 (College graduate and above)
The Coleman-Liau Index: 17 (graduate college)
The SMOG Index: 35.3 (graduate college)
Automated Readability Index: 88.1 (College graduate)
Linsear Write Formula: 120 (College Graduate and above)
(ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 66
Reading level: Impossible to comprehend
Reader’s age: College graduate
(ReadabilityFormulas.com, 2018)

Table 17: *CAPS* sample – Term 2

Original text



TIME	TOPIC	CONTENT & CONCEPTS	SUGGESTED ACTIVITIES: INVESTIGATIONS, PRACTICAL WORK, AND DEMONSTRATIONS	EQUIPMENT AND RESOURCES
2 weeks	**Separating mixtures**	**Mixtures** ▪ a mixture is made up of two or more substances or materials that have different physical properties. Where the properties differ, the substances can be separated **Methods of physical separation** ▪ the physical properties of the materials in a mixture determine the separating method to be used ▪ some methods used to separate materials include hand sorting (separating sheep wool from thorns), sieving (separating stones from sand), filtration (separating sand from water) *(refer to Grade 6 Matter & Materials)*	▪ **designing and explaining** about the best ways to separate and collect all the materials from a mixture of sand, iron filings, salt, ethanol and water. Explain why you have chosen each method of separation ▪ **demonstrating** distillation by using a Liebig condenser or any other suitable apparatus ▪ **separating** ink by chromatography *[use black ballpoint ink (or other koki colours), white paper strips and methylated spirits as a solvent]*	▪ Sieves ▪ Filter paper ▪ Funnel ▪ Glass or plastic jars
	Separating mixtures *[continued...]*	**Methods of physical separation** *[continued...]* ▪ additional methods include - using a magnet (separating iron from sand) - evaporation (retrieving salt from sea water) - distillation (retrieving pure water from sea water). Distillation always involves boiling and condensation *[change from gas to a liquid]* - chromatography (separating different colour pigments from one colour pigment, such as black **Sorting and recycling materials** ▪ it is every person's responsibility to dispose of waste in a proper way ▪ only certain materials are suitable for recycling, such as metals, plastics and glass. Organic waste can be made into compost. Material which cannot be recycled has to be dumped ▪ local authorities have systems for sorting and disposing of waste materials ▪ there are negative consequences associated with poor waste management such as pollution of water, soil and the environment; health hazards and diseases; blockage of sewage and water drainage systems; waste of land used for landfills; wastage of valuable materials which could be recycled	**discussing** about the many careers in chemistry, mining, waste management *[not for assessment purposes]*	▪ Magnets ▪ Iron or metal filings (or coins) ▪ Sugar/salt ▪ Heat source ▪ Liebig condenser (if available) or test tubes, stoppers and glass and rubber tubes ▪ Black ink ▪ Koki colours ▪ Methylated spirits

(Department of Education, 2011:22-23)

Readability test results

Flesch Reading Ease score:-10.2 (impossible to comprehend)

Gunning Fog: 31.4 (EXTREMELY difficult to read)

Flesch-Kincaid Grade Level: 29.2 (College graduate and above)

The Coleman-Liau Index: 14 (college)

The SMOG Index: 21.1 (graduate college)

Automated Readability Index: 33.6 (College graduate)

Linsear Write Formula: 42.8 (College Graduate and above)

(ReadabilityFormulas.com, 2018)

Readability consensus

Grade level: 28

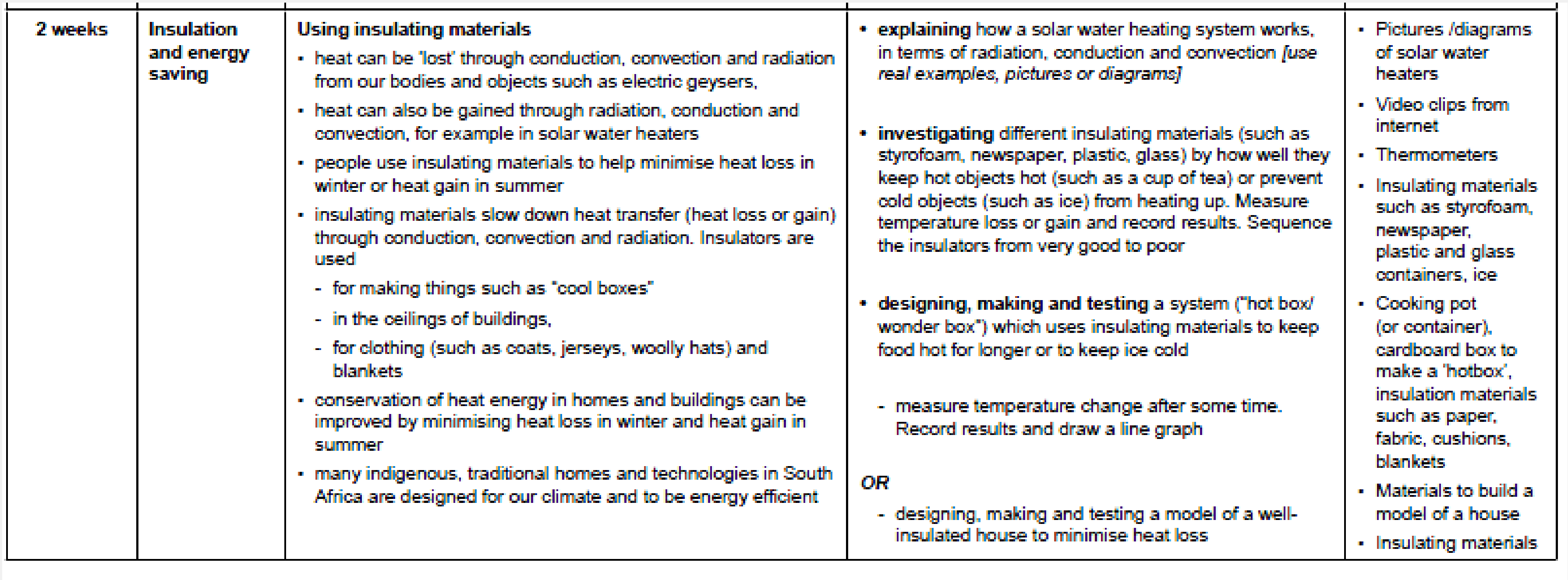
Reading level: Impossible to comprehend

Reader's age: College graduate

(ReadabilityFormulas.com, 2018)

Table 18: *CAPS* sample – Term 3

Original text



2 weeks	**Insulation and energy saving**	**Using insulating materials** ▪ heat can be 'lost' through conduction, convection and radiation from our bodies and objects such as electric geysers, ▪ heat can also be gained through radiation, conduction and convection, for example in solar water heaters ▪ people use insulating materials to help minimise heat loss in winter or heat gain in summer ▪ insulating materials slow down heat transfer (heat loss or gain) through conduction, convection and radiation. Insulators are used - for making things such as "cool boxes" - in the ceilings of buildings, - for clothing (such as coats, jerseys, woolly hats) and blankets ▪ conservation of heat energy in homes and buildings can be improved by minimising heat loss in winter and heat gain in summer ▪ many indigenous, traditional homes and technologies in South Africa are designed for our climate and to be energy efficient	▪ **explaining** how a solar water heating system works, in terms of radiation, conduction and convection *[use real examples, pictures or diagrams]* ▪ **investigating** different insulating materials (such as styrofoam, newspaper, plastic, glass) by how well they keep hot objects hot (such as a cup of tea) or prevent cold objects (such as ice) from heating up. Measure temperature loss or gain and record results. Sequence the insulators from very good to poor ▪ **designing, making and testing** a system ("hot box/ wonder box") which uses insulating materials to keep food hot for longer or to keep ice cold - measure temperature change after some time. Record results and draw a line graph *OR* - designing, making and testing a model of a well-insulated house to minimise heat loss	▪ Pictures /diagrams of solar water heaters ▪ Video clips from internet ▪ Thermometers ▪ Insulating materials such as styrofoam, newspaper, plastic and glass containers, ice ▪ Cooking pot (or container), cardboard box to make a 'hotbox', insulation materials such as paper, fabric, cushions, blankets ▪ Materials to build a model of a house ▪ Insulating materials

(Department of Education, 2011:28)

Readability test results

Flesch Reading Ease score: -7 (impossible to comprehend)

Gunning Fog: 34.3 (EXTREMELY difficult to read)

Flesch-Kincaid Grade Level: 30.9 (College graduate and above)

The Coleman-Liau Index: 13 (college)

The SMOG Index: 21.5 (graduate college)

Automated Readability Index: 36.8 (College graduate)

Linsear Write Formula: 47.5 (College Graduate and above)

(ReadabilityFormulas.com, 2018)

Readability consensus

Grade level: 30

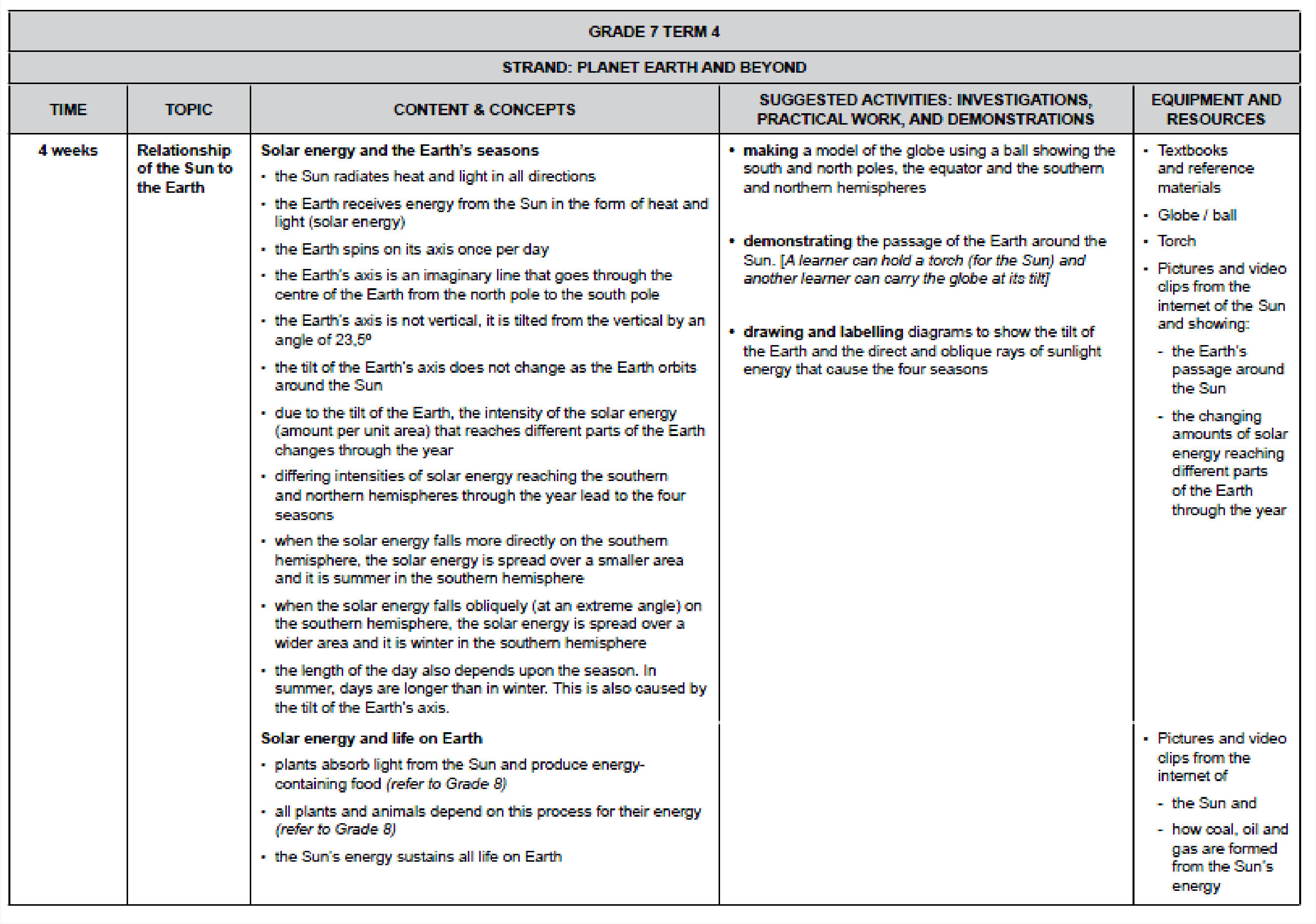
Reading level: Impossible to comprehend

Reader's age: College graduate

(ReadabilityFormulas.com, 2018)

Table 19: *CAPS* sample – Term 4

Original text



GRADE 7 TERM 4				
STRAND: PLANET EARTH AND BEYOND				
TIME	TOPIC	CONTENT & CONCEPTS	SUGGESTED ACTIVITIES: INVESTIGATIONS, PRACTICAL WORK, AND DEMONSTRATIONS	EQUIPMENT AND RESOURCES
4 weeks	**Relationship of the Sun to the Earth**	**Solar energy and the Earth's seasons** • the Sun radiates heat and light in all directions • the Earth receives energy from the Sun in the form of heat and light (solar energy) • the Earth spins on its axis once per day • the Earth's axis is an imaginary line that goes through the centre of the Earth from the north pole to the south pole • the Earth's axis is not vertical, it is tilted from the vertical by an angle of 23,5º • the tilt of the Earth's axis does not change as the Earth orbits around the Sun • due to the tilt of the Earth, the intensity of the solar energy (amount per unit area) that reaches different parts of the Earth changes through the year • differing intensities of solar energy reaching the southern and northern hemispheres through the year lead to the four seasons • when the solar energy falls more directly on the southern hemisphere, the solar energy is spread over a smaller area and it is summer in the southern hemisphere • when the solar energy falls obliquely (at an extreme angle) on the southern hemisphere, the solar energy is spread over a wider area and it is winter in the southern hemisphere • the length of the day also depends upon the season. In summer, days are longer than in winter. This is also caused by the tilt of the Earth's axis.	• **making** a model of the globe using a ball showing the south and north poles, the equator and the southern and northern hemispheres • **demonstrating** the passage of the Earth around the Sun. [*A learner can hold a torch (for the Sun) and another learner can carry the globe at its tilt]* • **drawing and labelling** diagrams to show the tilt of the Earth and the direct and oblique rays of sunlight energy that cause the four seasons	• Textbooks and reference materials • Globe / ball • Torch • Pictures and video clips from the internet of the Sun and showing: - the Earth's passage around the Sun - the changing amounts of solar energy reaching different parts of the Earth through the year
		Solar energy and life on Earth • plants absorb light from the Sun and produce energy-containing food *(refer to Grade 8)* • all plants and animals depend on this process for their energy *(refer to Grade 8)* • the Sun's energy sustains all life on Earth		• Pictures and video clips from the internet of - the Sun and - how coal, oil and gas are formed from the Sun's energy

(Department of Education, 2011:31)

Readability test results
Flesch Reading Ease score: -55.6 (impossible to comprehend)
Gunning Fog: 59.7 (EXTREMELY difficult to read)
Flesch-Kincaid Grade Level: 55.4 (College graduate and above)
The Coleman-Liau Index: 8 (Eighth grade)
The SMOG Index: 22.6 (graduate college)
Automated Readability Index: 68.2 (College graduate)
Linsear Write Formula: 84.8 (College Graduate and above)
(ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 48
Reading level: Impossible to comprehend
Reader's age: College graduate
(ReadabilityFormulas.com, 2018)

Although the overall grade level results differ for each text, all exceed a high school learner's grade level (the accepted level for this study, discussed in Section 3.8). Moreover, the readability consensus reveals that each text is 'impossible to comprehend', requiring a college graduate to make sense of it. The target audience for this selection of texts is indeed college graduates (the equivalent of a teacher with a three or four year degree or diploma), but assuming first language competency, which a standard reader may not necessarily have in the South African scenario, where not all teachers have these qualifications, and may or may not be at the recommended reading level. Furthermore, these results are based on the schooling system in the United States where the first language is English; this suggests that these texts may be harder for many South Africans, who are second or third language speakers, to comprehend. All of the readability tests take into account the number of syllables or characters per word and sentence length. Thus, the readability consensus suggests that the vocabulary in the text is lengthy, complex, and/or dense, and that the sentences are too long or too convoluted for an average person to easily digest.

It is also important to note that long words such as 'classified', 'recycling', 'materials' and 'imaginary' are equated to words such as 'arthropoda', 'distillation', 'conduction' and 'obliquely' in terms of complexity. This is problematic, as it merely counts the number of syllables and characters each word has, rather than taking into consideration the meaning of the words and whether or not they form part of everyday vocabulary. However, the test does reveal that the vocabulary in the text might be unnecessarily complex in places.

Unfortunately, the tests also do not take into consideration the fact that full stops have been omitted throughout each of the texts. This means that the readability checker 'reads' the text as one long sentence, rather than as a bulleted list, which affects the results of the tests. To address this potential misreading, I inserted the necessary punctuation (full stops, commas, colons, etc.) into the text and tested the readability again. The readability consensus that was reached this time appears in Table 20 (overleaf).

Table 20: New readability consensus

Readability consensus
Term 1: **Grade level:**14 **Reading level:** Difficult to read **Reader's age:** 21-22 yrs old (College level) (ReadabilityFormulas.com, 2018)
Term 2: **Grade level:** 14 **Reading level:** Very difficult to read **Reader's age:** 21-22 yrs old (College level) (ReadabilityFormulas.com, 2018)
Term 3: **Grade level:** 11 **Reading level:** Difficult to read **Reader's age:** 15-17 yrs old (Tenth to Eleventh graders) (ReadabilityFormulas.com, 2018)
Term 4: **Grade level:** 9 **Reader's level:** Standard/average **Reader's age:** 13-15 yrs old (Eighth and Ninth graders) (ReadabilityFormulas.com, 2018)

Although the grade level for each text had reduced markedly, the results still suggest that vocabulary and sentence structure are a challenge in the samples from Term 1 and Term 2. These two texts' scores are still very high and indicate that there is room to modify the communication in these samples. Term 3's consensus is far more reasonable and falls within the accepted grade level for the study, but the text is still reflected as 'Difficult to read', suggesting that there is also room for modification in this text. However, Term 4's consensus suggests that the lack of punctuation had a far greater impact on this text's readability than it had on the others. The text is now revealed to be of a suitable reading level, and should be understandable to the target audience for this text.

A closer look at the texts for their compliance to the revised plain language criteria had to be done next in order to establish whether or not the texts subscribe to these criteria.

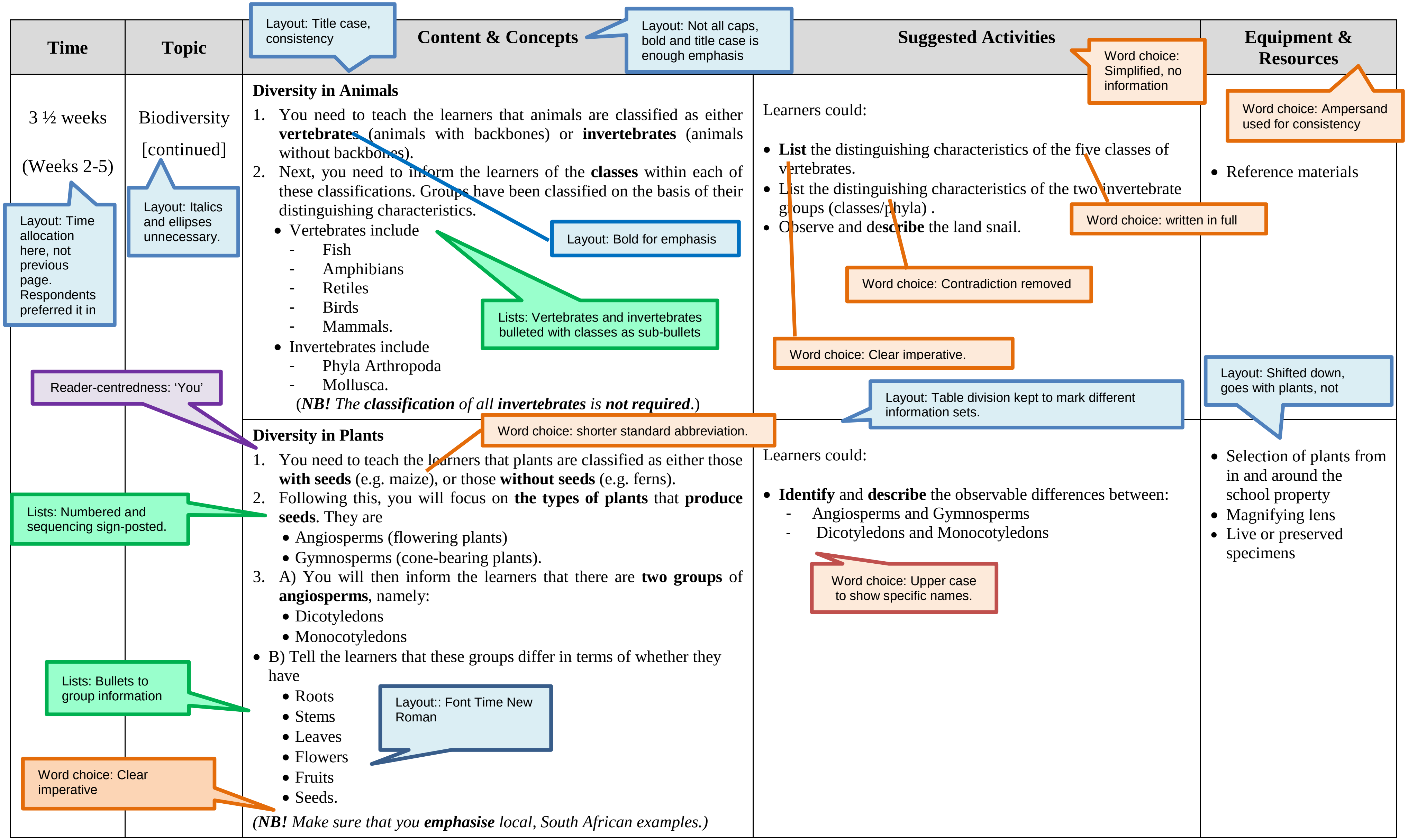
Because all of the samples have been written in a similar style and format, the texts are discussed together in Table 21.

Table 21: Compliance with plain language criteria

Plain language criteria	Appearance in the text
An average sentence length of 15-25 words	The readability tests revealed that part of the problem with the original sample texts is a lack of punctuation. Because of this, these texts were 'read' as one long sentence. Once the correct punctuation was put into these texts, the readability improved. But the results still suggested that sentence length was a potential problem in Term 1, Term 2, and Term 3's samples. When I manually analysed these samples, the sentence length was reasonable and this was not deemed to be an area for correction.
Focused paragraphs and lists	Each text is written in the form of a bulleted list, but these bullets differ in length and purpose (some bullets should be individual sentences). Platform statements have not been included, but these would help to navigate the reader, so they should be added. There are no set paragraphs in the texts and the bullets have not been effectively used, as the order of information is not always clear. For example, in the first term the classification of vertebrates and invertebrates appears in the same list as the subdivisions of vertebrates and invertebrates. Lists are normally used to break down information and to group pieces of information together for the reader. Thus, these lists should be adapted to perform both of these functions by adding numbers and bullets to signpost information.
Word choice	The readability tests suggest that the vocabulary is unnecessarily dense, particularly in Term 1, Term 2, and Term 3's samples. But, since the learners are being introduced to certain key scientific concepts, some of the dense vocabulary is necessary. A glossary that describes complex terms should be included to help the reader.
Favour the active voice	The texts have been written primarily in the active voice, and there is no clear indication that the passive voice is a problem in these texts.
Audience, register, and tone	These texts have been written to inform Grade 7 Natural Science teachers of the content they should teach. However, the style is slightly ambiguous as it lists information without a clear indication of what the audience should do with this information (P1 complained about this issue in the interview). This is remedied through reader-centredness.

Plain language criteria	Appearance in the text
	The register is formal, as it should be. The tone is neutral and 'confident', which is ideal as the reader should be certain of the facts being presented to her/him.
Non-sexist/biased language	Personal pronouns have been omitted throughout the texts, and the information is factually presented; there is no indication of sexism or bias in the language, but pronouns that address the reader should be added.
Reader-centred structure	These text samples do not address the reader at all. This style of writing would serve a purpose here as the reader needs to be certain of what s/he should be teaching the learners, e.g. 'You need to focus on…' This addition would help to direct the reader (clear indication of what the teacher should do), and these are gender-neutral pronouns, so no one is excluded from the text.
Clear layout	The information has been presented in a table for the reader. This is a good layout for the information that is being presented, but the information in each column does not always align correctly with the matching information in the column alongside it. Therefore, this format can be modified for the reader. Furthermore, the information has been broken down into bullets for the reader, which helps the reader to digest information. The layout could be clearer in terms of the subdivision and grouping of information. Headings should be more consistent and written in either sentence or title case, not a mix between the two.
Use alternatives to words	The information in each text has been presented in a table, which is good for this type of information. Graphic presentations would not be useful here as they would make the text too 'busy' and defeat the purpose of the text, which is for the teacher to get a brief overview of the content that needs to be taught.
Quality of content	The teacher should be able to comprehend what s/he should cover each week based on the information provided. Comprehension would improve with glossaries for complex terms (consider word choice).

Each text sample was revised in accordance with the arguments made above. Comments have been included in speech bubbles on the revision so that it is easy to see the changes that have been made. Most changes are reflected on the first revision, because many of these changes applied to all of the samples. Figure 2 (overleaf) and Figure 3 (p. 119) present the revised text and glossary for Term 1.



Time	Topic	Content & Concepts	Suggested Activities	Equipment & Resources
3 ½ weeks (Weeks 2-5)	Biodiversity [continued]	**Diversity in Animals** 1. You need to teach the learners that animals are classified as either **vertebrates** (animals with backbones) or **invertebrates** (animals without backbones). 2. Next, you need to inform the learners of the **classes** within each of these classifications. Groups have been classified on the basis of their distinguishing characteristics. • Vertebrates include - Fish - Amphibians - Retiles - Birds - Mammals. • Invertebrates include - Phyla Arthropoda - Mollusca. (***NB!*** *The* ***classification*** *of all* ***invertebrates*** *is* ***not required***.)	Learners could: • **List** the distinguishing characteristics of the five classes of vertebrates. • List the distinguishing characteristics of the two invertebrate groups (classes/phyla) . • Observe and des**cribe** the land snail.	• Reference materials
		Diversity in Plants 1. You need to teach the learners that plants are classified as either those **with seeds** (e.g. maize), or those **without seeds** (e.g. ferns). 2. Following this, you will focus on **the types of plants** that **produce seeds**. They are • Angiosperms (flowering plants) • Gymnosperms (cone-bearing plants). 3. A) You will then inform the learners that there are **two groups** of **angiosperms**, namely: • Dicotyledons • Monocotyledons • B) Tell the learners that these groups differ in terms of whether they have • Roots • Stems • Leaves • Flowers • Fruits • Seeds. (***NB!*** *Make sure that you* ***emphasise*** *local, South African examples.*)	Learners could: • **Identify** and **describe** the observable differences between: - Angiosperms and Gymnosperms - Dicotyledons and Monocotyledons	• Selection of plants from in and around the school property • Magnifying lens • Live or preserved specimens

Layout: Title case, consistency

Layout: Not all caps, bold and title case is enough emphasis

Word choice: Simplified, no information

Word choice: Ampersand used for consistency

Layout: Time allocation here, not previous page. Respondents preferred it in

Layout: Italics and ellipses unnecessary.

Layout: Bold for emphasis

Word choice: written in full

Word choice: Contradiction removed

Lists: Vertebrates and invertebrates bulleted with classes as sub-bullets

Word choice: Clear imperative.

Reader-centredness: 'You'

Layout: Table division kept to mark different information sets.

Layout: Shifted down, goes with plants, not

Word choice: shorter standard abbreviation.

Lists: Numbered and sequencing sign-posted.

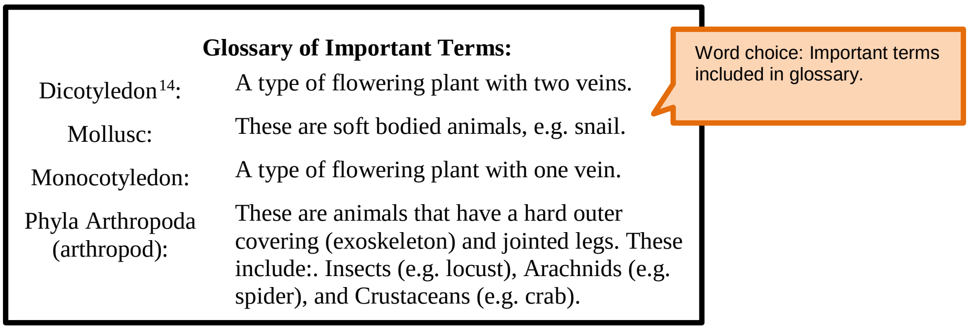
Word choice: Upper case to show specific names.

Lists: Bullets to group information

Layout:: Font Time New Roman

Word choice: Clear imperative

Figure 2: Plain English revision – Term 1a



Glossary of Important Terms:

Dicotyledon[14]:	A type of flowering plant with two veins.
Mollusc:	These are soft bodied animals, e.g. snail.
Monocotyledon:	A type of flowering plant with one vein.
Phyla Arthropoda (arthropod):	These are animals that have a hard outer covering (exoskeleton) and jointed legs. These include:. Insects (e.g. locust), Arachnids (e.g. spider), and Crustaceans (e.g. crab).

Word choice: Important terms included in glossary.

Figure 3: Plain English revision – Term 1b

The revised text was put through the readability checker to test if the plain language strategies affected the text's readability score. The original readability score and the revised original readability score have been included for the purposes of comparison. This score is presented in Table 22.

Table 22: Revised readability score – Term 1

Readability test results			
Flesch Reading Ease score: 61.7 (standard/average) **Gunning Fog:** 6.5 (fairly easy to read) **Flesch-Kincaid Grade Level:** 6.6 (Seventh Grade) **The Coleman-Liau Index:** 13 (college) **The SMOG Index:** 6.7 (Seventh Grade) **Automated Readability Index:** 6.9 (11-13 yrs old/Sixth and Seventh graders) **Linsear Write Formula:** 4.1 (Fourth Grade)			
Readability consensus			
Reading levels	**Original text**	**Revised original**	**Plain language**
Grade level	66	14	8
Reading level	Impossible to comprehend	Difficult to read	Standard/average
Reader's age	College graduate	College level	12-14 yrs old

(ReadabilityFormulas.com, 2018)

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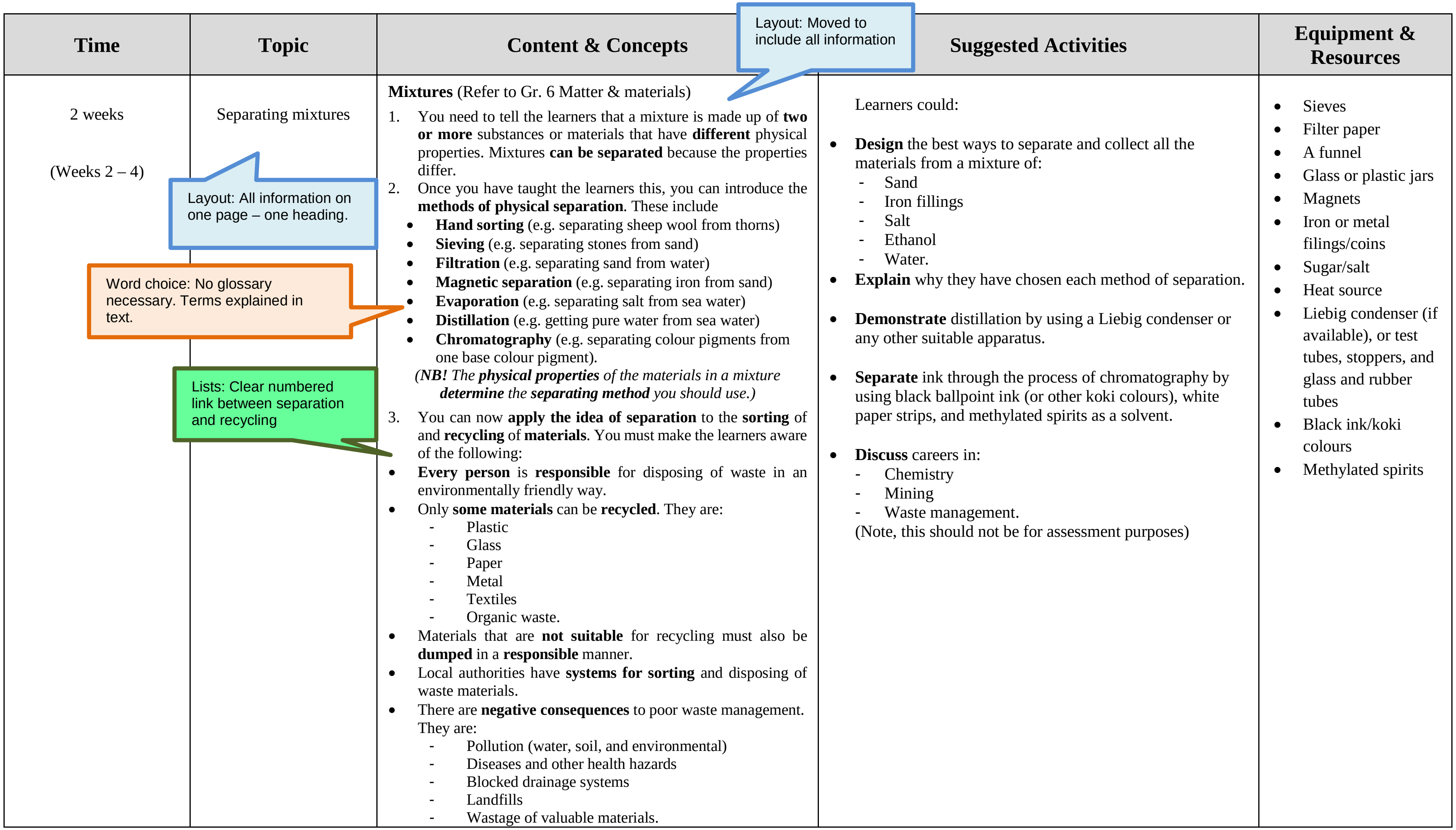
[14] Definitions for Dicotyledon and Monocotyledon were not in the original text. These are basic definitions that were included for demonstration purposes only. These definitions come from: Holganix Blog (2018).

The plain language revisions have significantly influenced the text’s readability score. The readability consensus for the original text stated that the text was ‘Impossible to comprehend’ and suitable for a ‘College graduate’. The revised original text also scored a very high readability consensus because of the text’s structure. Now, the text is presented as ‘Standard/average’ and suitable for 12-14 year olds. Although there are limitations to these results (discussed in Section 3.8), these results suggest that the plain language criteria have been applied effectively to the text and could have a significant impact on the reader’s ability to comprehend information upon first reading.

Figure 4 (overleaf) presents the plain language version of Term 2’s sample text.



Layout: Moved to include all information

Layout: All information on one page – one heading.

Word choice: No glossary necessary. Terms explained in text.

Lists: Clear numbered link between separation and recycling

Time	Topic	Content & Concepts	Suggested Activities	Equipment & Resources
2 weeks (Weeks 2 – 4)	Separating mixtures	**Mixtures** (Refer to Gr. 6 Matter & materials) 1. You need to tell the learners that a mixture is made up of **two or more** substances or materials that have **different** physical properties. Mixtures **can be separated** because the properties differ. 2. Once you have taught the learners this, you can introduce the **methods of physical separation**. These include • **Hand sorting** (e.g. separating sheep wool from thorns) • **Sieving** (e.g. separating stones from sand) • **Filtration** (e.g. separating sand from water) • **Magnetic separation** (e.g. separating iron from sand) • **Evaporation** (e.g. separating salt from sea water) • **Distillation** (e.g. getting pure water from sea water) • **Chromatography** (e.g. separating colour pigments from one base colour pigment). *(**NB!** The **physical properties** of the materials in a mixture **determine** the **separating method** you should use.)* 3. You can now **apply the idea of separation** to the **sorting** of and **recycling** of **materials**. You must make the learners aware of the following: • **Every person** is **responsible** for disposing of waste in an environmentally friendly way. • Only **some materials** can be **recycled**. They are: - Plastic - Glass - Paper - Metal - Textiles - Organic waste. • Materials that are **not suitable** for recycling must also be **dumped** in a **responsible** manner. • Local authorities have **systems for sorting** and disposing of waste materials. • There are **negative consequences** to poor waste management. They are: - Pollution (water, soil, and environmental) - Diseases and other health hazards - Blocked drainage systems - Landfills - Wastage of valuable materials.	Learners could: • **Design** the best ways to separate and collect all the materials from a mixture of: - Sand - Iron fillings - Salt - Ethanol - Water. • **Explain** why they have chosen each method of separation. • **Demonstrate** distillation by using a Liebig condenser or any other suitable apparatus. • **Separate** ink through the process of chromatography by using black ballpoint ink (or other koki colours), white paper strips, and methylated spirits as a solvent. • **Discuss** careers in: - Chemistry - Mining - Waste management. (Note, this should not be for assessment purposes)	• Sieves • Filter paper • A funnel • Glass or plastic jars • Magnets • Iron or metal filings/coins • Sugar/salt • Heat source • Liebig condenser (if available), or test tubes, stoppers, and glass and rubber tubes • Black ink/koki colours • Methylated spirits

Figure 4: Plain English revision – Term 2

The revised text was again put through the readability checker to test if the plain language strategies impacted the text's readability score. The original readability score and the revised original readability score have been included for the purposes of comparison. This score is presented in Table 23.

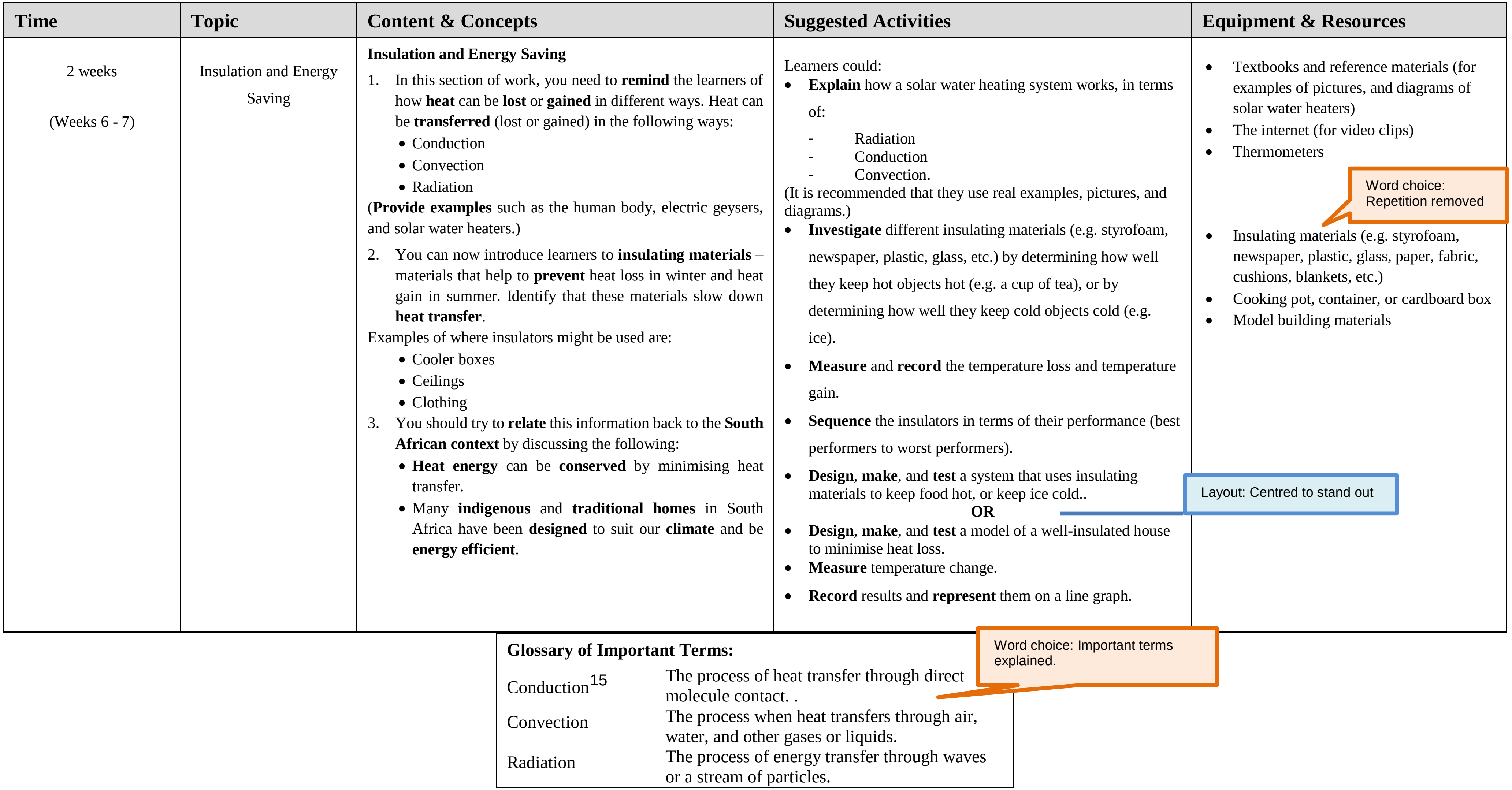
Table 23: Revised readability score – Term 2

Readability test results			
Flesch Reading Ease score: 48.4 (difficult to read) **Gunning Fog:** 9.8 (fairly easy to read) **Flesch-Kincaid Grade Level:** 8.4 (Eighth Grade) **The Coleman-Liau Index:** 12 (Twelfth Grade) **The SMOG Index:** 7.4 (Seventh Grade) **Automated Readability Index:** 6.5 (11-13 yrs old/Sixth and Seventh graders) **Linsear Write Formula:** 4.4 (Fourth Grade)			
Readability consensus			
Reading levels	**Original text**	**Revised original**	**Plain language**
Grade level	28	14	8
Reading level	Impossible to comprehend	Very difficult to read	Difficult to read
Reader's age	College graduate	College level	12 -14 yrs old

(ReadabilityFormulas.com, 2018)

Again, the plain language revisions have significantly altered the text's readability score. The readability consensus for the original text stated that the text was 'Impossible to comprehend' and suitable for a 'College graduate'. With the correct punctuation, the original text was upgraded to 'Very difficult to read' and accessible at a 'College level', suggesting that the text could be further modified. Now, the text is presented as 'Difficult to read' but suitable for 12-14 year olds. Even though the text is still presented as a challenge to read, the large grade and age discrepancies between these results and the initial results indicate that significant modifications to the sentence structure and the vocabulary have been made. Therefore, these results suggest that the plain language criteria have been applied to the text effectively.

The plain language revision of Term 3's sample is depicted in Figure 5 (overleaf).



Time	Topic	Content & Concepts	Suggested Activities	Equipment & Resources
2 weeks (Weeks 6 - 7)	Insulation and Energy Saving	**Insulation and Energy Saving** 1. In this section of work, you need to **remind** the learners of how **heat** can be **lost** or **gained** in different ways. Heat can be **transferred** (lost or gained) in the following ways: • Conduction • Convection • Radiation (**Provide examples** such as the human body, electric geysers, and solar water heaters.) 2. You can now introduce learners to **insulating materials** – materials that help to **prevent** heat loss in winter and heat gain in summer. Identify that these materials slow down **heat transfer**. Examples of where insulators might be used are: • Cooler boxes • Ceilings • Clothing 3. You should try to **relate** this information back to the **South African context** by discussing the following: • **Heat energy** can be **conserved** by minimising heat transfer. • Many **indigenous** and **traditional homes** in South Africa have been **designed** to suit our **climate** and be **energy efficient**.	Learners could: • **Explain** how a solar water heating system works, in terms of: - Radiation - Conduction - Convection. (It is recommended that they use real examples, pictures, and diagrams.) • **Investigate** different insulating materials (e.g. styrofoam, newspaper, plastic, glass, etc.) by determining how well they keep hot objects hot (e.g. a cup of tea), or by determining how well they keep cold objects cold (e.g. ice). • **Measure** and **record** the temperature loss and temperature gain. • **Sequence** the insulators in terms of their performance (best performers to worst performers). • **Design**, **make**, and **test** a system that uses insulating materials to keep food hot, or keep ice cold.. **OR** • **Design**, **make**, and **test** a model of a well-insulated house to minimise heat loss. • **Measure** temperature change. • **Record** results and **represent** them on a line graph.	• Textbooks and reference materials (for examples of pictures, and diagrams of solar water heaters) • The internet (for video clips) • Thermometers • Insulating materials (e.g. styrofoam, newspaper, plastic, glass, paper, fabric, cushions, blankets, etc.) • Cooking pot, container, or cardboard box • Model building materials

Word choice: Repetition removed

Layout: Centred to stand out

Word choice: Important terms explained.

Glossary of Important Terms:

Conduction[15]	The process of heat transfer through direct molecule contact. .
Convection	The process when heat transfers through air, water, and other gases or liquids.
Radiation	The process of energy transfer through waves or a stream of particles.

Figure 5: Plain English revision –Term 3

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[15] These definitions were not in the original text. These are basic definitions that were included for demonstration purposes only. These definitions come from: Gonzalez (2015).

As with the previous examples, the revised text was put through the readability checker to test if the plain language strategies that have been applied to the text have altered the readability score. The original readability score and the revised original readability score have been included for the purposes of comparison. The results are presented in Table 24.

Table 24: Revised readability score – Term 3

Readability test results			
Flesch Reading Ease score: 51.4 (fairly difficult to read) **Gunning Fog:** 12 (hard to read) **Flesch-Kincaid Grade Level:** 10.1 (Tenth Grade) **The Coleman-Liau Index:** 11 (Eleventh Grade) **The SMOG Index:** 10.1 (Tenth Grade) **Automated Readability Index:** 9.8 (14-15 yrs old/Ninth to Tenth graders) **Linsear Write Formula:** 11 (Eleventh Grade)			
Readability consensus			
Reading levels	**Original text**	**Revised original**	**Plain language**
Grade level	30	11	10
Reading level	Impossible to comprehend	Difficult to read	Fairly difficult to read
Reader's age	College graduate	15-17 yrs old	14-15 yrs old

(ReadabilityFormulas.com, 2018)

The original text was deemed 'Impossible to comprehend', but once the correct punctuation was put in, the text's readability score improved considerably. However, it was decided that this score could be improved by applying the plain language criteria to the text. This did not improve the readability score by much, but there is a slight difference. Where the text was initially 'Difficult to read', it is now only 'Fairly difficult to read', and suitable for 14-15 year olds as opposed to 15-17 year olds. The problem with this particular sample is the vocabulary had to remain somewhat dense because of the nature of the content. Therefore, the text's readability score could not improve by much. An effort to present the text in a clearer way has been made and the plain language score does suggest that teachers should find the revised text more accessible than the original.

Figure 6 (overleaf) depicts the revised text for Term 4.

Time	Topic	Content & Concepts	Suggested Activities	Equipment & Resources
4 weeks (Weeks 1 - 4)	Relationship between the Earth and the Sun	**Solar Energy and the Earth's Seasons** 1. You need to **identify** what **solar energy** is to the learners by mentioning the following: • The **Sun radiates heat** and **light** in all directions. • The **Earth receives** this **heat** and **light**, and we term this **solar energy**. 2. Now that the learners know where solar energy comes from, you can describe why the **Earth** has **four seasons** by identifying the following: • The Earth **spins** on its **axis** once per day. • The axis is an **imaginary line** that goes through the **centre** of the Earth (North Pole to South Pole). • The Earth's axis is **not vertical**, which means that the Earth **tilts** at an angle of 23,5˚. • This tilt is **unchanging** as we orbit the Sun. • Because of this tilt, different parts of the Earth get **different levels of solar energy** (amount per unit area) at **different times** of the year. • These **different intensities** of solar energy that reach the northern and southern hemispheres throughout the year lead to the **four seasons**. • When the **solar energy falls more directly** (spread across a smaller area) on the southern hemisphere, we get **summer** and the northern hemisphere gets winter. • When the **solar energy falls less directly** (spread over a wider area) on the southern hemisphere, we get **winter** and the northern hemisphere gets summer. • **Solar energy** not only affects heat, it also affects **light**. Thus, **days are longer** in **summer** due to the Earth's tilt. 3. You can now identify how solar energy also affects **life on Earth** by pointing out the following: • Plants **absorb** solar energy (light), which makes them an energy-containing food. • All plants and animals **depend** on this for energy. • Solar energy **sustains** life on Earth.	Learners could: • **Make** a model of the Earth by using a ball. The model could show the: - North and south poles - The equator - The northern and southern hemispheres. • **Demonstrate** the passage of the Earth around the Sun. For example, one learner can hold a torch, which represents the Sun, and another learner can carry the globe at its tilt. • **Draw** and **label** diagrams that show the tilt of the Earth and the direct and oblique rays of sunlight energy that cause the four seasons.	• Textbooks and reference materials • A ball or globe • A torch • The internet (for pictures and videos of the Sun, Earth's passage around the Sun, solar energy reaching different parts of Earth, and the formation of coal, oil, and gas from the Sun) Layout: Smaller bullets removed and no repetition of terms/

Lists: Clearer sign-posting

Figure 6: Plain English revision – Term 4

Once again, the revised text was put through the readability checker to test if the plain language strategies that have been applied to the text have altered the readability score. The original readability score and the revised original readability score have been included for the purposes of comparison. The results are presented in Table 25.

Table 25: Revised readability score – Term 4

Readability test results			
Flesch Reading Ease score: 62.8 (standard/average **Gunning Fog:** 11.8 (hard to read) **Flesch-Kincaid Grade Level:** 8.4 (Eighth Grade) **The Coleman-Liau Index:** 9 (Ninth Grade) **The SMOG Index:** 8.7 (Ninth Grade) **Automated Readability Index:** 8 (12-14 yrs old/Seventh and Eighth graders) **Linsear Write Formula:** 9.1 (Ninth Grade)			
Readability consensus			
Reading levels	**Original text**	**Revised original**	**Plain language**
Grade level	48	9	9
Reading level	Impossible to comprehend	Standard/average	Standard/average
Reader's age	College graduate	15-17 yrs old	13-15 yrs old

(ReadabilityFormulas.com, 2018)

The original text was deemed 'Impossible to comprehend' but with the correct punctuation, the text's readability score improved. This sample showed the most significant improvement after this revision. Plain language revisions were done on the text to see if the readability consensus could improve even further (even though it did not require an improvement). The plain language readability consensus was similar to the revised original text's consensus, suggesting that the plain language revisions did not significantly change the readability and comprehensibility of this text.

5.3.2 *CAPS* revision: discussion

The most significant revisions to each of the sample texts pertained to listing information, word choice, layout and creating a reader-centred structure. When platform statements are added and the information is sign-posted more clearly, readers are able to navigate the document more seamlessly and get a better sense of the groups and divisions of information. I provided alternative word choices where necessary, and included glossaries to explain important but challenging words for Term 1 and Term 3. The reader-centred structure gives readers a better sense of what they should be doing with the learners, rather than simply implying what should be done. The existing table layout serves this information well, but the improvements to the headings and alignment of information makes the document even more accessible and navigable. The font was changed to Times New Roman because the font was small and this was determined to be a clear font in size 9 text.

Six of the teachers who were interviewed preferred the revised weekly indication (stating the week as opposed to indicating how long it would take), but three did not like it, so I decided to include both timelines, because the text still looked presentable and it gives a better indication of timelines. This way it is clear how long it will take to cover the work and when it should be done.

Although there are limitations to readability tests, a comparison between the original score and the plain language score for each sample suggests that plain language does influence the readability of a text. Overall, these results were pleasing and indicated that modifications to a text, without changing the content, can significantly affect readers' access to important information.

5.4 TEACHER GUIDES FOR ANALYSIS

Spot On Natural Sciences for Grade 8 and *Platinum Natural Sciences* for Grade 9 were selected for analysis (I used the learner and teacher guides for both). Because the interviews gave no clear indication of which documents are used most frequently and which work is most challenging, ten random samples from each of the texts were put through the readability checker. Four samples from each set (two from the learner guide and two matching samples from the teacher guide) were selected for analysis based on these results. Selections from Term 1 and Term 2 were analysed from the *Spot On* series and selections for Term 3 and Term 4 were analysed from the *Platinum* series. The results appear in the two subsections below.

5.4.1 *Spot On Natural Sciences* Grade 8

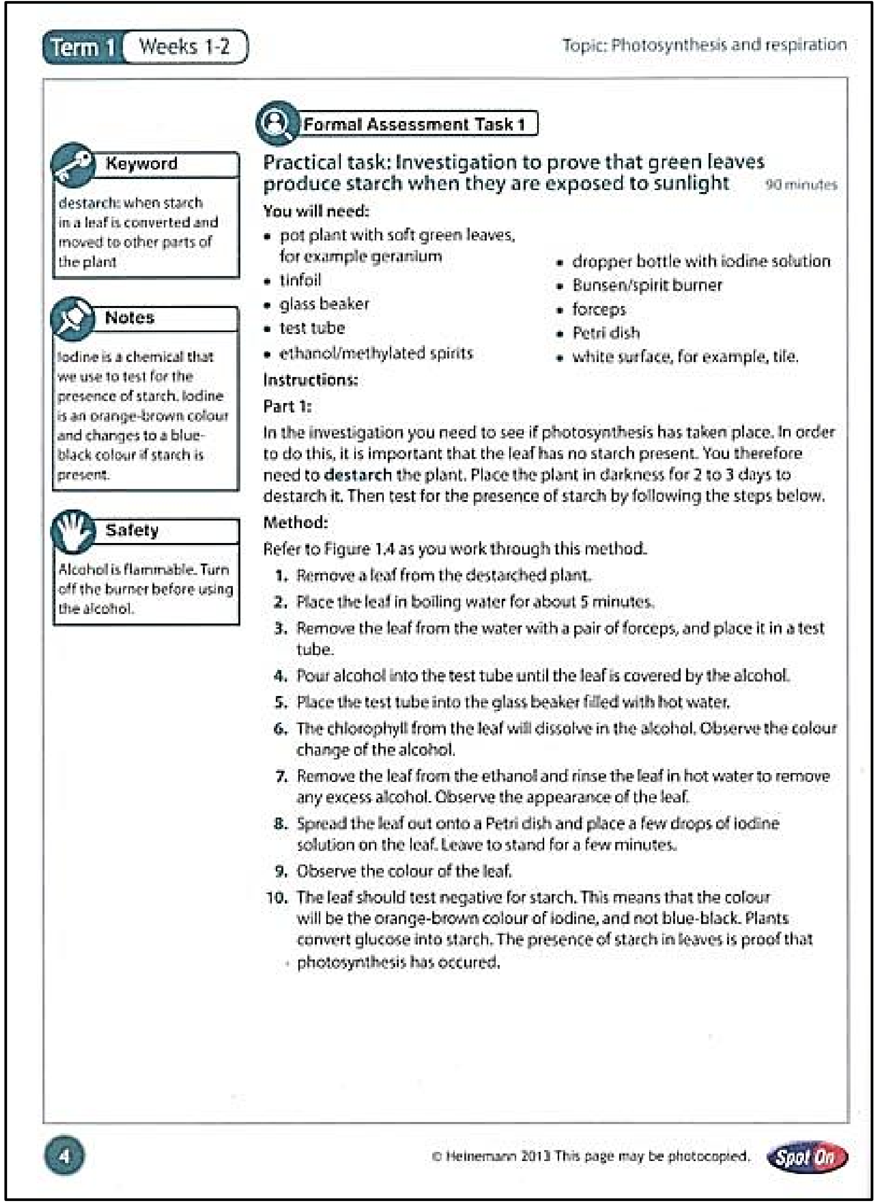
The teacher and learner guides function as a set. Matching samples from each term were put through the readability checker in order to see how well they comply (or do not comply) with the plain language criteria selected for the study. The readability test results came out similarly across the board, so, as stated previously, matching sections from the teacher and learner guides for Term 1 and Term 2 were selected to demonstrate the results.

Table 26 (overleaf) depicts the sample text for Term 1 from the *Spot On Natural Sciences* learner guide (Vermaak *et al*., 2013:4-5), the readability test results, and the readability consensus and Table 27 (pp. 131-132) depicts the matching sample text from the teacher guide (Vermaak *et al*., 2017:46-48), with its readability test results, and the readability consensus.

Table 28 (pp. 133-134) depicts the sample text for Term 2 from the *Spot On Natural Sciences* learner guide (Vermaak *et al*., 2013:50-52), the results of the readability tests, and the readability consensus, and Table 29 (pp. 135-136) shows the sample text for Term 2 from the learner guide (Vermaak *et al*., 2017:106-107), with its readability test results, and the readability consensus.

Table 26: Original text and readability test results (Term 1 learner guide)

Original text



Term 1 Weeks 1-2

Topic: Photosynthesis and respiration

Keyword

destarch: when starch in a leaf is converted and moved to other parts of the plant

Notes

Iodine is a chemical that we use to test for the presence of starch. Iodine is an orange-brown colour and changes to a blue-black colour if starch is present.

Safety

Alcohol is flammable. Turn off the burner before using the alcohol.

Formal Assessment Task 1

Practical task: Investigation to prove that green leaves produce starch when they are exposed to sunlight

90 minutes

You will need:

- pot plant with soft green leaves, for example geranium
- tinfoil
- glass beaker
- test tube
- ethanol/methylated spirits
- dropper bottle with iodine solution
- Bunsen/spirit burner
- forceps
- Petri dish
- white surface, for example, tile.

Instructions:

Part 1:

In the investigation you need to see if photosynthesis has taken place. In order to do this, it is important that the leaf has no starch present. You therefore need to **destarch** the plant. Place the plant in darkness for 2 to 3 days to destarch it. Then test for the presence of starch by following the steps below.

Method:

Refer to Figure 1.4 as you work through this method.

1. Remove a leaf from the destarched plant.
2. Place the leaf in boiling water for about 5 minutes.
3. Remove the leaf from the water with a pair of forceps, and place it in a test tube.
4. Pour alcohol into the test tube until the leaf is covered by the alcohol.
5. Place the test tube into the glass beaker filled with hot water.
6. The chlorophyll from the leaf will dissolve in the alcohol. Observe the colour change of the alcohol.
7. Remove the leaf from the ethanol and rinse the leaf in hot water to remove any excess alcohol. Observe the appearance of the leaf.
8. Spread the leaf out onto a Petri dish and place a few drops of iodine solution on the leaf. Leave to stand for a few minutes.
9. Observe the colour of the leaf.
10. The leaf should test negative for starch. This means that the colour will be the orange-brown colour of iodine, and not blue-black. Plants convert glucose into starch. The presence of starch in leaves is proof that photosynthesis has occured.

4

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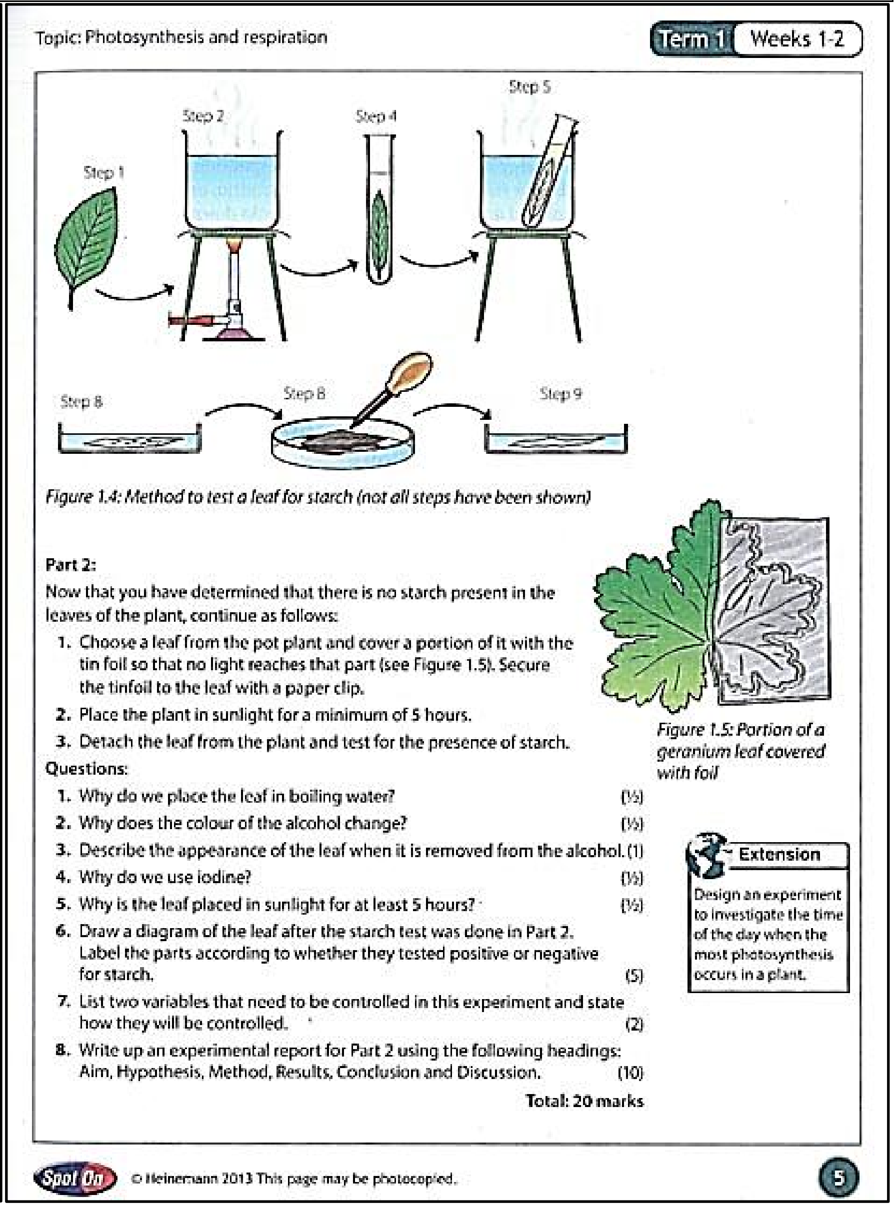
Spot On



Topic: Photosynthesis and respiration

Term 1 Weeks 1-2

Figure 1.4: Method to test a leaf for starch (not all steps have been shown)

Figure 1.5: Portion of a geranium leaf covered with foil

Part 2:

Now that you have determined that there is no starch present in the leaves of the plant, continue as follows:

1. Choose a leaf from the pot plant and cover a portion of it with the tin foil so that no light reaches that part (see Figure 1.5). Secure the tinfoil to the leaf with a paper clip.
2. Place the plant in sunlight for a minimum of 5 hours.
3. Detach the leaf from the plant and test for the presence of starch.

Questions:

1. Why do we place the leaf in boiling water? (½)
2. Why does the colour of the alcohol change? (½)
3. Describe the appearance of the leaf when it is removed from the alcohol. (1)
4. Why do we use iodine? (½)
5. Why is the leaf placed in sunlight for at least 5 hours? (½)
6. Draw a diagram of the leaf after the starch test was done in Part 2. Label the parts according to whether they tested positive or negative for starch. (5)
7. List two variables that need to be controlled in this experiment and state how they will be controlled. (2)
8. Write up an experimental report for Part 2 using the following headings: Aim, Hypothesis, Method, Results, Conclusion and Discussion. (10)

Total: 20 marks

Extension

Design an experiment to investigate the time of the day when the most photosynthesis occurs in a plant.

Spot On

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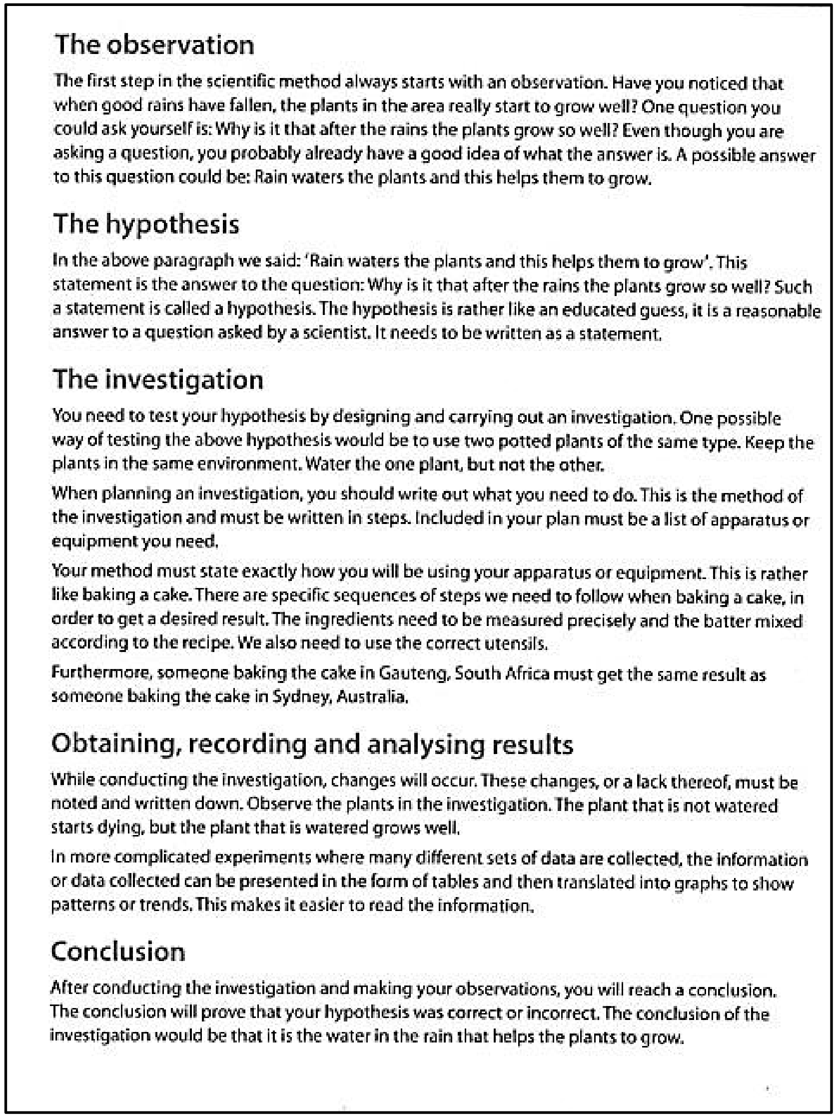
5

Readability test results
Flesch Reading Ease score: 81.7 (easy to read) **Gunning Fog:** 6.6 (fairly easy to read) **Flesch-Kincaid Grade Level:** 4.1 (Fourth Grade) **The Coleman-Liau Index:** 6 (Sixth Grade) **The SMOG Index:** 5.4 (Fifth Grade) **Automated Readability Index:** 2.2 (6-8 yrs old/ First and Second graders) **Linsear Write Formula:** 4.2 (Fourth Grade) (ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 4 **Reading level:** Easy to read **Reader’s age:** 8-9 yrs old (Fourth and Fifth graders) (ReadabilityFormulas.com, 2018)

Table 27: Original text and readability test results (Term 1 teacher guide)

Original text



The observation

The first step in the scientific method always starts with an observation. Have you noticed that when good rains have fallen, the plants in the area really start to grow well? One question you could ask yourself is: Why is it that after the rains the plants grow so well? Even though you are asking a question, you probably already have a good idea of what the answer is. A possible answer to this question could be: Rain waters the plants and this helps them to grow.

The hypothesis

In the above paragraph we said: 'Rain waters the plants and this helps them to grow'. This statement is the answer to the question: Why is it that after the rains the plants grow so well? Such a statement is called a hypothesis. The hypothesis is rather like an educated guess, it is a reasonable answer to a question asked by a scientist. It needs to be written as a statement.

The investigation

You need to test your hypothesis by designing and carrying out an investigation. One possible way of testing the above hypothesis would be to use two potted plants of the same type. Keep the plants in the same environment. Water the one plant, but not the other.

When planning an investigation, you should write out what you need to do. This is the method of the investigation and must be written in steps. Included in your plan must be a list of apparatus or equipment you need.

Your method must state exactly how you will be using your apparatus or equipment. This is rather like baking a cake. There are specific sequences of steps we need to follow when baking a cake, in order to get a desired result. The ingredients need to be measured precisely and the batter mixed according to the recipe. We also need to use the correct utensils.

Furthermore, someone baking the cake in Gauteng, South Africa must get the same result as someone baking the cake in Sydney, Australia.

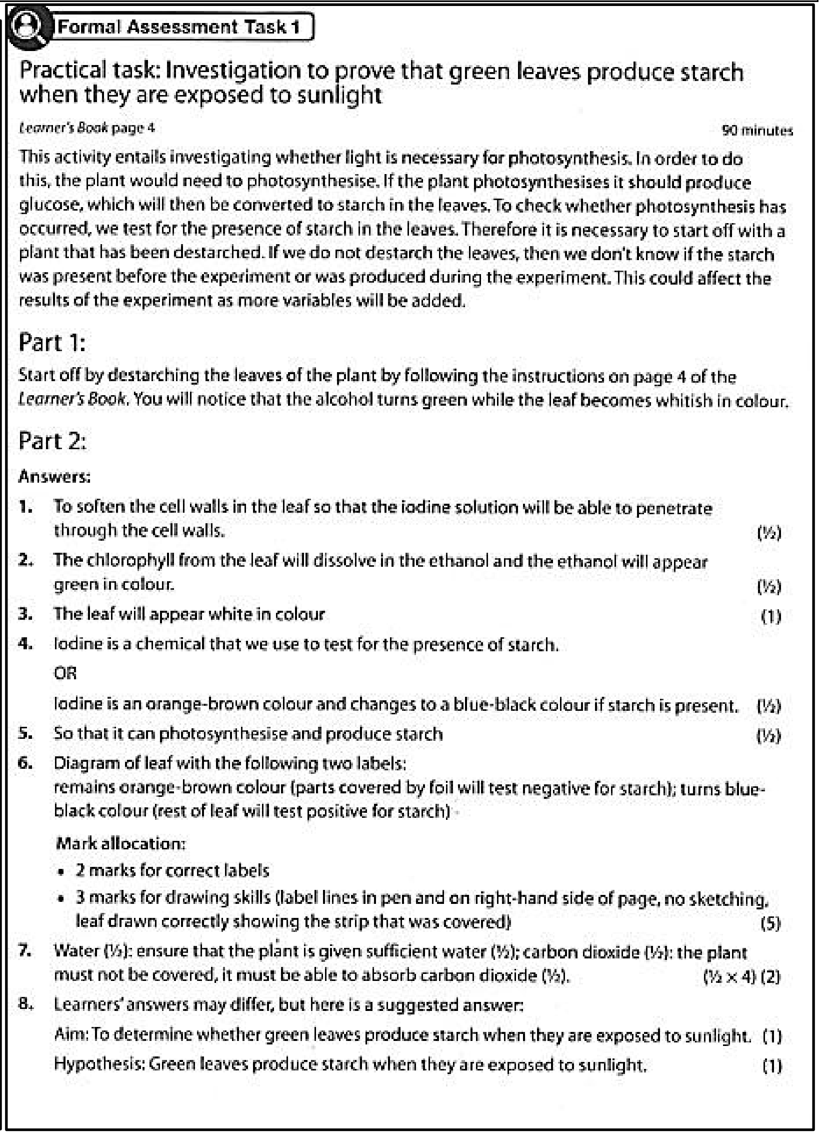
Obtaining, recording and analysing results

While conducting the investigation, changes will occur. These changes, or a lack thereof, must be noted and written down. Observe the plants in the investigation. The plant that is not watered starts dying, but the plant that is watered grows well.

In more complicated experiments where many different sets of data are collected, the information or data collected can be presented in the form of tables and then translated into graphs to show patterns or trends. This makes it easier to read the information.

Conclusion

After conducting the investigation and making your observations, you will reach a conclusion. The conclusion will prove that your hypothesis was correct or incorrect. The conclusion of the investigation would be that it is the water in the rain that helps the plants to grow.



Formal Assessment Task 1

Practical task: Investigation to prove that green leaves produce starch when they are exposed to sunlight

Learner's Book page 4 — 90 minutes

This activity entails investigating whether light is necessary for photosynthesis. In order to do this, the plant would need to photosynthesise. If the plant photosynthesises it should produce glucose, which will then be converted to starch in the leaves. To check whether photosynthesis has occurred, we test for the presence of starch in the leaves. Therefore it is necessary to start off with a plant that has been destarched. If we do not destarch the leaves, then we don't know if the starch was present before the experiment or was produced during the experiment. This could affect the results of the experiment as more variables will be added.

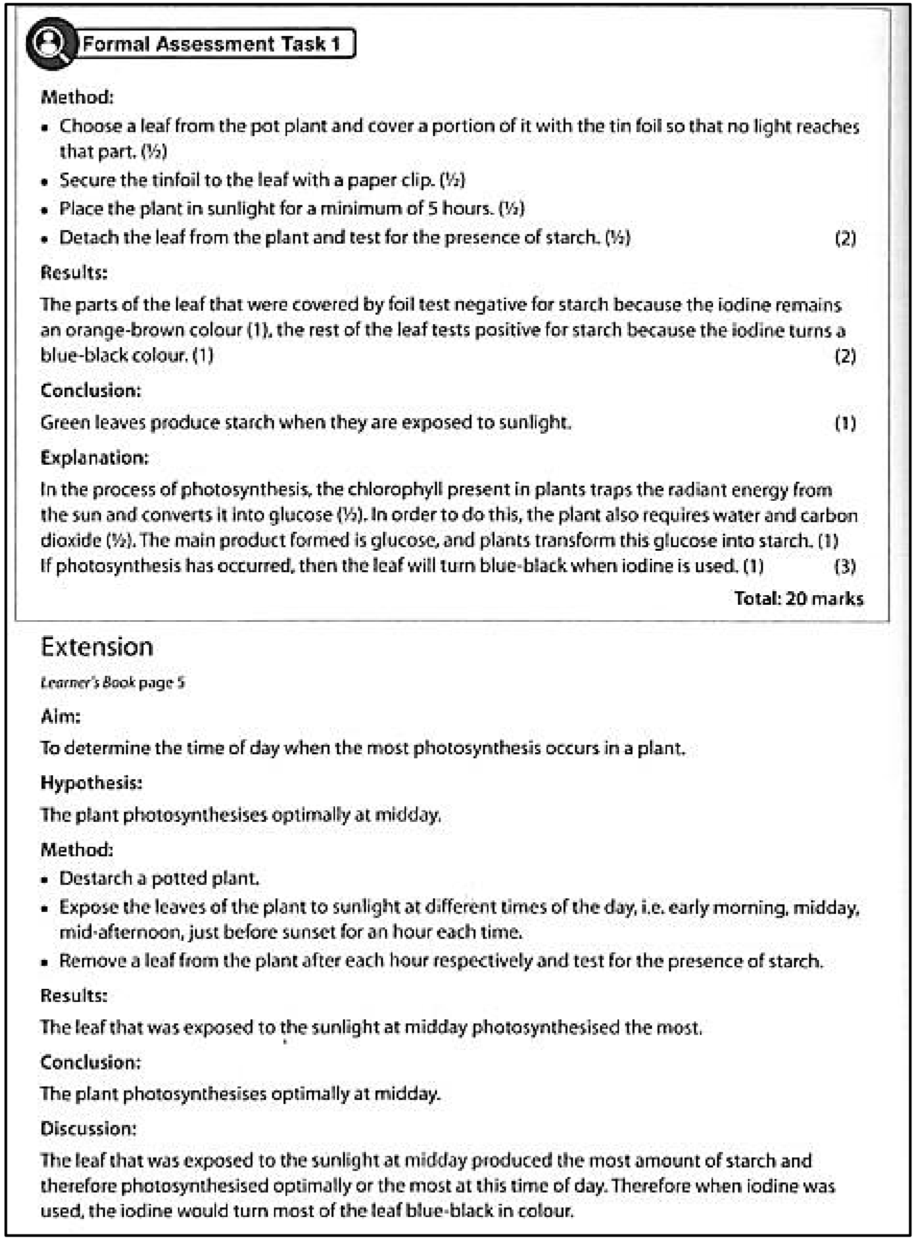
Part 1:

Start off by destarching the leaves of the plant by following the instructions on page 4 of the *Learner's Book*. You will notice that the alcohol turns green while the leaf becomes whitish in colour.

Part 2:

Answers:

1. To soften the cell walls in the leaf so that the iodine solution will be able to penetrate through the cell walls. (½)
2. The chlorophyll from the leaf will dissolve in the ethanol and the ethanol will appear green in colour. (½)
3. The leaf will appear white in colour (1)
4. Iodine is a chemical that we use to test for the presence of starch.
   OR
   Iodine is an orange-brown colour and changes to a blue-black colour if starch is present. (½)
5. So that it can photosynthesise and produce starch (½)
6. Diagram of leaf with the following two labels:
   remains orange-brown colour (parts covered by foil will test negative for starch); turns blue-black colour (rest of leaf will test positive for starch)
   Mark allocation:
   - 2 marks for correct labels
   - 3 marks for drawing skills (label lines in pen and on right-hand side of page, no sketching, leaf drawn correctly showing the strip that was covered) (5)
7. Water (½): ensure that the plant is given sufficient water (½); carbon dioxide (½): the plant must not be covered, it must be able to absorb carbon dioxide (½). (½ × 4) (2)
8. Learners' answers may differ, but here is a suggested answer:
   Aim: To determine whether green leaves produce starch when they are exposed to sunlight. (1)
   Hypothesis: Green leaves produce starch when they are exposed to sunlight. (1)



Formal Assessment Task 1

Method:

- Choose a leaf from the pot plant and cover a portion of it with the tin foil so that no light reaches that part. (½)
- Secure the tinfoil to the leaf with a paper clip. (½)
- Place the plant in sunlight for a minimum of 5 hours. (½)
- Detach the leaf from the plant and test for the presence of starch. (½) (2)

Results:

The parts of the leaf that were covered by foil test negative for starch because the iodine remains an orange-brown colour (1), the rest of the leaf tests positive for starch because the iodine turns a blue-black colour. (1) (2)

Conclusion:

Green leaves produce starch when they are exposed to sunlight. (1)

Explanation:

In the process of photosynthesis, the chlorophyll present in plants traps the radiant energy from the sun and converts it into glucose (½). In order to do this, the plant also requires water and carbon dioxide (½). The main product formed is glucose, and plants transform this glucose into starch. (1) If photosynthesis has occurred, then the leaf will turn blue-black when iodine is used. (1) (3)

Total: 20 marks

Extension

Learner's Book page 5

Aim:

To determine the time of day when the most photosynthesis occurs in a plant.

Hypothesis:

The plant photosynthesises optimally at midday.

Method:

- Destarch a potted plant.
- Expose the leaves of the plant to sunlight at different times of the day, i.e. early morning, midday, mid-afternoon, just before sunset for an hour each time.
- Remove a leaf from the plant after each hour respectively and test for the presence of starch.

Results:

The leaf that was exposed to the sunlight at midday photosynthesised the most.

Conclusion:

The plant photosynthesises optimally at midday.

Discussion:

The leaf that was exposed to the sunlight at midday produced the most amount of starch and therefore photosynthesised optimally or the most at this time of day. Therefore when iodine was used, the iodine would turn most of the leaf blue-black in colour.

Readability test results

Flesch Reading Ease score: 68.1 (standard/average)

Gunning Fog: 10.6 (hard to read)

Flesch-Kincaid Grade Level: 7.6 (Eighth Grade)

The Coleman-Liau Index: 9 (Ninth Grade)

The SMOG Index: 7.9 (Eighth Grade)

Automated Readability Index: 7.5 (12-14 yrs old/ Seventh and Eighth graders)

Linsear Write Formula: 8.6 (Ninth Grade)

(ReadabilityFormulas.com, 2018)

Readability consensus

Grade level: 8

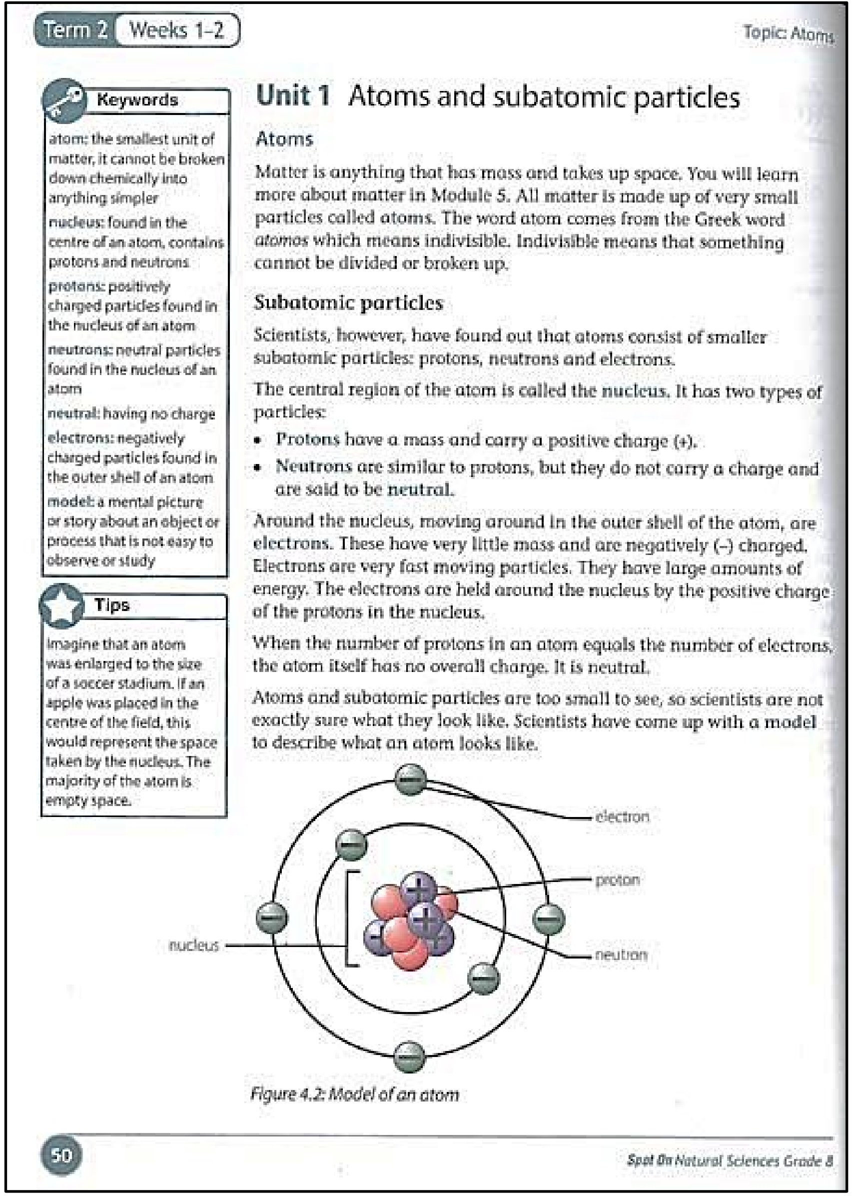
Reading level: standard/ average

Reader's age: 12-14 yrs old (Seventh and Eighth graders)

(ReadabilityFormulas.com, 2018)

Table 28: Original text and readability test results (Term 2 learner guide)

Original text



Keywords

atom: the smallest unit of matter, it cannot be broken down chemically into anything simpler

nucleus: found in the centre of an atom, contains protons and neutrons

protons: positively charged particles found in the nucleus of an atom

neutrons: neutral particles found in the nucleus of an atom

neutral: having no charge

electrons: negatively charged particles found in the outer shell of an atom

model: a mental picture or story about an object or process that is not easy to observe or study

Tips

Imagine that an atom was enlarged to the size of a soccer stadium. If an apple was placed in the centre of the field, this would represent the space taken by the nucleus. The majority of the atom is empty space.

Unit 1 Atoms and subatomic particles

Atoms

Matter is anything that has mass and takes up space. You will learn more about matter in Module 5. All matter is made up of very small particles called atoms. The word atom comes from the Greek word *atomos* which means indivisible. Indivisible means that something cannot be divided or broken up.

Subatomic particles

Scientists, however, have found out that atoms consist of smaller subatomic particles: protons, neutrons and electrons.

The central region of the atom is called the nucleus. It has two types of particles:

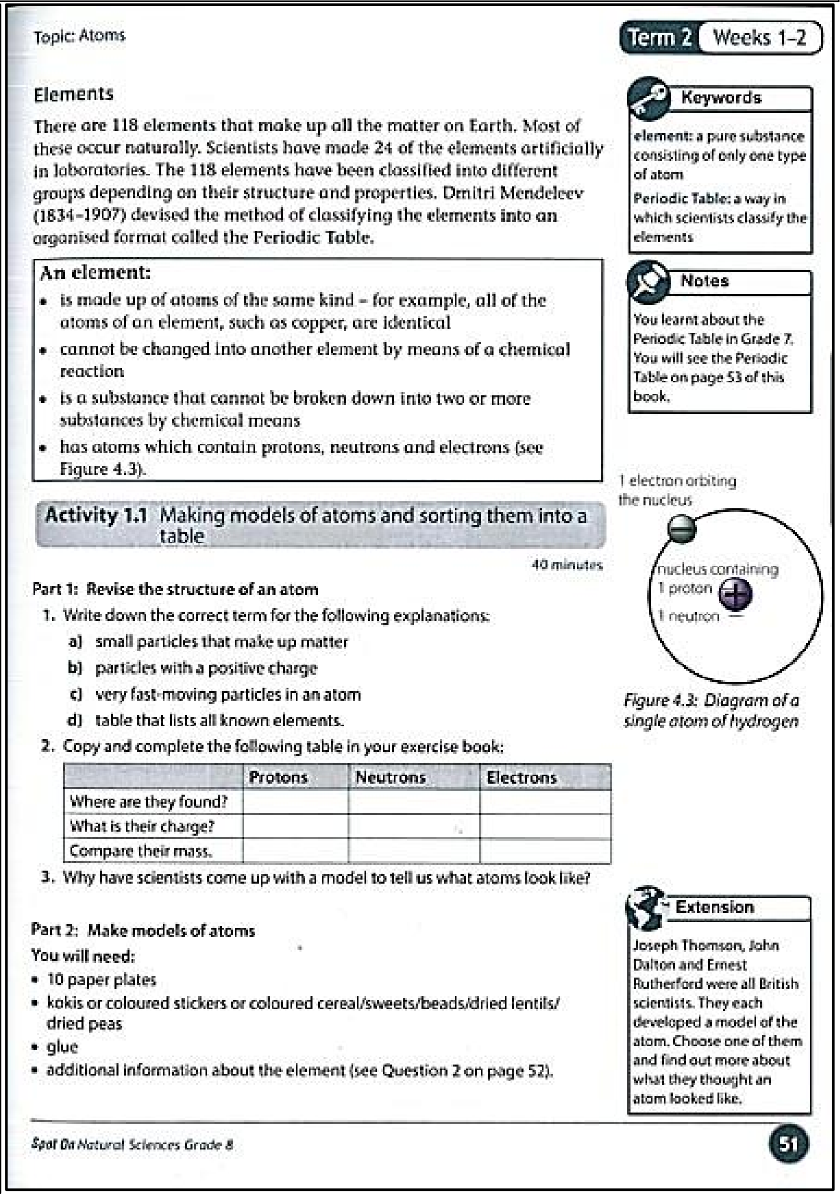
- Protons have a mass and carry a positive charge (+).
- Neutrons are similar to protons, but they do not carry a charge and are said to be neutral.

Around the nucleus, moving around in the outer shell of the atom, are electrons. These have very little mass and are negatively (–) charged. Electrons are very fast moving particles. They have large amounts of energy. The electrons are held around the nucleus by the positive charge of the protons in the nucleus.

When the number of protons in an atom equals the number of electrons, the atom itself has no overall charge. It is neutral.

Atoms and subatomic particles are too small to see, so scientists are not exactly sure what they look like. Scientists have come up with a model to describe what an atom looks like.

Figure 4.2: Model of an atom



Elements

There are 118 elements that make up all the matter on Earth. Most of these occur naturally. Scientists have made 24 of the elements artificially in laboratories. The 118 elements have been classified into different groups depending on their structure and properties. Dmitri Mendeleev (1834–1907) devised the method of classifying the elements into an organised format called the Periodic Table.

An element:

- is made up of atoms of the same kind – for example, all of the atoms of an element, such as copper, are identical
- cannot be changed into another element by means of a chemical reaction
- is a substance that cannot be broken down into two or more substances by chemical means
- has atoms which contain protons, neutrons and electrons (see Figure 4.3).

Keywords

element: a pure substance consisting of only one type of atom

Periodic Table: a way in which scientists classify the elements

Notes

You learnt about the Periodic Table in Grade 7. You will see the Periodic Table on page 53 of this book.

Figure 4.3: Diagram of a single atom of hydrogen

Activity 1.1 Making models of atoms and sorting them into a table

40 minutes

Part 1: Revise the structure of an atom

1. Write down the correct term for the following explanations:
   - a) small particles that make up matter
   - b) particles with a positive charge
   - c) very fast-moving particles in an atom
   - d) table that lists all known elements.
2. Copy and complete the following table in your exercise book:

	Protons	Neutrons	Electrons
Where are they found?			
What is their charge?			
Compare their mass.			

3. Why have scientists come up with a model to tell us what atoms look like?

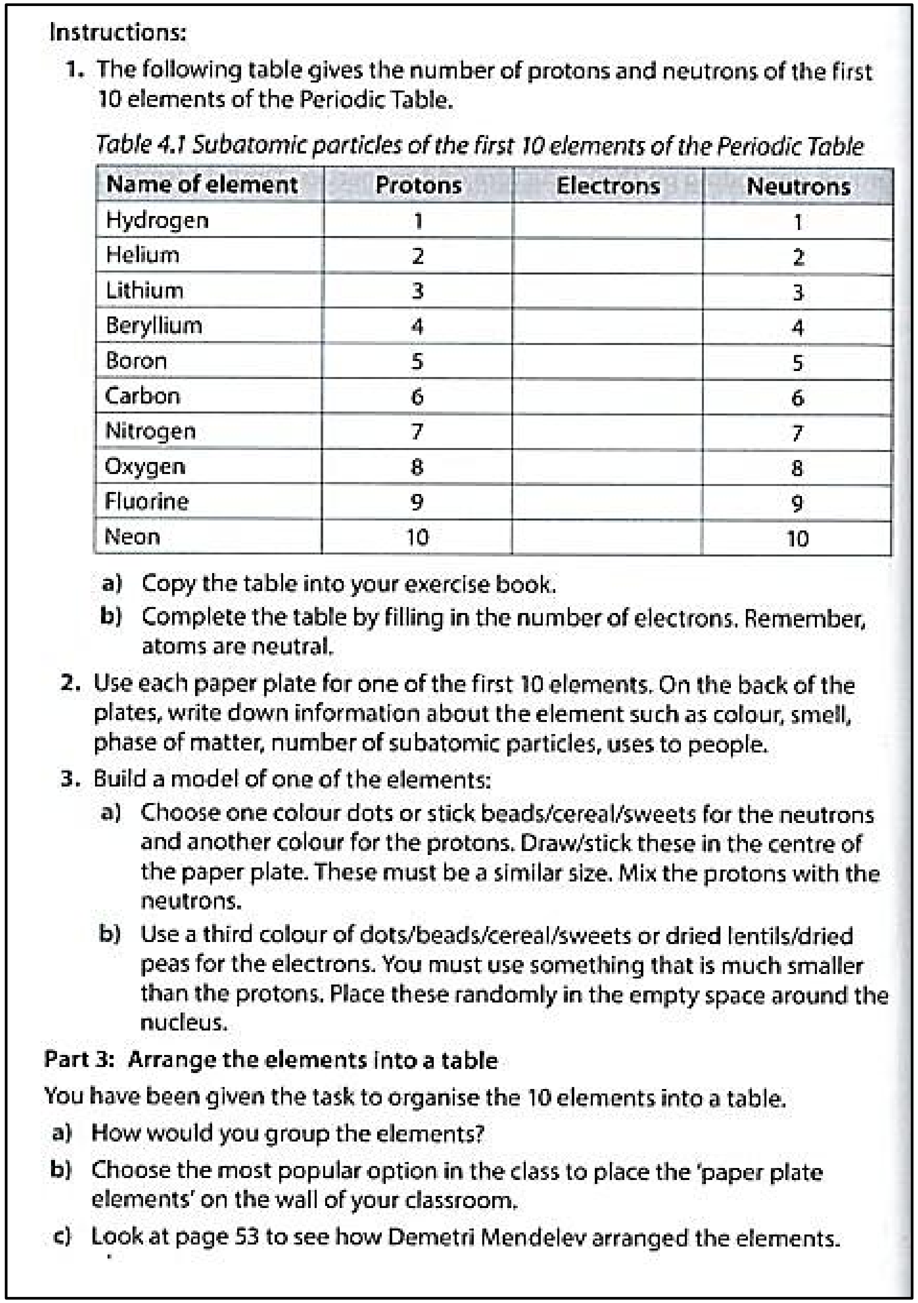
Part 2: Make models of atoms

You will need:

- 10 paper plates
- kokis or coloured stickers or coloured cereal/sweets/beads/dried lentils/dried peas
- glue
- additional information about the element (see Question 2 on page 52).

Extension

Joseph Thomson, John Dalton and Ernest Rutherford were all British scientists. They each developed a model of the atom. Choose one of them and find out more about what they thought an atom looked like.



Instructions:

1. The following table gives the number of protons and neutrons of the first 10 elements of the Periodic Table.

   Table 4.1 Subatomic particles of the first 10 elements of the Periodic Table

Name of element	Protons	Electrons	Neutrons
Hydrogen	1		1
Helium	2		2
Lithium	3		3
Beryllium	4		4
Boron	5		5
Carbon	6		6
Nitrogen	7		7
Oxygen	8		8
Fluorine	9		9
Neon	10		10

   a) Copy the table into your exercise book.
   b) Complete the table by filling in the number of electrons. Remember, atoms are neutral.
2. Use each paper plate for one of the first 10 elements. On the back of the plates, write down information about the element such as colour, smell, phase of matter, number of subatomic particles, uses to people.
3. Build a model of one of the elements:
   a) Choose one colour dots or stick beads/cereal/sweets for the neutrons and another colour for the protons. Draw/stick these in the centre of the paper plate. These must be a similar size. Mix the protons with the neutrons.
   b) Use a third colour of dots/beads/cereal/sweets or dried lentils/dried peas for the electrons. You must use something that is much smaller than the protons. Place these randomly in the empty space around the nucleus.

Part 3: Arrange the elements into a table

You have been given the task to organise the 10 elements into a table.

a) How would you group the elements?
b) Choose the most popular option in the class to place the 'paper plate elements' on the wall of your classroom.
c) Look at page 53 to see how Demetri Mendelev arranged the elements.

Readability test results

Flesch Reading Ease score: 61.6 (standard/average)
Gunning Fog: 10.8 (hard to read)
Flesch-Kincaid Grade Level: 8.1 (Eighth Grade)
The Coleman-Liau Index: 9 (Ninth Grade)
The SMOG Index: 8.2 (Eighth Grade)
Automated Readability Index: 6.7 (11-13 yrs old/ Sixth and Seventh graders)
Linsear Write Formula: 7.9 (Eighth Grade)

(ReadabilityFormulas.com, 2018)

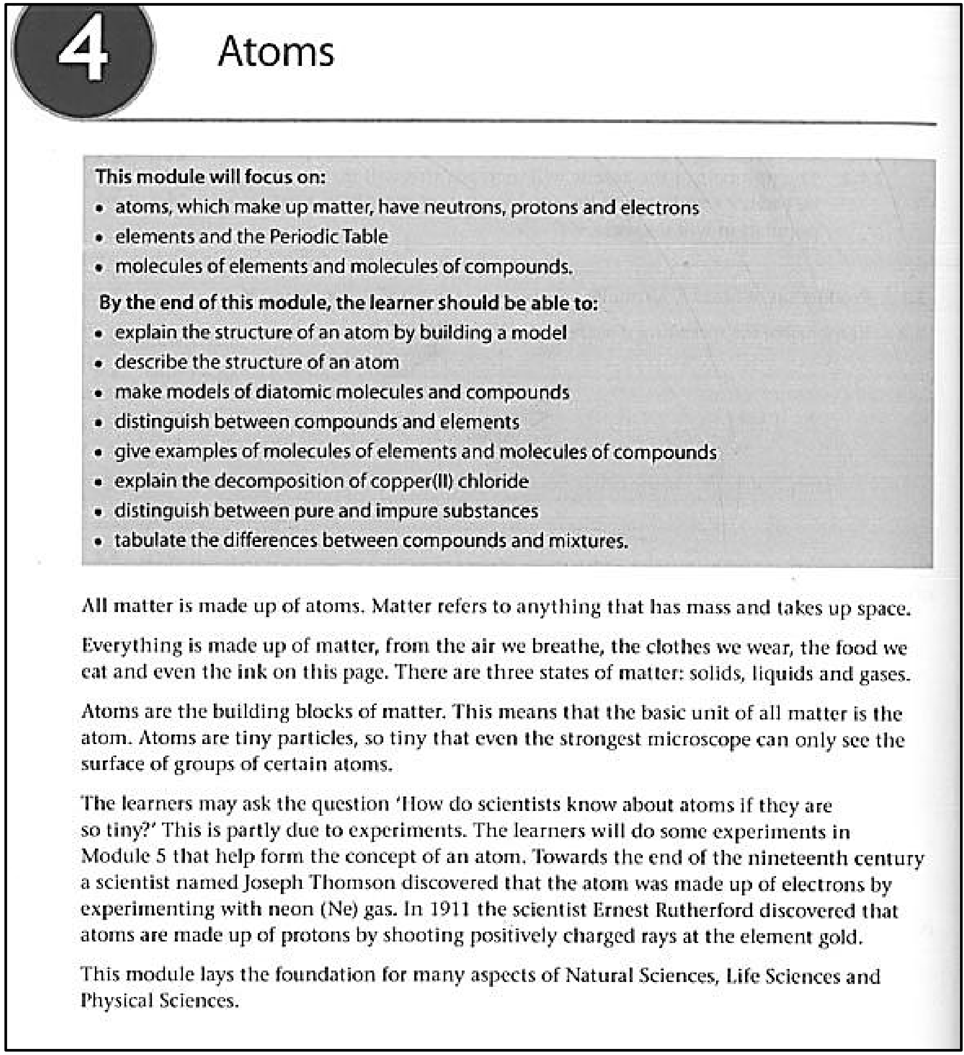
Readability consensus

Grade level: 8
Reading level: Standard/average
Reader's age: 12-14 yrs old (Seventh and Eighth graders)

(ReadabilityFormulas.com, 2018)

Table 29: Original text and readability test results (Term 2 teacher guide)

Original text



4 Atoms

This module will focus on:

- atoms, which make up matter, have neutrons, protons and electrons
- elements and the Periodic Table
- molecules of elements and molecules of compounds.

By the end of this module, the learner should be able to:

- explain the structure of an atom by building a model
- describe the structure of an atom
- make models of diatomic molecules and compounds
- distinguish between compounds and elements
- give examples of molecules of elements and molecules of compounds
- explain the decomposition of copper(II) chloride
- distinguish between pure and impure substances
- tabulate the differences between compounds and mixtures.

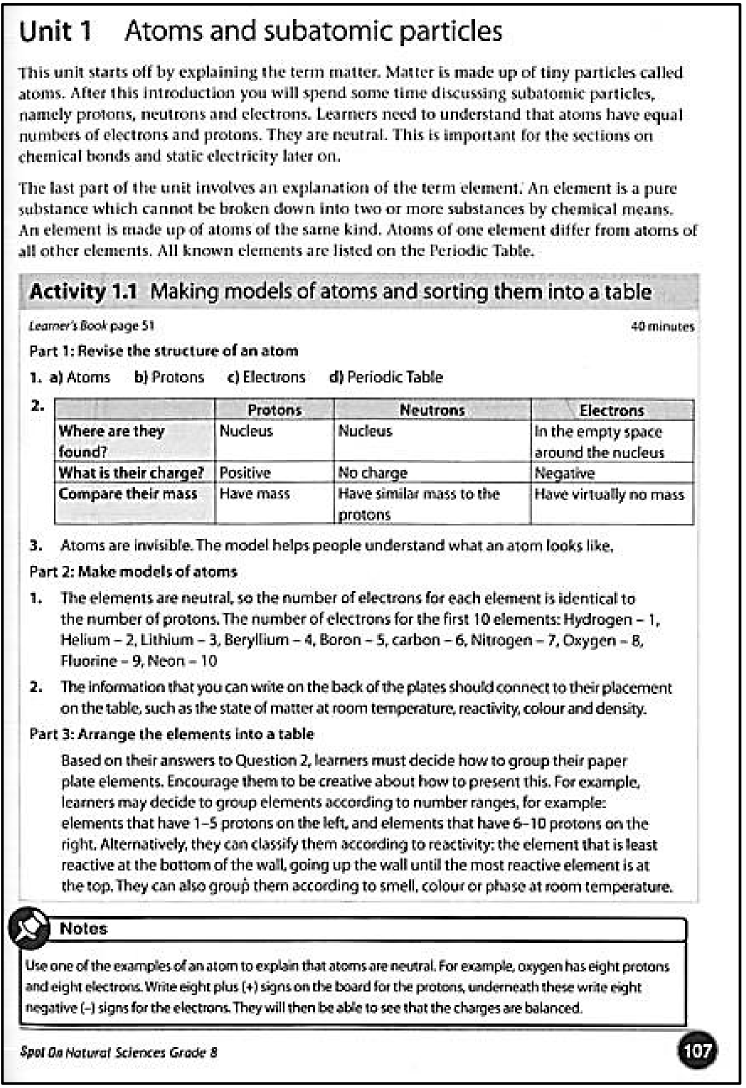
All matter is made up of atoms. Matter refers to anything that has mass and takes up space.

Everything is made up of matter, from the air we breathe, the clothes we wear, the food we eat and even the ink on this page. There are three states of matter: solids, liquids and gases.

Atoms are the building blocks of matter. This means that the basic unit of all matter is the atom. Atoms are tiny particles, so tiny that even the strongest microscope can only see the surface of groups of certain atoms.

The learners may ask the question 'How do scientists know about atoms if they are so tiny?' This is partly due to experiments. The learners will do some experiments in Module 5 that help form the concept of an atom. Towards the end of the nineteenth century a scientist named Joseph Thomson discovered that the atom was made up of electrons by experimenting with neon (Ne) gas. In 1911 the scientist Ernest Rutherford discovered that atoms are made up of protons by shooting positively charged rays at the element gold.

This module lays the foundation for many aspects of Natural Sciences, Life Sciences and Physical Sciences.



Unit 1 Atoms and subatomic particles

This unit starts off by explaining the term matter. Matter is made up of tiny particles called atoms. After this introduction you will spend some time discussing subatomic particles, namely protons, neutrons and electrons. Learners need to understand that atoms have equal numbers of electrons and protons. They are neutral. This is important for the sections on chemical bonds and static electricity later on.

The last part of the unit involves an explanation of the term element. An element is a pure substance which cannot be broken down into two or more substances by chemical means. An element is made up of atoms of the same kind. Atoms of one element differ from atoms of all other elements. All known elements are listed on the Periodic Table.

Activity 1.1 Making models of atoms and sorting them into a table

Learner's Book page 51 40 minutes

Part 1: Revise the structure of an atom

1. a) Atoms b) Protons c) Electrons d) Periodic Table

2.

	Protons	Neutrons	Electrons
Where are they found?	Nucleus	Nucleus	In the empty space around the nucleus
What is their charge?	Positive	No charge	Negative
Compare their mass	Have mass	Have similar mass to the protons	Have virtually no mass

3. Atoms are invisible. The model helps people understand what an atom looks like.

Part 2: Make models of atoms

1. The elements are neutral, so the number of electrons for each element is identical to the number of protons. The number of electrons for the first 10 elements: Hydrogen – 1, Helium – 2, Lithium – 3, Beryllium – 4, Boron – 5, carbon – 6, Nitrogen – 7, Oxygen – 8, Fluorine – 9, Neon – 10
2. The information that you can write on the back of the plates should connect to their placement on the table, such as the state of matter at room temperature, reactivity, colour and density.

Part 3: Arrange the elements into a table

Based on their answers to Question 2, learners must decide how to group their paper plate elements. Encourage them to be creative about how to present this. For example, learners may decide to group elements according to number ranges, for example: elements that have 1–5 protons on the left, and elements that have 6–10 protons on the right. Alternatively, they can classify them according to reactivity: the element that is least reactive at the bottom of the wall, going up the wall until the most reactive element is at the top. They can also group them according to smell, colour or phase at room temperature.

Notes

Use one of the examples of an atom to explain that atoms are neutral. For example, oxygen has eight protons and eight electrons. Write eight plus (+) signs on the board for the protons, underneath these write eight negative (–) signs for the electrons. They will then be able to see that the charges are balanced.

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Readability test results
Flesch Reading Ease score: 56.3 (fairly difficult to read) **Gunning Fog:** 11.3 (hard to read) **Flesch-Kincaid Grade Level:** 9.5 (Tenth Grade) **The Coleman-Liau Index:** 9 (Ninth Grade) **The SMOG Index:** 8.9 (Ninth Grade) **Automated Readability Index:** 8.2 (12-14 yrs old/ Seventh and Eighth graders) **Linsear Write Formula:** 10.6 (Eleventh Grade) (ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 9 **Reading level:** Fairly difficult to read **Reader's age:** 13-15 yrs old (Eighth and Ninth graders) (ReadabilityFormulas.com, 2018)

The readability test results and consensus for each of the *Spot On Natural Sciences* four samples indicates that the texts are well within the target range, as the reading age falls between 8 years and 15 years. These texts have been developed for learners in Grade 8 (aged 14) and Natural Science teachers (aged 21 and above). However, the texts range between ‘easy to read’ (Term 1 learner guide) and ‘Fairly difficult to read’ (Term 2 teacher guide). There are various reasons for this disparity. The first is that the sample from the Term 1 learner guide is an assessment that includes bulleted lists and short questions, with very little complex vocabulary; whereas the samples from the Term 2 learner and teacher guides include more scientific jargon, as the subject matter is atoms and subatomic particles and there are more paragraphs with denser information. Although the results suggest that these texts should still be comprehensible to teachers and to learners in Grade 8, this is not necessarily the case in the South African schooling system where there is a discrepancy between types of schools and language background amongst both teachers and learners. That said, the quantitative data from the readability tests indicate that the sentence structure and vocabulary in these samples are acceptable for the level at which these texts are pitched. Furthermore, the focus of this study is to see whether the available resources are suitable for a teacher to understand, not a learner, which further suggests that these texts are appropriately geared toward the target audience for this study.

Given that the goal of this study is to make resources more accessible to teachers specifically, it is important to consider the ease with which teachers are able to access all of the information that they need. Therefore, these samples, along with other samples that were tested, were critically analysed to see whether they subscribe to the selected plain language criteria for this study. The results appear in Table 30 (overleaf).

Table 30: Compliance with plain language criteria

Plain language criteria	Appearance in the text
An average sentence length of 15-25 words	The readability tests revealed that the sentence length in each of the samples is acceptable and falls within the selected range for the study. My analysis of the sentences confirmed this.
Focused paragraphs and lists	The texts do include some bulleted information, and this is well sign-posted for the readers. Questions and answers are numbered, and information is bulleted in places. There is room for more information to be listed. The paragraphs are relatively short and focused.
Word choice	The readability tests suggest that the vocabulary is not too dense or problematic in these samples. Some scientific jargon is used, but this is necessary, because the texts are teaching resources. Explanations are offered for more complex terminology, so there is no need for a glossary.
Favour the active voice	The texts are written primarily in the active voice. There is no need to alter this aspect of the texts because they comply well with this criterion.
Audience, register, and tone	These elements of the texts are also acceptable. However, it is not always clear that the teacher guide is geared toward an adult reader. The language could be formalised more for this audience.
Non-sexist/biased language	The information is factually presented, and no sexism is apparent. The plural form ‘learners’ is used in both texts in order to avoid sexism.
Reader-centred structure	The texts do not have a reader-centred structure. The texts state what the learner should do and only imply the teacher’s role in that. Readers could, however, be addressed more clearly, e.g. ‘You should…’
Clear layout	The information is well-presented. Headings are neat and are printed in sentence case, in bold. The font and font size are easy on the eye. Information is grouped together clearly, although there are one or two inconsistencies in structure.
Use alternatives to words	Images and alternative explanations are limited in the teacher guide, so there could be more consideration of this means of content delivery.
Quality of content	Information in the teacher guide is lacking. The teacher has to refer to the learner guide to gain an understanding of the information or the task at hand. There could be more of an effort to bridge this gap between the two guides.

These guides implement plain language strategies well. The documents are navigable and the information is clear; however, the overall user friendliness and navigation of the content for teachers can be improved in the teacher guide. The teachers currently have to negotiate two textbooks in order to attain all of the information they need.

In my revision, I try to bring all this information together into a single resource that is easy for the teacher to work through and comprehend. The style and information presented in the original texts is retained, but the information is brought together in such a way that teachers are able to get everything they needs from one consolidated resource. I added additional information at my own discretion to enhance the document.

Changes to the structure of the documents are discussed in speech bubbles on the document. A revised sample of the *Spot On Natural Sciences* teacher guide for Term 1 is presented in Figure 7.

How to write a scientific report:

Tone: Statements have been modified for an adult reader.

The learners will write a scientific report this week as their formal assessment task. Make sure you explain the following in order to assist them in the process:

Lists: Clear reader-centred platform statement. Bulleted list provided.

- **The observation** (this relates to the aim)

You need to explain that the first step in the scientific method is always the observation. For example, you might ask the learners if they have ever noticed that plants grow really well after heavy rains. This may lead to the question: Why do plants grow well after rain?

From this, the learners will be able to identify an aim for their experiment.

Reader-centred structure. Clear what teachers should do with information

- **The hypothesis**

Now you need to lead the learners to the hypothesis, which the learners need to understand is an educated guess. This is a possible answer to the question that was asked in the previous section. For example, the question was: Why do plants grow well after rain? A possible answer could be: Rain waters the plants and this helps them to grow.

Inform the learners that this needs to be written in the form of a statement.

Quality of content: Clarity of relationships between information.

- **The investigation** (this relates to the method)

Here you need to help the learners understand that they need to test the hypothesis by carrying out an investigation. For example, you could explain that one possible way of testing the hypothesis is to get two potted plants of the same type. Keep the plants in the same environment and water one plant but not the other.

You need to make it clear to the learners that they need to write out what they intend to do in the form of steps. These steps form the method. These steps must include the plan and the list of equipment (apparatus) that will be used. Explain this process by referring to a cake recipe – not only is there specific steps that must be followed, but it is also clear how the equipment will be used.

NB! Make it clear to the learners that these steps should be clear and anyone should be able to follow them.

Layout: Important information is identified as such.

- **Obtaining, recording and analysing results** (this relates to the results)

In this section, you should explain to the learners that changes will occur when they conduct the investigation. These changes, or lack thereof, must be written down. For example, the plant that has not been watered may start dying, while the plant that has been watered may be growing well.

Explain to the learners that data can be presented in many forms, such as tables or graphs.

- **Conclusion and Discussion**

Here, the learners must explain or prove that their hypothesis was either correct or incorrect. You will explain to the learners that the investigation and observation of results will help them to reach this conclusion. For example, in this investigation it was clear that the water in the rain helped the plants to grow.

Formal Assessment: Task 1 (90 minutes)

Layout: Clearer placement of time.

Practical task: Investigation to prove that green leaves produce starch when they are exposed to sunlight *(Page 4 in Learner's book)*

Layout: Clear indication of place in learner's book.

In this activity, the learners need to investigate whether or not light is necessary for photosynthesis to take place. In order to do this, the plant needs to photosynthesise. Plants produce glucose, which is then converted to starch in the leaves, if photosynthesis has taken place. Thus, to check if photosynthesis has occurred, the learners need to check for the presence of starch in the leaves. Therefore, the learners have to start off with a leaf that has been destarched (the learners will do this as part of their experiment). Explain to the learners that if the leaves have not been destarched, then it is impossible to know if the starch was present before the experiment or produced during the experiment. This will affect the results of the experiment as more variables will be added.

Audience: Engagement with the audience.

The learners will need:

- A pot plant with soft, green leaves. E.g. geranium
- Tinfoil
- A glass beaker
- A test tube
- Ethanol/methylated spirits

Quality of content: Copied from learner guide.

- A dropper bottle with iodine solution
- A Bunsen/spirit burner
- Forceps
- A Petri dish
- A white surface. E.g. tile

Part 1:

The learners will start off by destarching the leaves. They will do so by placing the plant in darkness for 2-3 days. They will then test for starch by doing the following:

Lists: Parallel structure; continuous tense.

1. Removing a leaf from the destarched plant.
2. Placing the leaf in boiling water for about 5 minutes.
3. Removing the leaf from the water with a pair of forceps, and placing it in the test tube.
4. Pouring the ethanol/methylated spirits into the test tube until the leaf is fully immersed.
5. Placing the test tube into the glass beaker that is filled with hot water.
6. Observing the chlorophyll from the leaf dissolving into the ethanol/methylated spirits (the ethanol/methylated spirits should turn green)
7. Removing the leaf from the ethanol/methylated spirits and rinsing the leaf in hot water to remove any excess ethanol/methylated spirits (the leaf should be whitish in colour).
8. Spreading the leaf out onto a Petri dish and placing a few drops of iodine solution on the leaf (the learners should leave this to stand for a few minutes).
9. Observing the colour of the leaf (orange-brown in colour).
10. Testing the leaf for starch by noting that the colour of the leaf is orange-brown (like iodine) and not blue-black.

Word choice: Consistency (highlighted in grey).

Part 2:

Once the learners have determined that there is no starch present in the leaves of the plant, they should continue with the following:

1. Choosing a leaf from the pot plant and covering a portion of it with tinfoil so that no light can reach that part of the leaf. The learners can secure the tinfoil to the leaf with a paper clip.
2. Placing the plant in sunlight for a minimum of 5 hours.
3. Detaching the leaf from the plant and testing for the presence of starch.

You should assist the learners with these steps if necessary. The learners will be assessed on their responses to the following questions so you need to make sure that these things have been explained to them in the process of conducting their experiments:

Quality of content: Additional information for clarity.

1. Why do we place the leaf in boiling water?
   To soften the cell walls in the leaf so that the iodine solution is able to penetrate through them. (½)
2. Why does the colour of the ethanol/methylated spirits change?
   The chlorophyll from the leaf dissolves in the ethanol/methylated spirits, leaving it green in colour. (½)
3. Describe the appearance of the leaf when it has been removed from the ethanol/methylated spirits.
   The leaf is now white in colour. (1)
4. Why was iodine used?
   Iodine is a chemical that is used to test for the presence of starch. (½)
   OR
   Iodine is orange-brown in colour and changes to blue-black in colour if starch is present. (½)
5. Why is the leaf placed in sunlight for at least 5 hours?
   So that it can photosynthesise and produce starch. (½)
6. Draw a diagram of the leaf after the starch test was done in Part 2. Label the parts according to whether they tested positive or negative for starch.
   The diagram of the leaf should have two labels:

- Remains orange-brown in colour (parts covered by foil will test negative for starch)
- Turns blue-black in colour (rest of leaf will test positive for starch)

Mark allocation:

Quality of content: Questions and answers included.

- 2 marks for correct labels
- 3 marks for diagram (label lines in pen and on right-hand-side of page; no sketching; leaf drawn correctly, showing the strip that was covered). (5)

7. List two variables that need to be controlled in this experiment and explain how they will be controlled.

- **Water** (½): **ensure that the plant is given sufficient water** (½).
  Carbon dioxide (½): **the plant must not be covered; it must be able to absorb carbon dioxide (½).** (2)

Layout: Answers in bold.

8. Write up an scientific report for Part 2 using the following headings: Aim, Hypothesis, Method, Results, Conclusion and Discussion. (10)
   Aim: To determine whether green leaves produce starch when they are exposed to sunlight. (1)
   Hypothesis: Green leaves produce starch when they are exposed to sunlight. (1)
   Method: (2)

- Choose a leaf from the pot plant and cover a portion of it with the tinfoil so that no light reaches that part. (½)
- Secure the tinfoil to the leaf with a paper clip. (½)
- Place the plant in sunlight for a minimum of 5 hours. (½)
- Detach the leaf from the plant and test for the presence of starch. (½)

Results: The parts of the leaf that were covered with tinfoil test negative for starch because the iodine remains an orange-brown colour. (1) The rest of the leaf tests positive for starch because the iodine turns a blue-black colour. (1) **Conclusion and Discussion:** (4) **Conclusion:** Green leaves produce starch when they are exposed to sunlight. (1) **Discussion:** • In the process of photosynthesis, the chlorophyll present in the plant traps the radiant energy from the sun and converts it into glucose. (½) • In order to do this, the plant also needs water and carbon dioxide. (½) • The main product formed is glucose, and plants transform this glucose into starch. (1) • If photosynthesis has occurred, then the leaf will turn blue-black when iodine is used. (1) Total: 20 marks	Lists: Bulleted list rather than paragraph.

Figure 7: ***Spot On Natural Science*s Grade 8 revision (Term 1 teacher guide)**

As with the original texts, the revised text was put through the readability checker to see whether the revised teacher guide, which is a combination of the learner and teacher guides, maintained an acceptable reading level. The original results for the teacher and learner guides have been included in order to draw a comparison. The results appear in Table 31.

Table 31: Revised readability score Term 1 teacher guide

Readability test results			
Flesch Reading Ease score: 71.1 (fairly easy to read) **Gunning Fog:** 9.1 (fairly easy to read) **Flesch-Kincaid Grade Level:** 6.9 (Seventh Grade) **The Coleman-Liau Index:** 9 (Ninth Grade) **The SMOG Index:** 7 (Seventh Grade) **Automated Readability Index:** 6.8 (11-13 yrs old/ Sixth and Seventh graders) **Linsear Write Formula:** 7.5 (Eighth Grade)			
Readability consensus			
Reading levels	**Learner guide**	**Teacher guide**	**Revised text**
Grade level	4	8	8
Reading level	Easy to read	Standard/average	Fairly easy to read
Reader's age	8-9 yrs old	12-14 yrs old	12-14 yrs old

(ReadabilityFormulas.com, 2018)

The results reveal that the revised teacher guide for Term 1 is 'Fairly easy to read', rather than its original result of 'standard/average'. The suitable reading age has remained 12-14 years, which means that the text has maintained its reading age, but actually improved in terms of its reading ease. This suggests that bringing the essential information from the two texts together has not altered its comprehensibility in a negative way. In fact, the results suggest that the comprehensibility of the text has actually improved. Although the learner guide is reflected as 'Easy to read' and pitched at a Grade 4 level, this may be too rudimentary a text for a teacher, but augurs well for readability in the classroom.

Figure 8 depicts the plain language version of the *Spot On Natural Sciences* teacher guide selection for Term 2.

4. Atoms

This module will focus on:

- Atoms, which make up matter, and have neutrons, protons and electrons.
- Elements and the Periodic Table.
- Molecules of elements and molecules of compounds

By the end of this module, the learner should be able to:

- Explain the structure of an atom by building a model.
- Describe the structure of an atom.
- Make models of diatomic molecules and compounds.
- Distinguish between compounds and elements.
- Give examples of molecules of elements and molecules of compounds.
- Explain the decomposition of copper (II) chloride.
- Distinguish between pure and impure substances.
- Tabulate the differences between compounds and mixtures.

Audience: Platform statement; reader-centred

When you introduce this module to the learners, go through the following:

- All matter is made up of atoms.
- Matter refers to anything that has mass and takes up space, from the air we breathe, to the clothes we wear, and the food we eat and even the ink on this page.
- There are three states of matter: solids, liquids and gases.
- Atoms are the building blocks of matter. This means that the basic unit of all matter is the atom.
- Atoms are tiny particles, so tiny that even the strongest microscope can only see the surface of groups of certain atoms.

The learners may ask the question 'How do scientists know about atoms if they are so tiny?'

- This is partly due to experiments – the learners will do some experiments in Module 5 that help form the concept of an atom.

Towards the end of the nineteenth century a scientist named Joseph Thomson discovered that the atom was made up of electrons by experimenting with neon (Ne) gas. In 1911 the scientist Ernest Rutherford discovered that atoms are made up of protons by shooting positively charged rays at the element gold.

This module lays the foundation for many aspects of Natural Sciences, Life Sciences and Physical Sciences.

Unit 1: Atoms and subatomic particles

This unit starts off by explaining the term matter. Matter is made up of tiny particles called atoms. The word 'atom' comes from the Greek word *atomos* which means indivisible (cannot be divided or broken up).

After this introduction you will spend some time discussing subatomic particles, namely:

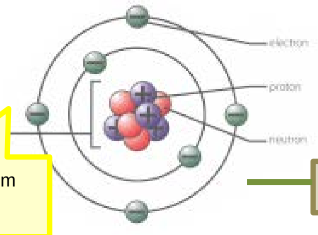
- Protons: In the nucleus; have a mass; carry a positive (+) charge.
- Neutrons: In the nucleus; have a mass; do not carry a charge (neutral).
- Electrons: Around the nucleus; very little mass; carry a negative (-) charge; fast moving; high energy.

Learners need to understand that atoms have equal numbers of electrons and protons, and that electrons are held around the nucleus by the positive (+) charge of the protons. You need to ensure that the learners also know that atoms are neutral – this is important for the sections on chemical bonds and static electricity later on.

It is also important that the learners know that scientists are not certain of what atoms and subatomic particles look like, but that scientists have developed the following model to demonstrate what an atom could look like.

Reader-centred structure: Teacher addressed

Lists: Paragraph replaced with bulleted list



Quality of content: From learner guide

Visual: Aids explanation

The last part of the unit involves an explanation of the term element. Ensure that you cover the following information with the learners:

- Elements make up all matter on Earth
- An element is a pure substance which cannot be broken down into two or more substances by chemical means.
- An element is made up of atoms of the same kind.
- Atoms of one element differ from atoms of all other elements – all known elements are listed on the Periodic Table.
- Most elements occur naturally, but scientists have been able to make 24 elements artificially in laboratories.
- There are 118 elements that have been broken into different groups depending on their structure and properties.
- Dmitri Mendeleev (1834-1907) devised the method of classifying elements into the format we know as the Periodic Table.

Activity 1.1: Making models of atoms and sorting them into a table (40 minutes)

Part 1: Revise the structure of an atom *(Page 51 in Learner's book)*

1. Write down the correct term for the following explanations.
   a) Small particles that make up matter **(atoms)**
   b) Particles with a positive charge **(protons)**
   c) Very fast moving particles in an atom **(electrons)**
   d) Table that lists all known elements **(Periodic Table)**
2. Copy and complete the following table in your exercise book:

Layout: Answers in bold and highlighted

Question	Protons	Neutrons	Electrons
Where are they found?	**Nucleus**	**Nucleus**	**Empty space around nucleus**
What is their charge?	**Positive**	**No charge**	**Negative**
Compare their mass.	**Have mass**	**Have similar mass to protons**	**Virtually no mass**

3. Why have scientists come up with a model to tell us what atoms look like? **Atoms are invisible and the model helps us to understand what they look like.**

Part 2: Make models of atoms

Learners need:

- 10 paper plates
- Kokis or coloured stickers/cereal/sweets/beads/dried lentils/dried peas
- Glue
- Information about elements

Instructions:

1. Learners should be given a table which gives the number of protons and neutrons in the first 10 elements on the Periodic Table.
   a) Copy the table into your exercise book.
   b) Complete the table by filling in the number of electrons – remember atoms are neutral.

Name of element	Protons	Electrons	Neutrons
Hydrogen	1	**1**	1
Helium	2	**2**	2
Lithium	3	**3**	3
Beryllium	4	**4**	4
Boron	5	**5**	5
Carbon	6	**6**	6
Nitrogen	7	**7**	7
Oxygen	8	**8**	8
Fluorine	9	**9**	9
Neon	10	**10**	10

Quality of content: Table included

2. Use your paper plates to represent the first 10 elements (one paper per element). On the back of each plate, write down the information about each element. I.e. colour, smell, state of matter at room temperature, number of subatomic particles, uses to people.
   Learners should provide answers, you must just mediate discussion.

Part 3: Arrange the elements into a table

Learners must organise the 10 elements into a table.

a) How would you group the elements?
   Allow creative thinking. Learners may consider:
   - **Number ranges, e.g. elements that have 1-5 protons on the left, and elements that have 6-10 protons on the right.**
   - **Reactivity, e.g. the element that is least reactive at the bottom of the wall, going up the wall until the most reactive element is at the top.**

• **Smell** • **Colour** • **Phase at room temperature.** b) Decide on the most popular and effective option in the class, and place the ‘paper plate elements’ on the wall of your classroom. c) Look at page 53 to see how Dmitri Mendeleev arranged the elements. **Go through the structure of the Periodic Table with the learners.**	Quality of content: Information added; spelling corrected from learner guide

Figure 8: ***Spot On Natural Sciences*** **Grade 8 revision (Term 1 teacher guide)**

The revised text was put through the readability checker to see whether the revised teacher guide, which is again a combination of the learner and teacher guides, maintained an acceptable reading level. The original results for the teacher and learner guides have been included in order to draw a comparison. The results appear in Table 32.

Table 32: Revised readability score Term 2 teacher guide

<table>
<tr><th colspan="4">Readability test results</th></tr>
<tr><td colspan="4">Flesch Reading Ease score: 58.8 (fairly difficult to read)
Gunning Fog: 10.6 (hard to read)
Flesch-Kincaid Grade Level: 8.7 (Ninth Grade)
The Coleman-Liau Index: 10 (Tenth Grade)
The SMOG Index: 8.4 (Eighth Grade)
Automated Readability Index: 7.8 (12-14 yrs old/ Seventh and Eighth graders)
Linsear Write Formula: 8.3 (Eighth Grade)</td></tr>
<tr><th colspan="4">Readability consensus</th></tr>
<tr><th>Reading levels</th><th>Learner guide</th><th>Teacher guide</th><th>Revised text</th></tr>
<tr><td>Grade level</td><td>8</td><td>9</td><td>9</td></tr>
<tr><td>Reading level</td><td>Standard/average</td><td>Fairly difficult to read</td><td>Fairly difficult to read</td></tr>
<tr><td>Reader’s age</td><td>12-14 yrs old</td><td>13-15 yrs old</td><td>13-15 yrs old</td></tr>
</table>

(ReadabilityFormulas.com, 2018)

The readability consensus for Term 2’s document remained similar to that of the original. Both the original teacher guide and the revised teacher guide reflected a consensus that the text is ‘Fairly difficult to read’ with a suitable reading age of 13-15 years. This indicates that the revised text has not negatively affected the comprehensibility of the text. It has maintained its original reading level, while including more information for the teacher. Again, the learner guide reflects a lower reading age, but that text is specifically geared toward learners.

I read the texts carefully and used the plain language criteria as effectively as possible, which has resulted in resources that are easy to navigate, and that include more information for teachers to refer to in the teacher guide. By listing information and improving the quality of the content, the resource is more complete, navigable, and comprehensible. The text was also revised to involve the readers. In this way teachers have a clearer indication of what they should be doing with the learners and with the information that has been provided. Previously, the tone and audience of the teacher guide suggested that the text was geared toward learners, but the text was altered for an adult audience. Only minor visual aids were included; this is a challenging criterion because teachers can find them invasive to the text, but where they were deemed helpful, they were added. Arial font size 9 was used because it is a legible font in this size (like Times New Roman).

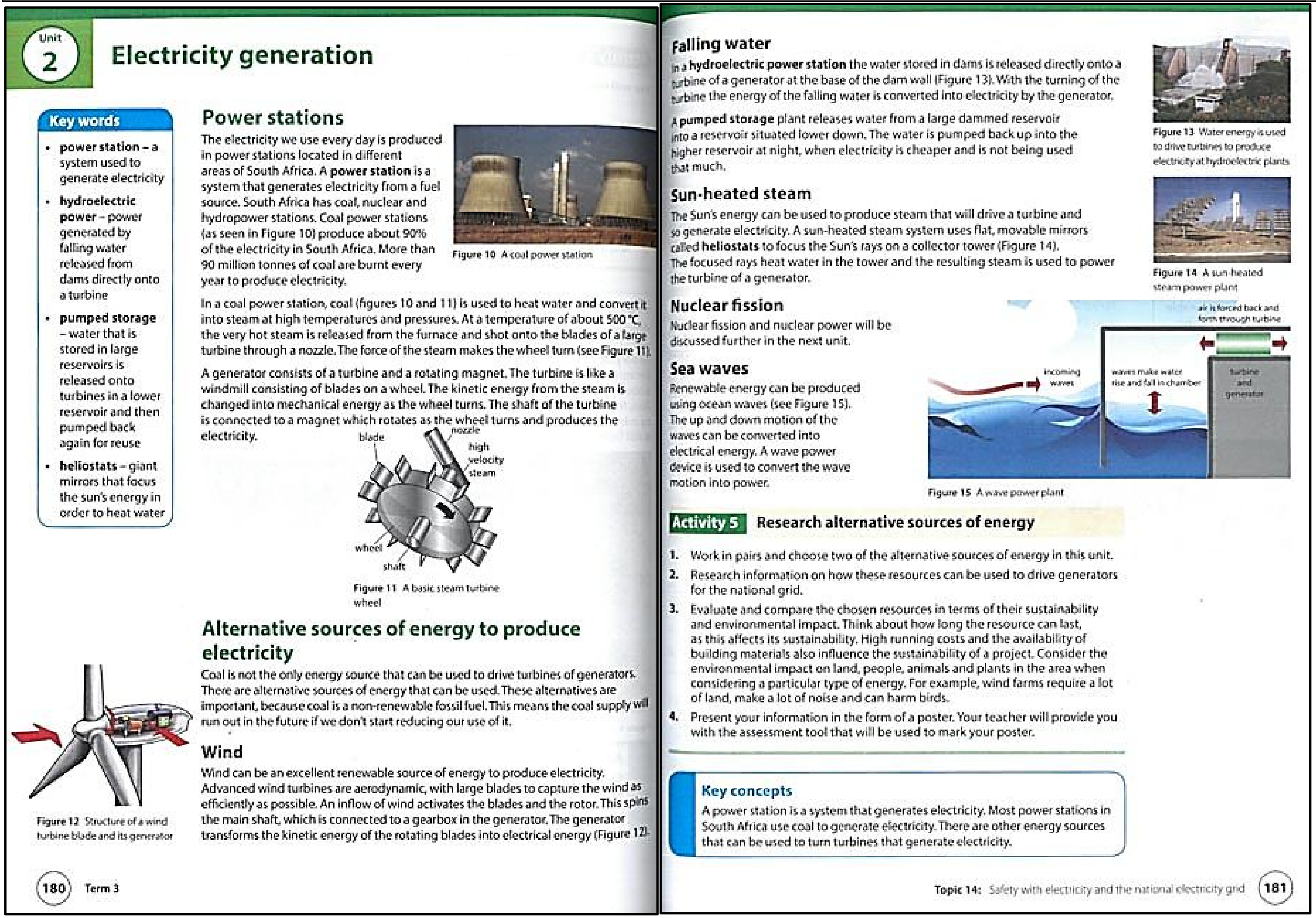
The goal was to eliminate as many gaps between the learner and teacher guides as possible, and this was achieved by the abovementioned means.

5.4.2 *Platinum Natural Sciences* Grade 9

As with the *Spot On* teacher and learner guides, the *Platinum* guides also function as a set. I undertook the same process that I used with the previous examples. The original texts were put through the readability checker to see how well they comply with plain language criteria. I use sample texts from Term 3 and Term 4 to demonstrate the results. The original text from the learner guide (Bester *et al*., 2018a:180-181) for Term 3 appears in Table 33 (overleaf), followed by the readability test results and the readability consensus. Table 34 (pp. 151-152) contains the matching sample for Term 3 from the teacher guide (Bester *et al*., 2018b:96), its readability test results and readability consensus.

Table 35 (pp. 153-154) presents the matching sample for Term 4 from the learner guide (Bester *et al*., 2018a:254-257), its readability test results and readability consensus, and Table 36 (pp. 155-156) shows the matching sample for Term 4 from the teacher guide (Bester *et al*., 2018b:138-139), its readability test results and readability consensus.

Table 33: Original text and readability test results (Term 3 learner guide)

Original text


Electricity generation

Key words

- **power station** – a system used to generate electricity
- **hydroelectric power** – power generated by falling water released from dams directly onto a turbine
- **pumped storage** – water that is stored in large reservoirs is released onto turbines in a lower reservoir and then pumped back again for reuse
- **heliostats** – giant mirrors that focus the sun's energy in order to heat water

Power stations

The electricity we use every day is produced in power stations located in different areas of South Africa. A **power station** is a system that generates electricity from a fuel source. South Africa has coal, nuclear and hydropower stations. Coal power stations (as seen in Figure 10) produce about 90% of the electricity in South Africa. More than 90 million tonnes of coal are burnt every year to produce electricity.

Figure 10 A coal power station

In a coal power station, coal (figures 10 and 11) is used to heat water and convert it into steam at high temperatures and pressures. At a temperature of about 500 °C, the very hot steam is released from the furnace and shot onto the blades of a large turbine through a nozzle. The force of the steam makes the wheel turn (see Figure 11).

A generator consists of a turbine and a rotating magnet. The turbine is like a windmill consisting of blades on a wheel. The kinetic energy from the steam is changed into mechanical energy as the wheel turns. The shaft of the turbine is connected to a magnet which rotates as the wheel turns and produces the electricity.

Figure 11 A basic steam turbine wheel

Alternative sources of energy to produce electricity

Coal is not the only energy source that can be used to drive turbines of generators. There are alternative sources of energy that can be used. These alternatives are important, because coal is a non-renewable fossil fuel. This means the coal supply will run out in the future if we don't start reducing our use of it.

Wind

Wind can be an excellent renewable source of energy to produce electricity. Advanced wind turbines are aerodynamic, with large blades to capture the wind as efficiently as possible. An inflow of wind activates the blades and the rotor. This spins the main shaft, which is connected to a gearbox in the generator. The generator transforms the kinetic energy of the rotating blades into electrical energy (Figure 12).

Figure 12 Structure of a wind turbine blade and its generator

Falling water

In a **hydroelectric power station** the water stored in dams is released directly onto a turbine of a generator at the base of the dam wall (Figure 13). With the turning of the turbine the energy of the falling water is converted into electricity by the generator.

A **pumped storage** plant releases water from a large dammed reservoir into a reservoir situated lower down. The water is pumped back up into the higher reservoir at night, when electricity is cheaper and is not being used that much.

Figure 13 Water energy is used to drive turbines to produce electricity at hydroelectric plants

Sun-heated steam

The Sun's energy can be used to produce steam that will drive a turbine and so generate electricity. A sun-heated steam system uses flat, movable mirrors called **heliostats** to focus the Sun's rays on a collector tower (Figure 14). The focused rays heat water in the tower and the resulting steam is used to power the turbine of a generator.

Figure 14 A sun-heated steam power plant

Nuclear fission

Nuclear fission and nuclear power will be discussed further in the next unit.

Sea waves

Renewable energy can be produced using ocean waves (see Figure 15). The up and down motion of the waves can be converted into electrical energy. A wave power device is used to convert the wave motion into power.

Figure 15 A wave power plant

Activity 5 **Research alternative sources of energy**

1. Work in pairs and choose two of the alternative sources of energy in this unit.
2. Research information on how these resources can be used to drive generators for the national grid.
3. Evaluate and compare the chosen resources in terms of their sustainability and environmental impact. Think about how long the resource can last, as this affects its sustainability. High running costs and the availability of building materials also influence the sustainability of a project. Consider the environmental impact on land, people, animals and plants in the area when considering a particular type of energy. For example, wind farms require a lot of land, make a lot of noise and can harm birds.
4. Present your information in the form of a poster. Your teacher will provide you with the assessment tool that will be used to mark your poster.

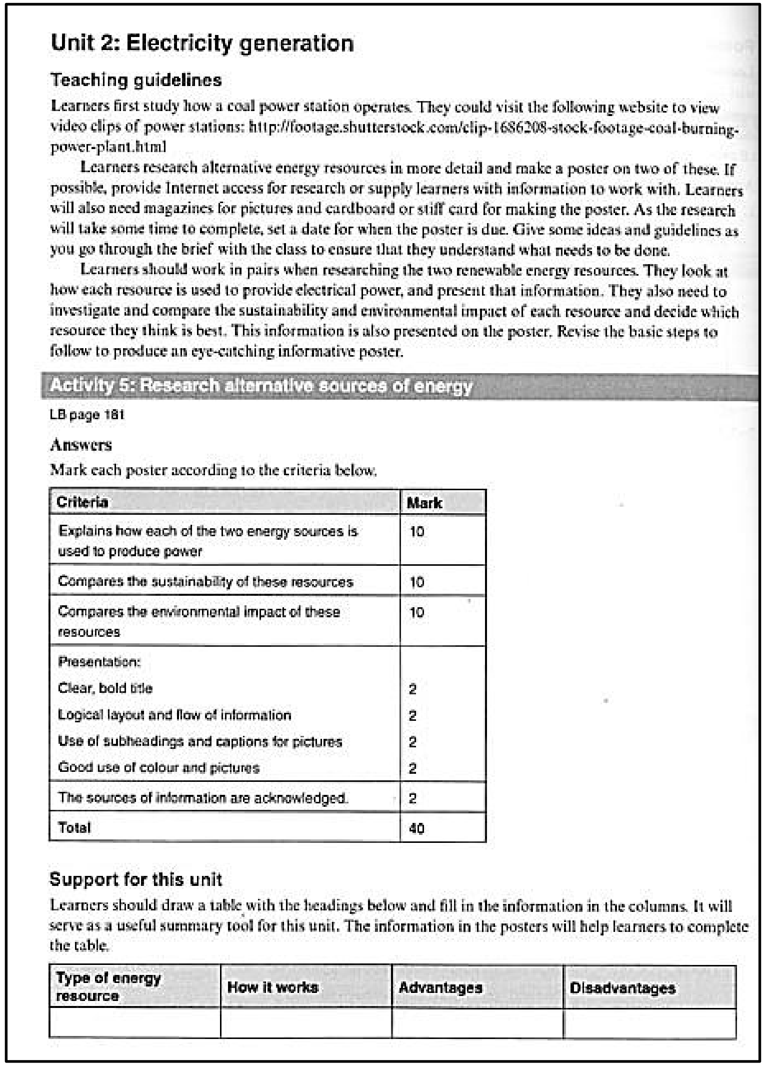
Key concepts

A power station is a system that generates electricity. Most power stations in South Africa use coal to generate electricity. There are other energy sources that can be used to turn turbines that generate electricity.

Readability test results
Flesch Reading Ease score: 56.3 (fairly difficult to read) **Gunning Fog:** 11.6 (hard to read) **Flesch-Kincaid Grade Level:** 9.2 (Ninth Grade) **The Coleman-Liau Index:** 10 (Tenth Grade) **The SMOG Index:** 8.7 (Ninth Grade) **Automated Readability Index:** 8.1 (12-14 yrs old/ Seventh and Eighth graders) **Linsear Write Formula:** 8.8 (Ninth Grade) (ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 9 **Reading level:** Fairly difficult to read **Reader’s age:** 13-15 yrs old (Eighth and Ninth graders) (ReadabilityFormulas.com, 2018)

Table 34: Original text and readability test results (Term 4 teacher guide)

Original Text



Unit 2: Electricity generation

Teaching guidelines

Learners first study how a coal power station operates. They could visit the following website to view video clips of power stations: http://footage.shutterstock.com/clip-1686208-stock-footage-coal-burning-power-plant.html

Learners research alternative energy resources in more detail and make a poster on two of these. If possible, provide Internet access for research or supply learners with information to work with. Learners will also need magazines for pictures and cardboard or stiff card for making the poster. As the research will take some time to complete, set a date for when the poster is due. Give some ideas and guidelines as you go through the brief with the class to ensure that they understand what needs to be done.

Learners should work in pairs when researching the two renewable energy resources. They look at how each resource is used to provide electrical power, and present that information. They also need to investigate and compare the sustainability and environmental impact of each resource and decide which resource they think is best. This information is also presented on the poster. Revise the basic steps to follow to produce an eye-catching informative poster.

Activity 5: Research alternative sources of energy

LB page 181

Answers

Mark each poster according to the criteria below.

Criteria	Mark
Explains how each of the two energy sources is used to produce power	10
Compares the sustainability of these resources	10
Compares the environmental impact of these resources	10
Presentation:	
Clear, bold title	2
Logical layout and flow of information	2
Use of subheadings and captions for pictures	2
Good use of colour and pictures	2
The sources of information are acknowledged.	2
Total	40

Support for this unit

Learners should draw a table with the headings below and fill in the information in the columns. It will serve as a useful summary tool for this unit. The information in the posters will help learners to complete the table.

Type of energy resource	How it works	Advantages	Disadvantages

Readability test results

Flesch Reading Ease score: 53.3 (fairly difficult to read)

Gunning Fog: 12 (hard to read)

Flesch-Kincaid Grade Level: 10.5 (Eleventh Grade)

The Coleman-Liau Index: 11 (Eleventh Grade)

The SMOG Index: 8.9 (Ninth Grade)

Automated Readability Index: 10.7 (15-17 yrs old/ tenth to Eleventh graders)

Linsear Write Formula: 11.7 (Twelfth Grade)

(ReadabilityFormulas.com, 2018)

Readability consensus

Grade level: 11

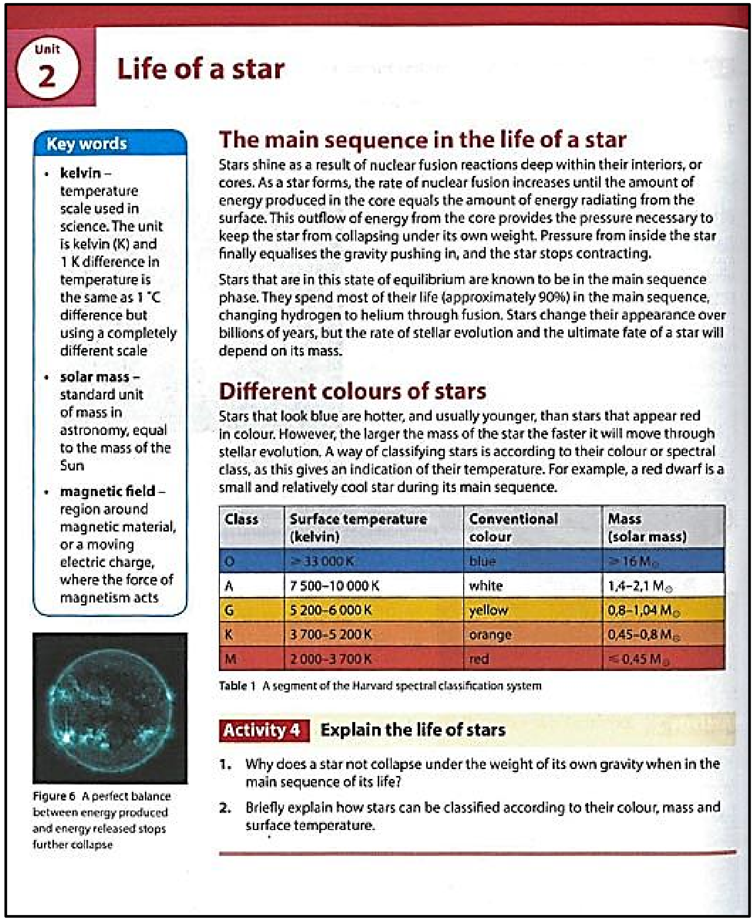
Reading level: Fairly difficult to read

Reader's age: 15-17 yrs old (Tenth to Eleventh graders)

(ReadabilityFormulas.com, 2018)

Table 35: Original text and readability test results (Term 4 learner guide)

Original text



Unit 2

Life of a star

Key words

- **kelvin** – temperature scale used in science. The unit is kelvin (K) and 1 K difference in temperature is the same as 1 ˚C difference but using a completely different scale
- **solar mass** – standard unit of mass in astronomy, equal to the mass of the Sun
- **magnetic field** – region around magnetic material, or a moving electric charge, where the force of magnetism acts

Figure 6 A perfect balance between energy produced and energy released stops further collapse

The main sequence in the life of a star

Stars shine as a result of nuclear fusion reactions deep within their interiors, or cores. As a star forms, the rate of nuclear fusion increases until the amount of energy produced in the core equals the amount of energy radiating from the surface. This outflow of energy from the core provides the pressure necessary to keep the star from collapsing under its own weight. Pressure from inside the star finally equalises the gravity pushing in, and the star stops contracting.

Stars that are in this state of equilibrium are known to be in the main sequence phase. They spend most of their life (approximately 90%) in the main sequence, changing hydrogen to helium through fusion. Stars change their appearance over billions of years, but the rate of stellar evolution and the ultimate fate of a star will depend on its mass.

Different colours of stars

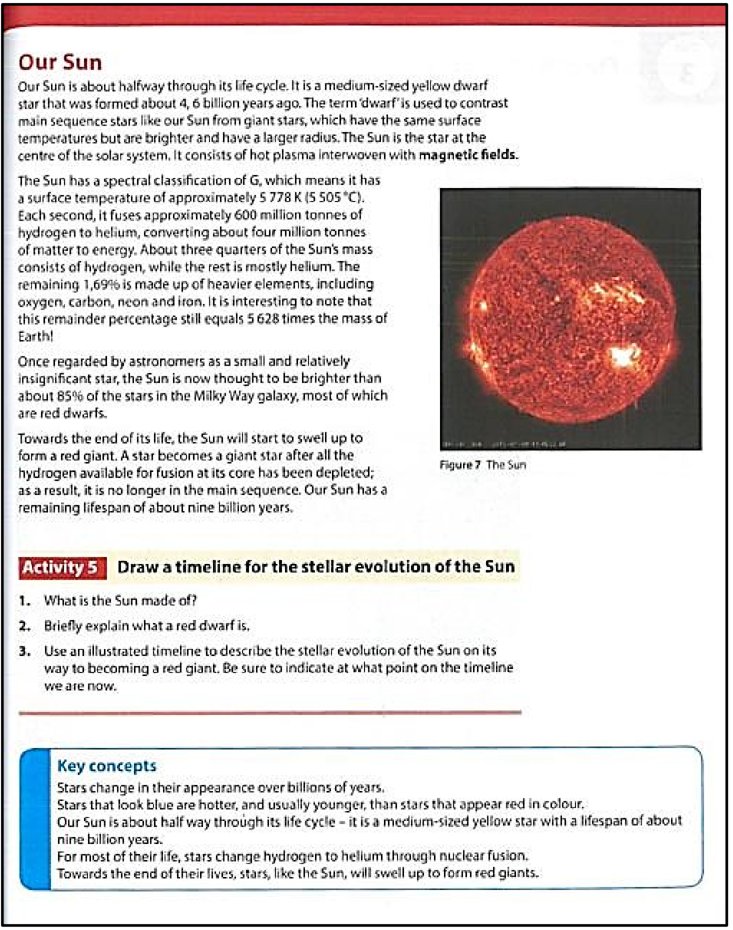
Stars that look blue are hotter, and usually younger, than stars that appear red in colour. However, the larger the mass of the star the faster it will move through stellar evolution. A way of classifying stars is according to their colour or spectral class, as this gives an indication of their temperature. For example, a red dwarf is a small and relatively cool star during its main sequence.

Class	Surface temperature (kelvin)	Conventional colour	Mass (solar mass)
O	≥ 33 000 K	blue	≥ 16 $M_\odot$
A	7 500–10 000 K	white	1,4–2,1 $M_\odot$
G	5 200–6 000 K	yellow	0,8–1,04 $M_\odot$
K	3 700–5 200 K	orange	0,45–0,8 $M_\odot$
M	2 000–3 700 K	red	≤ 0,45 $M_\odot$

Table 1 A segment of the Harvard spectral classification system

Activity 4 **Explain the life of stars**

1. Why does a star not collapse under the weight of its own gravity when in the main sequence of its life?
2. Briefly explain how stars can be classified according to their colour, mass and surface temperature.



Our Sun

Our Sun is about halfway through its life cycle. It is a medium-sized yellow dwarf star that was formed about 4, 6 billion years ago. The term 'dwarf' is used to contrast main sequence stars like our Sun from giant stars, which have the same surface temperatures but are brighter and have a larger radius. The Sun is the star at the centre of the solar system. It consists of hot plasma interwoven with **magnetic fields**.

The Sun has a spectral classification of G, which means it has a surface temperature of approximately 5 778 K (5 505 °C). Each second, it fuses approximately 600 million tonnes of hydrogen to helium, converting about four million tonnes of matter to energy. About three quarters of the Sun's mass consists of hydrogen, while the rest is mostly helium. The remaining 1,69% is made up of heavier elements, including oxygen, carbon, neon and iron. It is interesting to note that this remainder percentage still equals 5 628 times the mass of Earth!

Once regarded by astronomers as a small and relatively insignificant star, the Sun is now thought to be brighter than about 85% of the stars in the Milky Way galaxy, most of which are red dwarfs.

Towards the end of its life, the Sun will start to swell up to form a red giant. A star becomes a giant star after all the hydrogen available for fusion at its core has been depleted; as a result, it is no longer in the main sequence. Our Sun has a remaining lifespan of about nine billion years.

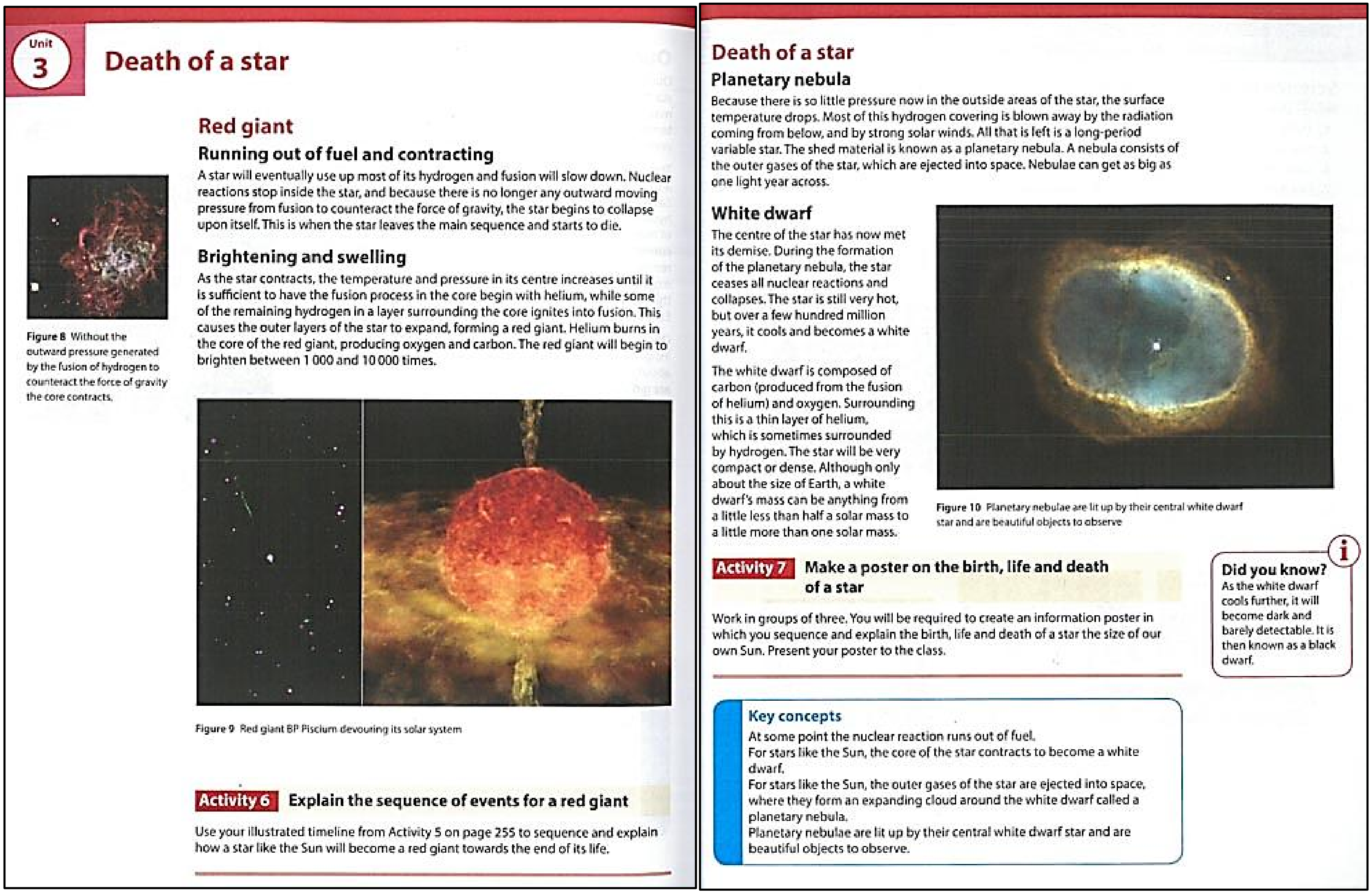
Figure 7 The Sun

Activity 5 **Draw a timeline for the stellar evolution of the Sun**

1. What is the Sun made of?
2. Briefly explain what a red dwarf is.
3. Use an illustrated timeline to describe the stellar evolution of the Sun on its way to becoming a red giant. Be sure to indicate at what point on the timeline we are now.

Key concepts

Stars change in their appearance over billions of years.
Stars that look blue are hotter, and usually younger, than stars that appear red in colour.
Our Sun is about half way through its life cycle – it is a medium-sized yellow star with a lifespan of about nine billion years.
For most of their life, stars change hydrogen to helium through nuclear fusion.
Towards the end of their lives, stars, like the Sun, will swell up to form red giants.



Unit 3

Death of a star

Red giant

Running out of fuel and contracting

A star will eventually use up most of its hydrogen and fusion will slow down. Nuclear reactions stop inside the star, and because there is no longer any outward moving pressure from fusion to counteract the force of gravity, the star begins to collapse upon itself. This is when the star leaves the main sequence and starts to die.

Figure 8 Without the outward pressure generated by the fusion of hydrogen to counteract the force of gravity the core contracts.

Brightening and swelling

As the star contracts, the temperature and pressure in its centre increases until it is sufficient to have the fusion process in the core begin with helium, while some of the remaining hydrogen in a layer surrounding the core ignites into fusion. This causes the outer layers of the star to expand, forming a red giant. Helium burns in the core of the red giant, producing oxygen and carbon. The red giant will begin to brighten between 1 000 and 10 000 times.

Figure 9 Red giant BP Piscium devouring its solar system

Activity 6 **Explain the sequence of events for a red giant**

Use your illustrated timeline from Activity 5 on page 255 to sequence and explain how a star like the Sun will become a red giant towards the end of its life.

Death of a star

Planetary nebula

Because there is so little pressure now in the outside areas of the star, the surface temperature drops. Most of this hydrogen covering is blown away by the radiation coming from below, and by strong solar winds. All that is left is a long-period variable star. The shed material is known as a planetary nebula. A nebula consists of the outer gases of the star, which are ejected into space. Nebulae can get as big as one light year across.

White dwarf

The centre of the star has now met its demise. During the formation of the planetary nebula, the star ceases all nuclear reactions and collapses. The star is still very hot, but over a few hundred million years, it cools and becomes a white dwarf.

The white dwarf is composed of carbon (produced from the fusion of helium) and oxygen. Surrounding this is a thin layer of helium, which is sometimes surrounded by hydrogen. The star will be very compact or dense. Although only about the size of Earth, a white dwarf's mass can be anything from a little less than half a solar mass to a little more than one solar mass.

Figure 10 Planetary nebulae are lit up by their central white dwarf star and are beautiful objects to observe

Activity 7 **Make a poster on the birth, life and death of a star**

Work in groups of three. You will be required to create an information poster in which you sequence and explain the birth, life and death of a star the size of our own Sun. Present your poster to the class.

Did you know?
As the white dwarf cools further, it will become dark and barely detectable. It is then known as a black dwarf.

Key concepts

At some point the nuclear reaction runs out of fuel.
For stars like the Sun, the core of the star contracts to become a white dwarf.
For stars like the Sun, the outer gases of the star are ejected into space, where they form an expanding cloud around the white dwarf called a planetary nebula.
Planetary nebulae are lit up by their central white dwarf star and are beautiful objects to observe.

Readability test results
Flesch Reading Ease score: 65.6 (standard/average) **Gunning Fog:** 11.5 (hard to read) **Flesch-Kincaid Grade Level:** 8.5 (Ninth Grade) **The Coleman-Liau Index:** 8 (Eighth Grade) **The SMOG Index:** 8.3 (Eighth Grade) **Automated Readability Index:** 7.8 (12-14 yrs old/ Seventh and Eighth graders) **Linsear Write Formula:** 10.8 (Eleventh Grade) (ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 9 **Reading level:** Standard/Average **Reader's age:** 13-15 yrs old (Eighth and Ninth graders) (ReadabilityFormulas.com, 2018)

Table 36: Original text and readability test results (Term 4 teacher guide)

Original text

Unit 2: Life of a star

Teaching guidelines

The main sequence of the star is the period where there is a perfect balance between energy produced and energy released, which prevents any further contraction.
Note: The segment of the Harvard spectral classification system only shows the first five classes and the conventional colour. The full table and other methods of star classification can be viewed at http://en.wikipedia.org/wiki/Stellar_classification.

Activity 4: Explain the life of stars

LB page 254

Answers

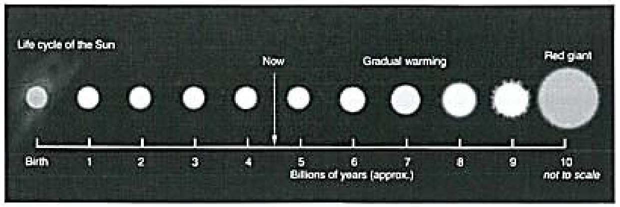
1. The rate of nuclear fusion increases until the amount of energy produced in the core equals the amount of energy radiating from the surface. This outflow of energy from the core provides enough outward pressure to keep the star from collapsing under its own weight. Pressure from inside the star finally equalises the gravity pushing in, and the star stops contracting.
2. Stars that look blue are hotter and usually younger than stars that appear red in colour. The larger the mass of the star the faster it will move through stellar evolution. A red dwarf is a small and relatively cool star on the main sequence. Stars can be classified according to their colour or spectral class, which gives an indication of their temperature.

Activity 5: Draw a timeline for the stellar evolution of the Sun

LB page 255

Answers

1. About three quarters of the Sun's mass consists of hydrogen, while the rest is mostly helium. The remaining 1,69% is made up of heavier elements including oxygen, carbon, neon and iron.
2. Learners need to do further research to provide a detailed answer. A red dwarf is a small and relatively cool star on the main sequence. They develop very slowly because in those with less than 35% of the Sun's mass, the helium produced by the thermonuclear fusion of hydrogen is constantly remixed throughout the star, avoiding a build-up at the core. They therefore develop over hundreds of billions of years until their fuel is depleted. We have no red dwarfs of advanced age to study because the universe is believed to have only existed for about 14 billion years.
3. Learners' timelines should show a) that the Sun gradually gets larger, b) that when it becomes a red giant it is very large, c) that at present it is about halfway through its lifespan. The timeline shown below is more complicated than what you should expect learners to draw, but it gives a model. Make sure learners understand that after the Sun has become a red giant, it starts to die.



Extension for this unit

Learners can research and write a presentation about what the future holds for planet Earth as the Sun goes through its stellar evolution.

Unit 3: Death of a star

Teaching guidelines

The sequence of events to take place when a star dies depends on its mass. This unit will focus primarily on what happens to stars with an initial solar mass of less than eight solar masses, such as our own Sun. Learners may investigate what happens to larger stars as an extension activity.

Activity 6 Explain the sequence of events for a red giant

LB page 256

Answers

Learners are to draw simple diagrams to illustrate and explain each of the following steps in the formation of a red giant:

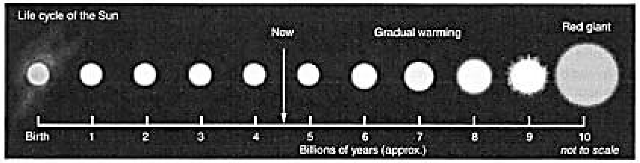
- The star will eventually use up most of its hydrogen and be left with helium.
- There is not enough pressure pressing in on the star to create a nuclear reaction with the helium.
- Nuclear reactions stop happening inside the star.
- Then, because there is no longer any outward moving pressure from fusion, the star begins to contract.
- This collapse creates more and more pressure inside the star until there is enough pressure again to start the fusion process with helium in the core, which produces oxygen and carbon.
- The red giant will begin to brighten between 1 000 and 10 000 times.

Activity 7: Make a poster on the birth, life and death of a star

LB page 257

Answers

Working in groups, learners create illustrated information posters that sequence and explain the life cycle of a star the size of our own Sun. They then present the poster to the class.
What is shown below is a model of a poster using a timeline. Learners' posters will vary. Ensure that they have represented the central facts.



Support for this unit

The best way to support learners with the concepts of this unit on the death of stars is to show them images and videos. If it is not possible to take learners to an observatory or access the Internet, try to acquire educational DVDs on the death of stars, or visit public and teachers' libraries that have the necessary resources.

Readability test results
Flesch Reading Ease score: 60.3 (standard/average) **Gunning Fog:** 11.6 (hard to read) **Flesch-Kincaid Grade Level:** 9.3 (Ninth Grade) **The Coleman-Liau Index:** 9 (Ninth Grade) **The SMOG Index:** 8.3 (Eighth Grade) **Automated Readability Index:** 9.1 (13-15 yrs old/ Eighth and Ninth graders) **Linsear Write Formula:** 11 (Eleventh Grade) (ReadabilityFormulas.com, 2018)
Readability consensus
Grade level: 9 **Reading level:** Standard/Average **Reader’s age:** 13-15 yrs old (Eighth and Ninth graders) (ReadabilityFormulas.com, 2018)

The results of the readability tests conducted on these four samples show that the age range for the texts is slightly higher (13-17 years) than for the *Spot On* guides. The texts are geared toward a higher age group – Grade 9 learners – and teachers. The sample that reflected the highest age range is the teacher guide for Term 3. An examination of this guide revealed that the text is short but dense. The information is presented in a paragraph and many words are fairly long, such as ‘alternative’ and ‘sustainability’, but not necessarily difficult to understand. Thus, although the text is rated as more challenging than the others, it may not necessarily be so.

The readability test results also indicated that the matching texts for Term 3 are ‘Fairly difficult to understand’, whereas the matching texts for Term 4 are both ‘standard/average’. This comes down to the vocabulary used in the texts. The focus of the information in the Term 3 samples is ‘Electricity Generation’ and ‘Alternative Energy Sources’, as a result these lengthy words come up throughout the samples. However, the focus of the Term 4 samples is ‘The Life and Death of a Star’ and the words that appear throughout the text have fewer characters and syllables than the samples from Term 3. Again, this suggests that none of the texts would necessarily be challenging for a Grade 9 teacher to understand.

An observation of the samples was also done to see if the texts meet the selected plain language criteria (this analysis appears in Table 37). As with the *Spot On* samples, these guides met the criteria, on the whole. An overview of the *Platinum* teacher guide did, however, reveal that the information presented there is far vaguer than the information presented in the *Spot On* teacher guide.

Table 37: Compliance with plain language criteria

Plain language criteria	Appearance in the text
An average sentence length of 15-25 words	The readability tests suggest that the sentence length in each of the samples is acceptable and falls within the correct range. My analysis of the samples confirmed this.
Focused paragraphs and lists	The texts do not include any bulleted lists. The paragraphs of information can overwhelm the reader, so more bulleted lists would be beneficial. The paragraphs have been kept relatively short and focused in the learner guides, but they are quite dense in the teacher guides. Lists would help to break up the information for the reader.

Plain language criteria	Appearance in the text
Word choice	The readability tests suggest that the vocabulary is fairly technical in Term 3's samples, and less so in Term 4's samples. It is important to note that this is necessary in these texts because they are educational texts. The wording around the jargon is acceptable, and the technical terms are explained to the readers. There are some terminological descriptions that are confusing – this is indicated on the revised texts.
Favour the active voice	The texts are written in the active voice. This criterion has not come up as an issue in the samples.
Audience, register, and tone	These elements of the texts are also acceptable. However, the teacher guide is a very vague text (more of an answer book than a guide), and if information is added to the text, the target audience must be considered.
Non-sexist/biased language	The information is factually presented, and the plural form of 'learners' and 'they' has been used consistently. The gender neutral pronoun 'you' should be added to contribute to the reader-centred structure.
Reader-centred structure	The texts state what the learners should do. This is acceptable to an extent because the learner guide is for learners and the teacher guide aims to assist teachers in helping learners, but a more clearly reader-centred structure should be considered.
Clear layout	The information is laid out clearly for the readers and there is good use of colour in the learner guide. The information is both vague and dense in the teacher guide. It serves as an answer guide, so there is a lack of information for the readers, but the paragraphs are dense and can be broken up more. No colour is used in the teacher guide (this may be a cost consideration), but colour would enhance some of the content. The headings and subdivisions of information are clear.
Use alternatives to words	Images and colour are used to aid explanations when necessary in the learner guide, although there is some repetition of images.
Quality of content	There are gaps in the content in the teacher guide because it simply functions as an answer book. It would be beneficial to draw the learner and teacher guides together to create a more comprehensive source and eliminate the need to work from two guides.

Plain language strategies are used well in these texts, but the teacher guide is vague in its directions for teachers. Hence, I used the same approach as with the *Spot On* guides and combined the information in the teacher guide, using applicable plain language strategies. Figure 9 demonstrates the revised text for Term 3.

Unit 2: Electricity generation

Layout: Clear platform statement provided

Teaching guidelines

In this unit learners will learn about how power stations operate and about alternative energy sources.

Power stations

Reader-centred structure: Clear statement of what teacher should do

You need to explain to learners how coal power stations operate. They can visit the following website to view video clips of power stations: http://footage.shutterstock.com/clip-1686208-stock-footage-coal-burning-power-plant.html

Introduction:

- The electricity we use every day is produced in power stations in different areas of South Africa.
- A power station generates electricity from a fuel source.
- South Africa uses coal, nuclear and hydropower stations.
- Coal power stations produce about 90% of South Africa's electricity.
- More than 90 million tonnes of coal are burnt every year to produce electricity.

Visual to aid explanation

How coal power stations work:

- Coal is used to heat water and convert it into steam at high temperatures and pressures.
- At a temperature of about 500˚C, the very hot steam is released from the furnace and shot onto the blades of a large turbine through a nozzle.
- The force of the steam makes the wheel turn.
- A generator consists of a turbine and a rotating magnet.
- The turbine is like a windmill consisting of blades on a wheel.
- The kinetic energy from the steam is converted into mechanical energy as the wheel turns.
- The shaft of the turbine is connected to a magnet which rotates as the wheel turns and produces electricity.

Quality of content: Information from learner guide

Alternative energy sources

Once you have covered alternative energy sources, the learners will research alternative energy sources in more detail and make a poster on two of these.

Introduction:

- Coal is not the only energy source that can be used to drive turbines of generators.
- Alternative energy sources are important because coal is a non-renewable fossil fuel. I.e. We can run out of it.

Alternatives to coal:

Quality of content: Learner guide information included.

- **Wind:**
  - An excellent source of renewable energy.
  - Advanced wind turbines capture the wind as efficiently as possible.
  - An inflow of wind activates the blades and the rotor.
  - This spins the main shaft, which is connected to a gearbox in the generator.
  - The generator transforms the kinetic energy of the rotating blades into electrical energy.
- **Falling water:**
  - In hydroelectric power stations the water, that is stored in dams, is released directly onto a turbine of a generator at the base of the dam wall.
  - As the turbine turns, the energy of the falling water is converted into electricity.
  - A pumped storage plant generates electricity in this way too, but the water comes from a large dammed reservoir and flows into a reservoir situated lower down.
  - The water is then pumped back up into the higher reservoir at night, when electricity is cheaper and not being used as much.
- **Sun-heated steam**
  - The Sun's energy can be used to produce steam that will drive a turbine and generate electricity.
  - Flat, movable mirrors called heliostats are used to focus the Sun's rays on a collector tower.
  - The focused rays heat water in the tower and the resulting steam is used to power the turbine for the generator.
- **Nuclear fission** *(discussed in the next unit)*
- **Sea waves**
  - The up and down motion of the waves is converted into electrical energy.
  - A wave power device is used to convert the wave motion into power.

Word choice: An assump-tion of meaning had to be made here based on research.

Activity 5: Research alternative sources of energy

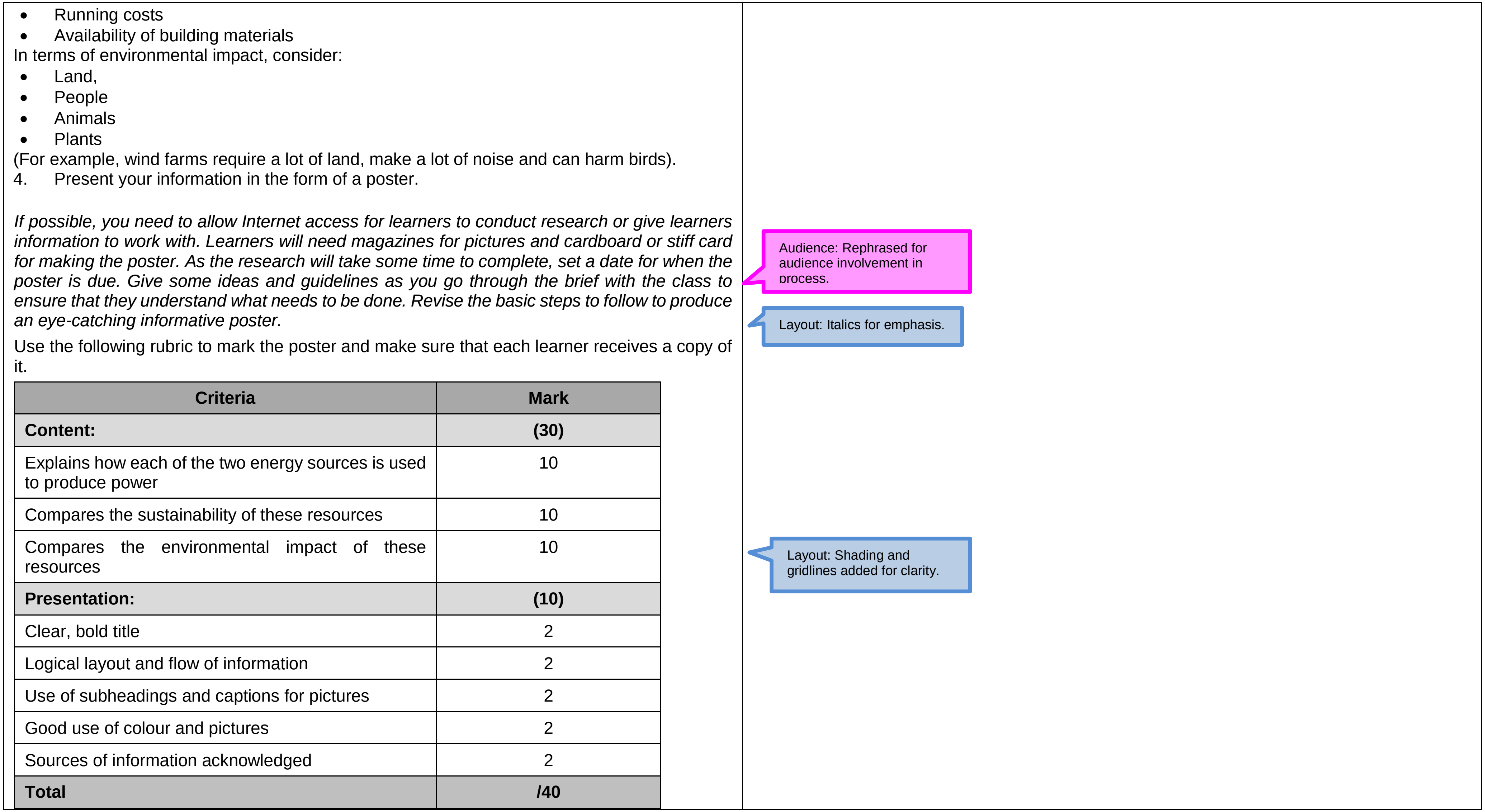
Lists: Information bulleted where possible.

The learners have been asked to do the following:

1. Work in pairs and choose two of the alternative sources of energy in this unit.
2. Research information on how the resources can be used to drive generators for the national grid.
3. Evaluate and compare the chosen resources in terms of their sustainability and environmental impact. In terms of sustainability, consider:

- How long the resource can last

Lists: Numbered list indicates process



- Running costs
- Availability of building materials

In terms of environmental impact, consider:

- Land,
- People
- Animals
- Plants

(For example, wind farms require a lot of land, make a lot of noise and can harm birds).

4. Present your information in the form of a poster.

If possible, you need to allow Internet access for learners to conduct research or give learners information to work with. Learners will need magazines for pictures and cardboard or stiff card for making the poster. As the research will take some time to complete, set a date for when the poster is due. Give some ideas and guidelines as you go through the brief with the class to ensure that they understand what needs to be done. Revise the basic steps to follow to produce an eye-catching informative poster.

Use the following rubric to mark the poster and make sure that each learner receives a copy of it.

Criteria	Mark
Content:	**(30)**
Explains how each of the two energy sources is used to produce power	10
Compares the sustainability of these resources	10
Compares the environmental impact of these resources	10
Presentation:	**(10)**
Clear, bold title	2
Logical layout and flow of information	2
Use of subheadings and captions for pictures	2
Good use of colour and pictures	2
Sources of information acknowledged	2
Total	**/40**

Audience: Rephrased for audience involvement in process.

Layout: Italics for emphasis.

Layout: Shading and gridlines added for clarity.

Figure 9: *Platinum Natural Sciences* Grade 9 revision (Term 3 teacher guide)

The revised text was run through the readability checker to see if it maintained its original readability consensus. The original results for the teacher and learner guides are included in order to draw a comparison. The results appear in Table 38.

Table 38: Revised readability score Term 3 teacher guide

<table>
<tr><th colspan="4">Readability test results</th></tr>
<tr><td colspan="4">Flesch Reading Ease score: 57.1 (fairly difficult to read)
Gunning Fog: 11.3 (hard to read)
Flesch-Kincaid Grade Level: 8.9 (Ninth Grade)
The Coleman-Liau Index: 10 (Tenth Grade)
The SMOG Index: 8.6 (Ninth Grade)
Automated Readability Index: 8.4 (12-14 yrs old/ Seventh and Eighth graders)
Linsear Write Formula: 8.5 (Ninth Grade)</td></tr>
<tr><th colspan="4">Readability consensus</th></tr>
<tr><th>Reading level</th><th>Learner guide</th><th>Teacher guide</th><th>Revised text</th></tr>
<tr><td>Grade level</td><td>9</td><td>11</td><td>9</td></tr>
<tr><td>Reading level</td><td>Fairly difficult to read</td><td>Fairly difficult to read</td><td>Fairly difficult to read</td></tr>
<tr><td>Reader’s age</td><td>13-15 yrs old</td><td>15-17 yrs old</td><td>13-15 yrs old</td></tr>
</table>

(ReadabilityFormulas.com, 2018)

The original results for the Term 3 teacher guide indicated that the text is ‘Fairly difficult to read’, which is the same comment that the revised text received. However, the reader’s age is now reflected at 13-15 years, as opposed to 15-17 years, which suggests that the difficulty of the text has improved. The revised text includes a lot of information from the learner guide, and the readability test for the revised teacher’s guide reflects the same consensus as that for the learner’s guide. This suggests that not much can be done to the difficulty level of the text, because of the nature of the content. However, the text should be comprehensible to a Natural Sciences teacher. Moreover, these results indicate that the additional information did not have a negative impact on the readability of the text; in fact, it enhanced readability.

Figure 10 depicts the revised of Term 4’s teacher guide content.

Unit 2: Life of a star

Teaching guidelines

In this unit, you will discuss the life of a star. It is important that you highlight that the main sequence of a star is the period when there is a perfect balance between energy produced and energy released. This prevents a star from further contraction.

The main sequence in the life of a star

Go through the following with the learners:

- Stars shine as a result of nuclear fusion that takes place in their core.
- The rate of nuclear fusion increases until the amount of energy produced in the core equals the amount of energy radiating from the surface.
- The outflow of energy provides the pressure necessary to keep the star from collapsing under its own weight.
- When the pressure from inside the star equals the gravity pushing in, the star stops contracting.
- Stars in a state of equilibrium are in the main sequence phase.
- Approximately 90% of a star's life is spent in the main sequence, changing hydrogen to helium through fusion.
- Stars change in appearance over billions of years.
- The rate of stellar evolution and the ultimate fate of a star is dependent on its mass.

The different colours of stars

Layout: Colour used enhance to content

The different colours of stars are an indication of their temperature and age. The general rule is:

Blue = hotter and younger Red = Cooler and Older

It is important to note that the larger the mass of a star, the faster it moves through stellar evolution. Stars are classified according to their colour and spectral class – these give an indication of a star's temperature. E.g. A red dwarf is a small and relatively cool star during its main sequence.

Class	Surface temperature (kelvin)	Conventional colour	Mass (solar mass)
O	≥ 33 000 K	Blue	≥ 16 Mo
A	7 500 – 10 000 K	White	1,4 – 2,1 Mo
G	5 200 – 6 000 K	Yellow	0,8 – 1,04 Mo
K	3 700 – 5 200 K	Orange	0,45 – 0,8 Mo
M	2 000 – 3 700 K	Red	≤ 0,45 Mo

The table is a segment of the Harvard spectral classification system.

Note! This table only shows the first five classes and the conventional colour. The full table and other methods of star classification can be viewed at: http://en.wikipedia.org/wiki/Stellar_classification

Quality of content: Information in guides brought together.

Activity 4: Explain the life of stars

1. Why does a star not collapse under the weight of its own gravity when in the main sequence of its life?
   - **The rate of nuclear fusion increases until the amount of energy produced in the core equals the amount of energy radiating from the surface.**
   - **The outward flow of energy provides enough outward pressure to keep the star from collapsing under its own weight.**
   - **When the pressure inside the star equals the gravity pushing in, the star stops contracting.**
2. Briefly explain how a star's colour, mass and surface temperature are inter-related.
   - **Blue stars are usually hotter and younger than stars that appear red in colour.**
   - **The larger the mass of the star, the faster it will move through stellar evolution.**
   - **A red dwarf is a small and relatively cool star on the main sequence.**
   - **Stars can be classified according to their colour or spectral class, which indicates their temperature.**

Layout: Answers in bold.

Our Sun

Tell the learner's the following facts about the lifecycle of our Sun:

- It is about halfway through its lifecycle.
- It is a medium-sized yellow dwarf that was formed approximately 4,6 billion years ago.
  (The term 'dwarf' is used to differentiate main sequence stars like our Sun from giant stars, which are brighter and have a larger radius).
- The Sun is in the centre of our solar system.
- It consists of hot plasma interwoven with magnetic fields.
- It is classified as 'G' on the spectral classification system.
- 600 million tonnes of hydrogen and helium are fused every second on the Sun. This results in 4 million tonnes of matter that is converted into energy.
- Three-quarters of the Sun's mass is hydrogen. The rest is mostly helium, although 1,69% is made up of heavier elements like oxygen, carbon, neon, and iron – 5 628 times the mass of Earth.
- The Sun is thought to be brighter than 85% of stars in the Milky Way galaxy, although it was once considered relatively small.

- Most of the stars in the Milky Way are red dwarfs.
- Towards the end of its life, the Sun will start to swell up to form a red giant. (A star becomes a giant after all hydrogen available for fusion gets depleted, leading to it no longer being in the main sequence).
- Our Sun has a remaining lifespan of approximately 9 billion years.

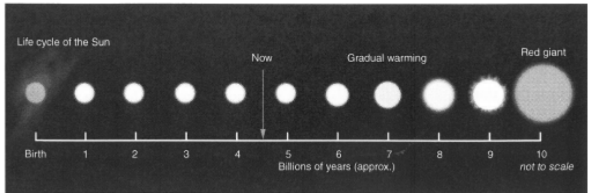
Reader-centred structure: Teacher focus

Activity 5: The stellar evolution of the Sun

1. What is the Sun made of?
    - **Three-quarters hydrogen**
    - **The rest is primarily helium**
    - **1,69% of heavier elements, including oxygen, carbon, neon, and iron.**
2. Briefly explain what a red dwarf is.
    - **A small, relatively cool star in the main sequence.**
    - **It develops slowly because in those with less than 35% of the Sun's mass, the helium produced by the thermonuclear fusion of hydrogen is constantly remixed, resulting in no build-up at the core.**
    - **They develop of hundreds of billions of years, until their fuel is depleted.**
    - **There are no red dwarfs of advanced age to study because it is believed that our universe is only approximately 14 billion years old. (Learners need to do their own research to develop a detailed answer).**
3. Use an illustrated timeline to depict the stellar evolution of the Sun on its way to becoming a red giant. Indicate at what point in the timeline the Sun is now.

    The learners' timelines must show:
    - **The Sun gets gradually larger.**
    - **When it becomes a red giant, it is very large.**
    - **It is roughly halfway through its lifespan.**

    The example depicted below is more detailed than the one you can expect of learners, but it gives you an indication of what you can expect to see. Learners must understand that when the Sun becomes a red giant, it starts to die.



Visual: Duplicate image removed.

Unit 3: Death of a star

Teaching guidelines

This unit will focus primarily on what happens to stars with an initial solar mass of less than eight solar masses, such as our Sun. You need to highlight that the sequence of events that take place when a star dies, depend on its mass.

This unit has been sub-divided into two sections: Red giant and Death of a star

Quality of content: Facts provided for teacher.

Red giant

- Running out of fuel and contracting
    - Every star will eventually use up most of its hydrogen and fusion will slow down.
    - When the nuclear reactions inside the star stop, there is no longer outward pressure to counteract the force of gravity. As a result, the star begins to collapse on itself.
    - At this point the star leaves the main sequence and starts to die.
- Brightening and swelling
    - As the star contracts, the temperature and pressure in its centre increase. Eventually it increases enough for the helium in the core to fuse with the remaining hydrogen in the layer surrounding the core.
    - As a result, the outer layers of the star expand and it forms into a red giant.
    - As helium burns in the core of the red giant, it produces oxygen and carbon.
    - This combination of elements leads the star to brighten between 1 000 and 10 000 times its usual brightness.

Activity 6: Explain the sequence of events for a red giant

Use your illustrated timeline from Activity 5 to sequence and explain how a star like the Sun will become a red giant toward the end of its life.

Learners must demonstrate each of the following steps in the formation of a red giant:

- **The star will eventually use up most of its hydrogen and be left with helium.**
- **There is not enough pressure pressing in on the star to create a nuclear reaction with the helium.**
- **Nuclear reactions stop happening inside the star.**
- **Because there is no outward moving pressure from fusion, the star begins to contract.**
- **This collapse creates more and more pressure inside the star until there is enough pressure to start the process of fusion with helium in the core, which produces oxygen and carbon.**
- **The star then brightens between 1 000 and 10 000 times its usual brightness.**

Death of a star

- Planetary nebula
  - The low pressure on the outside areas of the star leads to a drop in surface temperature.
  - As a result, the hydrogen covering is blown away by the radiation coming from below, and by the strong winds.
  - All that is left is a long-period variable star.
    The shed materials are known as planetary nebula.
  - A nebula consists of the outer gases of a star, which have been ejected or blown into space.
  - Nebulae can get as big as one light year across.
- White dwarf
  - The centre of the star has now met its demise.
  - During the formation of planetary nebula, the star ceases all nuclear reactions and collapses.
  - The star is still very hot, but over a few hundred million years, it cools and becomes a white dwarf.
  - A white dwarf is composed of carbon (produced from the fusion with helium) and oxygen.
  - Surrounding this is a thin layer of helium, which is sometimes surrounded by hydrogen.
  - The star is very compact and dense.
  - Although only the size of Earth, a white dwarf's mass can be anything from a little less than half a solar mass to a little more than one solar mass.

Activity 7: Make a poster on the birth, life, and death of a star

In groups of three you are required to create an information poster on which you sequence the birth, life, and death of a star the size of our Sun. Present your poster to the class.

- **Learners' posters will vary, but ensure that they have represented the central facts. Refer to the timeline in Activity 5 to ensure that the sequence is correct.**

Figure 10: *Platinum Natural Sciences* Grade 9 revision (Term 4 teacher guide)

The results of the revised text's readability test and the new readability score appear in Table 39, showing that the revised text maintained an acceptable readability level. The original results for the teacher and learner guides have been included in order to draw a comparison.

Table 39: Revised readability score Term 4 teacher guide

Readability test results			
Flesch Reading Ease score: 65.1 (standard/average) **Gunning Fog:** 10.9 (hard to read) **Flesch-Kincaid Grade Level:** 8.2 (Eighth Grade) **The Coleman-Liau Index:** 8 (Eighth Grade) **The SMOG Index:** 8 (Eighth Grade) **Automated Readability Index:** 7.5 (12-14 yrs old/ Seventh and Eighth graders) **Linsear Write Formula:** 8.9 (Ninth Grade)			
Readability consensus			
Reading level	**Learner guide**	**Teacher guide**	**Revised text**
Grade level	9	9	8
Reading level	Standard/average	Standard/average	Standard/average
Reader's age	13-15 yr. old	13-15 yrs old	12-14 yrs old

(ReadabilityFormulas.com, 2018)

The readers' age for the Term 4 revised text went down slightly, compared to the results for the original learner and teacher guides. The age is now reflected as 12-14 years, as opposed to 13-15 years. The level has remained 'standard/average', however. This suggests that the amount of information has not had a negative impact on the comprehensibility of the text.

The information in the teacher guides was considerably enhanced by applying the relevant plain language elements to text. Bulleted lists were included where possible because teachers indicated that as their preference. There was some ambiguity in the explanation of terms and this had to be clarified through my own research; textbook publishers should be careful to avoid potential problems of this nature. The information was adapted to the audience (teachers). This had to be done because the information was taken from the learner guide and teachers do not want to feel as though they are being addressed as learners. A reader-centred structure is adopted for the purpose of clarity.

Overall, the *Platinum* learner guide is a comprehensive source, but the teacher guide is much more sketchy. Gaps in the content can be reduced by drawing the information from the sources together to form a more comprehensive resource.

5.5 CONCLUSION

The results from these analyses indicate that the *CAPS* document could be significantly improved to deliver content better to readers by using plain language strategies. The findings of the teacher interviews suggested that there were ways in which the document's communication can be improved, and this was confirmed by the analysis of the document. This content is extremely important to all Senior Phase Natural Science teachers, so the Department of Basic Education should seriously reconsider the presentation of information in this document.

The results of the analysis of the two teacher guides indicate that the presentation of information in these documents is not a problem. The authors and publishers of these documents have clearly given the presentation of the information some thought and present them in an accessible, reader-friendly manner. However, the teacher guides tend to lack important information, and it is recommended that in future editions an effort is made to bring the two guides (teacher and learner guides) together in order to make one comprehensive resource for teachers.

CHAPTER 6:
CONCLUSION

I began this study with only a rudimentary understanding of the role of language in the education system. My research revealed some of the challenges that the South African education system, especially in poor black communities, faces in South Africa in terms of breaking a vicious language cycle. Various historical factors have resulted in poor English language acquisition, and this has filtered into the current generation, which is detrimental because English has become the primary vehicle for education in the country. This has occurred for various reasons, one of which pertains to the observation made by Butcher (2001:83) that '[e]ducation is a process of engagement between two groups of people, learners and teachers. If either is not equipped to engage effectively, it is unlikely to succeed'. It is difficult for learners to develop beyond the limitations they have inherited and which continue to be imposed upon them, and this has led to a language crisis in the South African education system.

The aim of this exploratory qualitative mixed methods research was to show whether and how using Plain English to communicate subject matter to Senior Phase Natural Science teachers who lack solid English proficiency can help them to understand the curriculum and subject matter. In order to do this, a comprehensive literature review was conducted which helped to gather information on the role and influence of language in the education system in South Africa, gain an understanding of science education in South Africa, outline plain language definitions, understand the history of plain language globally and locally, and establish the role of plain language in science education. All of this information was used to underpin a solid working definition for plain language that could be usefully applied in the study and the establishment of plain language criteria for the study.

Interviews were conducted with nine science teachers in Gauteng in 2018 and one non-Gauteng teacher completed the same interview schedule/questionnaire via email. The interviews established how teachers felt about the resources available to them, focusing on the *CAPS* document and their selected learner and teacher guides. They also showed how these teachers respond to the preliminary plain language criteria through the use of examples. These findings informed the selection of materials that would be analysed later in the study and helped to establish a final set of plain language criteria.

An analysis of the resources selected for the study revealed that the *CAPS* document, particularly the section deemed most important by the teachers (the Natural Science content and concepts), could implement the selected plain language criteria more effectively to make the document more clear, concise, and comprehensible for readers. The analyses conducted on *Spot On Natural Sciences* for Grade 8 and *Platinum Natural Sciences* for Grade 9 revealed that the documents had already made good use of the plain language criteria selected for the study. However, the learner and teacher guides could be combined as a teacher resource to provide a more complete, user-friendly, and navigable resource without having a negative impact on the readability of the document.

This chapter provides a summary of the main findings, a reflection on the study, and some concluding remarks. In my reflection, I discuss the contributions of the study, as well as the limitations and recommendations for further research.

6.1 SUMMARY OF MAIN FINDINGS AND RECOMMENDATIONS

The literature review confirmed that science education in South Africa is in crisis in the Senior Phase. South Africa had the lowest performance in science out of the 39 countries involved in the TIMSS study (Reddy *et al*., 2016:3-16). This reveals that effort needs to go into improving various aspects of science education in this phase, including resources for both learners and teachers. The literature also indicated that non-fee paying public schools (those in poor black communities) are the worst performers out of the types of schools in the country. Factors such as large class sizes and home circumstances as well as language challenges lead to poor discipline in the classroom, which further exacerbates the situation. One participant in my study stated that these factors cloud the problems with English language proficiency and illiteracy in the classroom. This participant argued that this is not just her/his feeling, but the general consensus amongst teachers in the community. As a result, this participant reverts to code-switching (commonplace in classroom environments like this) in order to try to get concepts across to learners in the limited class time available. Unfortunately, code-switching leads to further problems because learners are still assessed in English and struggle to translate key concepts into the language of learning and teaching.

The abovementioned factors indicate that South African schooling, particularly in poor black communities, faces a multitude of challenges in the education environment that partially emanate from and culminate in poor English language proficiency, creating a vicious cycle.

The teachers who were interviewed for the study highlighted areas that may contribute to this crisis. Some of the participants were open about the fact that they did not prioritise their Senior Phase teaching. They tended to focus on the FET Phase. Moreover, they indicated that they felt that the Department of Education also does not prioritise Senior Phase teaching. They found the resources lacking and the *CAPS* document (the document that communicates departmental guidelines to teachers) unclear regarding its expectations of teachers. One of the participants indicated that s/he was able to find many resources online that assist with FET Phase teaching and learning, but few that assist with the Senior Phase. Moreover, the *CAPS* document for FET Phase Physical Science is divided into three separate, useful and concise documents for readers, whereas the Senior Phase document is more difficult to navigate and does not provide technical definitions and exam guidelines. The Department of Education has also made it compulsory for schools to use *CAPS*-compliant textbooks, but two of the participants in the study revealed that they have to make photocopies of the textbooks for learners because the learners cannot afford them. These tentative findings suggest that aside from the problems that non-fee paying public schools already face, the Senior Phase may not be getting the attention and focus it needs to develop scientifically literate learners.

While there was consensus amongst the interviewees that learners lack proficiency in the language of learning and teaching (English), none of the teachers were willing to admit their own language proficiency challenges – even though some of them tangentially indicated that they struggle with some language areas. The interviewed teachers may not lack overall proficiency in the language of learning and teaching, but their unwillingness to admit that there might be a problem is something that hampers real insight. This finding pointed toward the importance of accessible resources (in terms of language) for teachers.

Research into the plain language movement revealed that many countries, including South Africa, have implemented policies that encourage this style of content delivery. However, there is no consensus on the definition for plain language. Furthermore, the science community has not yet embraced plain language, even though there are some proponents for this movement, suggesting that plain language is feasible in this field; consequently, I developed my own working definition for this study.

Closer analysis pointed to the importance of the *CAPS* document – one participant stated that it is a ‘teaching Bible’ – but also the lack of user-friendliness of the document. Some participants even indicated that they did not use the document for this reason. It was clear, based on the interviewees’ responses to the revised plain language texts, the readability tests, my analysis of the texts’ compliance with plain language criteria, and the revised text samples, that the *CAPS* document could benefit tremendously by implementing the criteria that were selected for this study. For such important content, there needs to be a stronger focus on its delivery.

The study revealed that there are a number of *CAPS*-compliant resources available to teachers, and that the ones selected for analysis, *Spot On Natural Sciences* and *Platinum Natural Sciences*, already apply some plain language strategies. However, there are limitations to the ones selected for this study. The selected plain language criteria have generally been applied well to the learner guides, and generally quite well to the teacher guides. However, teachers currently have to refer to two sources to get all of the information they need (the teacher and learner guides). This is not practical in an environment where time is already limited. Moreover, some of the interviewed teachers stated that they cannot rely on the guides for the delivery of challenging content to learners, suggesting that the quality and/or quantity of content may be a problem in these documents. If plain language criteria are effectively applied, they could eliminate gaps in content or at least make them more obvious, so that they can be addressed. It is beyond the scope of this study to comment on the curriculum itself, but, based on the findings, it can recommend both the use of plain language and the combination of the learner and teacher guides in the resources for teachers in future editions of these texts.

6.2 REFLECTING ON THE STUDY

The contributions and limitations of the study and recommendations for further research are discussed below.

6.2.1 Contributions

The most significant contribution of this study is that it goes beyond identifying the challenges of multilingualism by proposing proactive use of Plain English to make pertinent information accessible, and specific criteria to use. The study is exploratory in its use of mixed methodology, which is not common in the English Studies context, to address the potential application of Plain English.

The aim was pursued by conducting a thorough literature review that provided valuable insight into the problem area (language in education and science education) and the plain language movement. Using this information, I was able to develop a sound workable definition for the study. This definition was used to inform the selection of preliminary plain language criteria for the study, which were refined into a usable set of criteria (see Appendix C).

Qualitative, open-ended interviews were useful in providing an understanding of science teachers' perspectives of the resources available to them. By interviewing teachers from different backgrounds, I was able to gain valuable insight into various perspectives on this matter. Furthermore, their responses to the plain language examples presented to them helped to get a sense of whether or not the selected criteria could positively influence the delivery of content to science teachers in the Senior Phase. Such testing of Plain English outcomes is not undertaken often enough and makes a strong contribution to knowledge on whether the criteria work.

By using this data, a useful list of plain language criteria could be developed and used on text samples to assess whether or not these ultimately influence the readability of resources. The results of the readability tests were positive and indicated that these criteria could indeed potentially improve the delivery of content to teachers and, consequently, learners. Although there are limitations to this research (discussed below), this is a good starting point for ultimately developing and presenting resource content to teachers so that they can develop their confidence in what they have to teach and develop learners who are prepared to further their science education. This research does not claim to offer a full solution to the science education crisis in our country because the problems are manifold, but offers a useful strategy to assist in the delivery of content.

6.2.2 Limitations and recommendations for further research

This research makes a useful contribution to knowledge on the use of Plain English in South African science teaching, although there are some limitations to the study. These can be seen as opportunities for further research.

With regard to the interview data, the selected sample is not a statistically significant sample and therefore no clear trends can be predicted based upon this data. However, long and in-depth discussions with the participants took place. The purpose of these interviews was not to gather statistically significant information, but to gain qualitative insight into science teachers' perspectives of the resources available to them and the plain language criteria selected for the study. This is valuable information that I could use to inform my final criteria and analyses. A larger sample was not necessary for this insight, and data saturation was reached for many of the data.

The sample did reflect the heterogeneity of the South African teaching body, but it was not a representative sample, as there were not many township school teachers. Moreover, 50% of the interviewees were home language English speakers, which does not represent South Africa's demographics. However, as stated previously, the goal was not to come to quantifiable conclusions but simply to gain valuable insight, which this sample provided. In future, larger samples could be used, and a strong attempt could be made to recruit more participants from rural and township schools, as well as more second or third language speakers of English, to confirm or contradict the findings of my study.

The readability tests are all based on the American schooling system, which means that the study could provide no unambiguous understanding how reader-friendly the texts actually are for the South African context. As Cutts (2013:235) says, '[t]he most important thing is testing, as people who read and write fluently can only guess what these people can understand'. Thus, it is recommended that a study into how readability tests can be adapted to the South African education system would help those who develop content to see how it suits the local context.

Furthermore, the interviews pointed toward a problem with the quality of content in teacher and learner guides. Although plain language can be used to bring together the sources of information, it cannot improve upon the accuracy of the information in these guides. More research could go into this area in order to determine if these sources need to be more accurate and detailed in the information they present to learners and teachers. This implies that in future research authors and publishers might be included among the participants to ascertain information around how the content is generated and quality controls.

The research indicated that plain language was largely developed by/for first language English speakers. Thus, it is still not fully understood if the application of these criteria would necessarily benefit the non-first language English speakers for whom this study was intended. This is a relatively new movement in South Africa, and I am a first language English speaker with a limited sense of what it is like for people approaching language from a second language perspective. Thus, further investigation into Plain English for non-first language speakers is an area for further investigation.

One of the biggest problems that the basic education system still faces is the inability of many South Africans to speak, read and write in English, the language in which many are taught. There is also subtractive bilingualism (Plüddemann, 2013:21), which means that both languages remain underdeveloped. Overcoming these obstacles takes more than improving the presentation of information in teacher resources. Thus, further investigation into improving teacher literacy and ways in which to avoid or overcome subtractive bilingualism could be an avenue for further exploration.

Furthermore, it was noted that Foundation Phase learning needs to be prioritised as this has been identified as the area where the problems lie. Many learners are functionally illiterate as a result of their Foundation Phase education. Consequently, learners' results across the board suffer in the Intermediate, Senior, and FET Phases because they lack the basic foundations for further learning. Plain language helps those who are already functionally literate to some degree (however that is defined), which implies that it does not matter how information is presented if the person reading it is functionally illiterate.

Other problems, such as 'family structure [which] is a very strong determinant of educational outcomes such as enrolment rates, number of grades completed and student achievement' (Spaull *et al*., 2016:10) and class size are also things that need to be considered in the equation. This is a factor that one of the participants in the study indicated was a problem. This suggests that plain language interventions could have little impact in an environment where the problems go beyond language understanding. Further studies need to be undertaken to see how best to overcome these bigger issues that affect the basic education system in South Africa. Plain language is an intervention that could help the teacher to grasp content more easily, but does not resolve the bigger issues we face.

Furthermore, regulations mean that no actual changes can be made to any of the documents selected for the study. The adapted texts could only be used as support material. If the recommended changes were to be implemented in the documents, they may also increase the length of the text in some places, making them more expensive. These issues would have to be explored by those who create the documents in the first place, such as government departments and publishers, but this study offers a tentative example of what future studies might consider.

6.3 CONCLUDING REMARKS

'Plain English is not an absolute' as Cutts (2013:xiii) rightly points out, but administering plain language principles when one is still learning (and teaching) is helpful. Thus, it would be beneficial to implement relevant plain language strategies in order to aid reader comprehension. In this respect, I heed Cornelius's (2010:173) call to cater for the least experienced readers in our country, and this needs to occur in South African schools by empowering teachers. Throughout, I acknowledge that the development of clear plain language texts requires skilled writers and, for plain language science texts, writers with a good understanding of the subject matter (these two different skillsets do not always go hand in hand). Because of the heterogeneity of the South African population, assumptions about language comprehension often have to be made and applied to the population as a whole, and can at best be approximations.

This study has illuminated various challenges that the South African education system faces and, although these challenges are manifold and not likely to be resolved in the near future, it is hopeful to see that people are taking cognisance of these issues and trying to find ways (whether big or small) to overcome them. The gap between teachers in South Africa may have led to difficulty in developing resources for teachers and presenting the content in such a way that it is pleasing to everyone. Plain language is a strategy that has already been used in resources, but this approach can be developed future in order to improve the presentation and fullness of information for anyone who chooses to access it. We can only move forward in the pragmatic recognition that 'successes and sometimes dreadful defeats will continue to reflect the South African struggle to be a more democratic, enlightened and industrious society' (Aitcheson, 2001:150).

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Appendix A: Participant consent form

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Department of English
University of Pretoria
Pretoria 0002, South Africa
072 117 5166

Participant Consent Form

Dear Prospective Participant

My name is Lauren Fouché. I am a student doing an MA in English at the University of Pretoria under the supervision of Dr Idette Noome, who can be reached at 0124203379 or idette.noome@up.ac.za for further information.

I hereby invite you to participate in the study entitled 'The presence/absence of Plain English in selected Senior Phase science material for educators'.

The purpose of this study is to investigate whether or not selected Senior Phase science material for educators adheres to the principles of plain language to make content more accessible to science educators. The procedure will consist of semi-structured interviews with the aim of gaining an understanding of science teachers' perspectives on the readability and clarity of the Natural Science syllabus through the *Curriculum and Assessment Policy Statement* (*CAPS*) document and through their teacher guides. Each interview will take between 90 and 120 minutes.

Your participation in this study is voluntary. Refusal to participate will involve no penalty. You have a right to withdraw from the study at any time. Any information you provide will be kept completely anonymous. I will ensure that no personal information you provide can be linked to your responses. You are also assured that only the researcher, transcriber and supervisor will have access to the data. Pseudonyms will be used instead of names to ensure anonymity. With your permission the interviews will be audio-taped and saved onto my private computer as a digital back-up. The password-protected computer and audiotapes will be kept in separate secure locations.

As the purpose of this study is to improve upon existing science education material, there are no foreseeable risks in this study. One of the benefits of participating in this study is that you will provide a better perspective of the issues that science teachers face. This may contribute to a potential improvement upon the materials available to science teachers in the Senior Phase in future. The results of the study will be made available to you upon request after the completion of the examining of the dissertation.

Please note that you are under no obligation to answer any questions you are not comfortable with. You are hereby requested to grant your permission to audiotape the interview in order to ensure an accurate record of the information you provide.

My contact details are Lauren Fouche, Tel 0721175166, fouchelauren@gmail.com.

Consent form:

I …………………have read the informed consent form provided above. I voluntarily agree to participate in this study and give permission for the interview to be audio-recorded. I have the right to print a copy of this consent form for my personal information.

I can be contacted for arrangements for the interview at (tel./email) ………………………………

Signature…………………………………..   Date……………………………………….

Humanities 16-29
University of Pretoria
PRETORIA 0002
Republic of South Africa

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www.up.ac.za

Appendix B: Sample interview schedule/Questionnaire

Name: ______________________________ **School:** _________________________

Demographics

1. For how long have you been a science teacher?

Years	Tick
0 – 3	
3 – 5	
5 -10	
10 -15	
15+	

Dates: ___/___/_____ → ___/___/2018

2. Please indicate the type of school at which you currently teach or at which you may previously have taught science.

School type	Current (Tick)	Previous (Tick)
Government school		
Independent/private school		
Semi-private school		
Township school		
Other (please specify):		

3. Do you teach Natural Science to Senior Phase learners (Grades 7 – 9)?

Yes ☐ No ☐

Which Senior Phase grade(s) do you teach?

Senior Phase (Grades 7 – 9)	Tick
Grade 7	
Grade 8	
Grade 9	

4. If you are not a Natural Science teacher in the Senior Phase, please indicate the subject(s) you teach and the grade(s) you teach.

Subject	Intermediate Phase (Grades 4 -6)	Tick	FET Phase (Grades 10 -12)	Tick
Natural Science				
	Grade 4		Grade 10	
	Grade 5		Grade 11	
	Grade 6		Grade 12	
Physical Science				
	Grade 4		Grade 10	
	Grade 5		Grade 11	
	Grade 6		Grade 12	
Life Science				
	Grade 4		Grade 10	
	Grade 5		Grade 11	
	Grade 6		Grade 12	
Other (Please specify):				
	Grade 4		Grade 10	
	Grade 5		Grade 11	
	Grade 6		Grade 12	

5. Do you have a science qualification?

Yes ☐ No ☐

Qualification(s):

____

____

Institution(s):

____

____

6. Do you have a teaching qualification?

Yes ☐ No ☐

Qualification(s):

____

Institution(s):

____

7. Please select your home language and/or languages in which you feel you are proficient (able to speak, read and write).

Language	Home (Tick)	Proficient (Tick)
English		
Afrikaans		
isiZulu		
isiXhosa		
Sepedi		
Setswana		
Sesotho		
Xitsonga		
SiSwati		
Tshivenda		
IsiNdebele		
Other (please specify):		

8. Please select the language in which you teach.

Language	Tick
English	
Afrikaans	
Other (please specify):	
Shift between two or more languages in class	

General awareness of the problem area:

9. Do you find it easy to convey scientific content and concepts to learners in the language of learning and teaching? Please select the option most applicable to you.

Option	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Yes					
It depends on the subject matter					
Reason	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**
Not all learners in the class are proficient in the language of learning and teaching					
I am proficient in the language of learning and teaching					
Complex terminology is difficult to explain to the learners					
Concepts are clearly explained in the learner and/or teacher guide					
There are not a lot of resources available on the topic/s					
Other (please specify):					

10. Are you familiar with the concept of Plain Language*?

Yes ☐ No ☐

*A written communication is in plain language if its wording, structure, and design are so clear that the intended readers can easily find what they need, understand it, and use it. (Cutts, 2013:xii)

Criteria for plain language:

- Short focused sentences and paragraphs
- Words that have one clear meaning
- Active voice, e.g. do this (vs this should be done)
- Application of the KISS principle (Keep It Short and Simple)
- Vertical listing (bullets or numbered points)
- Writing pitched at the correct level (taking the target audience into account regarding their age, background, language proficiency)
- Language that is not sexist or biased
- Reader-centred structure (e.g. going from the known to the unknown, putting important points first)
- A clear layout
- The use of visual aids

CAPS document (Curriculum and Assessment Policy Statement):

11. Do you have a copy of the CAPS document applicable to the subject that you teach? Please provide a reason(s) for your answer.

Response	**Yes**	**No**
I have a hardcopy of the applicable CAPS document		
I have an electronic copy of the applicable CAPS document		
Reason	**Yes**	**No**
You received a copy of the document when you took your teaching post		
You have access to the internet		
You have access to a computer or tablet		
Your copy of the document has gone missing		
Other (please specify):		

12. If you have the applicable CAPS document, how regularly do you refer to this document?

Option	**Tick**
Daily	
Weekly	
Monthly	
At the start of each term	
Never	
Not applicable (I do not have the document)	

13. Do you find the CAPS document easy to use and understand? Please provide a reason(s) for your answer.

Response	**Yes**	**No**
I find the CAPS document easy to use and understand		
Reason	**Yes**	**No**
It is difficult to find what I am looking for		
The explanations are clear		
There is too much unnecessary information		
Other (please specify):		

14. From the list provided please select the elements of the document you find most understandable and useful to those that you find least understandable and useful (1 most understandable; 5 least understandable).

Element	**Number**
The description of science and indigenous knowledge systems (pg. 8)	
The list of resources (pg. 12)	
The detailed summary of Natural Sciences concepts, content and time allocations (pg. 13 -16)	
The Natural Science content and concepts (pg. 17 – 84)	
The assessment schedule (pg. 86 – 93)	

15. Do you feel that the information presented in the CAPS document is adequately communicated to you?

Response	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**
I feel that the information in the CAPS document is adequately communicated					
Reason	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**
Macro structure					
It is easy to find the information you are looking for					
There is a lot of unnecessary information					
The headings are unclear					
Micro structure					
Information is repeated unnecessarily (redundancy)					
The meaning of words or sentences is clear					
The sentences or paragraphs are too long					
The document addresses me as the reader					
The descriptions/explanations are unclear					
Lists or tables are not useful					
Visual aids (e.g. diagrams, tables, graphs) have been provided					
There need to be more specific examples and definitions					
Other (please specify):					

16. Please select the option you find **easier to understand** from the examples provided by ticking the column alongside the example.

Example A	Tick	Example B	Tick
Indigenous knowledge includes knowledge about agriculture and food production, pastoral practices and animal production, forestry, plant classification, medicinal plants, management of biodiversity, food preservation, management of soil and water, iron smelting, brewing, making dwellings and understanding astronomy.		Indigenous knowledge includes knowledge about: • Agriculture • Food production • Pastoral practices • Animal production • Forestry • Plant classification • Medicinal plants • Biodiversity • Food preservation • Soil management • Water management • Iron smelting • Brewing • Building dwellings • Astronomy	
Example A	**Tick**	**Example B**	**Tick**
While it is acknowledged that it is not ideal to have to improvise equipment, teachers should remember that it is more important for learners to have the experience of carrying out a variety of investigations than to depend on the availability of equipment.		It is important for learners to carry out a variety of investigations so, when possible, you must be creative and conduct experiments with the learners.	

Example A	**Tick**
Grade 7 **Term 1: Life and Living**	**9 weeks**
The biosphere • What is the biosphere? • What are the requirements for sustaining life?	**Week 1**
Biodiversity • How do we classify living things? • The diversity of animals • The diversity of plants	**Weeks 2 - 5**
Sexual reproduction • Sexual reproduction in angiosperms (seed bearing plants) • Human reproduction	**Weeks 5 – 8**
Species variation • What is a species? • What is species variation?	**Week 9**

Example B		**Tick**
GRADE	**TERM 1:** LIFE & LIVING	
	TOPIC	**WKS**
7	• **The biosphere** - The concept of the biosphere - Requirements for sustaining life' • **Biodiversity** - Classification of living things - Diversity of animals - Diversity of plants • **Sexual Reproduction** - Sexual reproduction of angiosperms - Human reproduction • **Variation** - Variations exists within a species	1 3 ½ 3 ½ 1 **9 wks**

Teacher Guide:

17. Do you have a science teacher guide?

Yes ☐ No ☐

18. Please name the science teacher guide which you use.

____

____

19. Do the learners have the corresponding learner guide?

Yes ☐ No ☐

If not, please explain how this situation came about:

____

____

____

20. In your opinion, do the two guides correspond closely to each other?

Yes ☐ No ☐

If not, please explain and provide an example of a problematic area:

____

____

____

____

21. Do you feel that the information in the teacher guide is well communicated?

Yes ☐ No ☐

Please comment:

____

____

____

____

22. Do you find it difficult to teach or explain some of the prescribed topics to learners by using only the teacher/learner guide?

Yes ☐ No ☐

Please number the topics from 1 – 4 (1 most problematic; 4 least problematic).

Topic	Number
Life and living	
Matter and materials	
Energy and change	
Planet Earth and beyond	

Please discuss the area(s) you find more difficult to communicate when using only the prescribed teacher/learner guide. (If you are an FET teacher, please explain in which areas you feel the learners are lacking when they reach the class you teach).

23. Does the teacher guide help you to communicate more challenging concepts to learners?

Yes ☐ No ☐ Sometimes ☐

Please comment:

24. Have you had to do a lot of your own research and develop a lot of your own resources in order to communicate challenging concepts more clearly to learners?

Yes ☐ No ☐

Please provide an example:

25. Do you feel that there are any areas of communication that require improvement in the teacher guide?

Response	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**
I feel that there are areas of communication that require improvement in the teacher guide.					
Option	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**
Macro structure					
It is difficult to find the information you are looking for					
There is enough information					
The headings are unclear					
The information in the teacher guide corresponds with that in the learner guide					
Micro structure					
Information is vague					
The meaning of words or sentences is unclear					
The sentences or paragraphs are too long or incomplete					
The document addresses me as the reader					
The descriptions/explanations are unclear					
Lists or tables are useful					
Visual aids (e.g. diagrams, tables, graphs) have not been well used					
There need to be more specific examples and definitions					
Other (please specify):					

26. Please select the option you find easier to understand from the examples provided by ticking the column alongside the example.

Example A	**Tick**
Photosynthesis In this session you need to ensure that learners understand what photosynthesis is. You can do this by reproducing the following equation on the board: Carbon dioxide + Water $\xrightarrow[\text{Sunlight}]{\text{Chlorophyll}}$ Glucose + Oxygen **NB!** Make sure that the learners understand the position of chlorophyll and sunlight in the equation. Even though these are not directly involved in the chemical reaction, the chemical reaction would not happen without them.	

Example B	**Tick**
Learners must be able to understand and reproduce the chemical word equation for photosynthesis. Write it down on the board (or use the poster) so that you can talk them through it slowly and carefully. Ensure that learners understand the positioning of the chlorophyll and sunlight in the equation – these are not directly involved in the chemical reaction, but the chemical reaction would not happen if not for them.	

Example A	**Tick**
The scientific method **The scientific method for writing an experimental report** When we are faced with a scientific problem, there is a specific sequence of steps that we need to follow, in order to come to a reasonable explanation for our problem.	
Example B	**Tick**
Scientific method **How to write an experimental report:** There is a specific sequence of steps that you need to follow when faced with a scientific problem. You need to follow these steps in order to come up with a reasonable explanation for the problem.	

Example A	**Tick**
The flow diagram below outlines the sequence of steps that the scientific method follows: Observation made ↓ A question is formulated ↓ Hypothesis formulated ↓ An experiment is designed ↓ Conduct the experiment ↓ Obtain results ↓ Analyse results ↓ Draw conclusions ↓ Accept or reject hypothesis	
Example B	**Tick**
You must follow the sequence of steps outlined below when writing an experimental report: 10. Make an observation 11. Formulate a question 12. Formulate an hypothesis 13. Design an experiment 14. Conduct the experiment 15. Obtain your results 16. Analyse your results 17. Draw a conclusion 18. Either accept or reject the hypothesis	

27. Are you willing to answer follow-up questions if necessary?

Yes ☐ No ☐

If yes, please provide a telephone number or email address where I can reach you.

____

Thank you!

Appendix C: Plain language criteria

Criteria	Explanation
An average sentence length of 15-25 words	Medium-length sentences were selected for this study because the aim is for teachers to be able to digest information in small amounts, rather than via lengthy explanations.
Focused paragraphs and lists	Each paragraph should have an issue, development and conclusion. Furthermore, a paragraph should be approximately 150 – 200 words in length (Greene, 2013:67). Large chunks of information should be divided into lists in order to make it easier for the reader to digest information (Cutts, 2013:5).
Reader-friendly word choice	Science is a discipline with complex terms, but these terms are often overused or used unnecessarily. As a result, shorter words are favoured over longer words (where possible), terms are kept consistent, and noun strings are broken up.
Active voice	The active voice is more direct than the passive voice, and is often shorter than the passive option. Moreover, active sentences are easier to understand as they reflect the way we speak every day (Greene, 2013: 22). However, in science, where the focus is often on the process rather than the agent, the passive voice is useful and can make a text shorter and more understandable. Hence, the passive has not been omitted entirely but is used only when necessary.
Audience, register, and tone	Writing must be pitched at the correct level. This should be done in such a way that the audience does not feel spoken down to (as if they cannot understand what is being said). For this reason, the register should remain primarily formal but with carefully crafted informal elements (Greene, 2013:7). In addition, the tone should project confidence in the knowledge that is being presented (Greene, 2013:10).
Non-sexist/biased language	It is important to make sure that language is not sexist (Cutts, 2013:34), especially when it comes to the sciences, which are often perceived as dominated by men. Language should also not present any racial or political biases.
Reader-centred structure	By placing the reader at the centre of the text, s/he is able to grasp important information early. The idea behind textbooks is to help the reader to learn information quickly, which is why a reader-centred structure is promoted in this instance.
Clear layout	Layout has an influence on the reader's ability to take information in, so the layout needs to help the reader to access the information. Elements such as font, font size, line spacing, colour, and headings should be considered, as these can influence the reader's experience negatively (Cutts, 2013:246).
Use alternatives to words	According to Cutts (2013:178), '[t]he written word alone is not always the best way of communicating a message. Graphic devices such as tables, illustrations, pie charts, diagrams, maps, strip cartoons, mathematical formulas and photographs can all help.' There are no set rules here, but it is useful to experiment with these alternatives.
Quality of content	There should be careful consideration for the quality of content, because comprehension of 'essential information' (Cutts, 1995:3) is one of the principles of plain language. There should be no gaps in content, explanations should be full and complete, and the reader should not have to draw from two sources to gain a complete understanding (i.e. having to use both the teacher and learner get an idea of what will be covered in class).

Appendix D: Readability test explanations

The tests set out below were used to establish a readability consensus for each text. Each readability consensus was derived from Readability Formulas.com (2018) which combines all these measures.

Formula	Explanation
Flesch Reading Ease Readability Formula	This is a simple approach to assess the grade-level of the reader. This formula is best applied to school texts, but can be used to assess the difficulty of any reading passage written in English. Formula: RE = 206.835 – (1.015 x ASL) – (84.6 x ASW) where RE = Readability Ease ASL = Average Sentence Length (i.e. the number of words divided by the number of sentences) ASW = Average number of syllables per word (i.e. the number of syllables divided by the number of words) RE is a number ranging from 0 to 100. The higher the number, the easier the text is to read. • Scores between 90.0 and 100.0 are considered easily understandable by an average (American) fifth grader. • Scores between 60.0 and 70.0 are considered easily understood by eighth and ninth graders. • Scores between 0.0 and 30.0 are considered easily understood by college graduates.
Gunning's Fog Index (or FOG) Readability Formula	This formula was initially developed for newspapers and business documents, but can be applied to any English text. Method: Step 1: Take a sample passage of at least 100-words and count the number of exact words and sentences. Step 2: Divide the total number of words in the sample by the number of sentences to arrive at the Average Sentence Length (ASL). Step 3: Count the number of words of three or more syllables that are NOT (i) proper nouns, (ii) combinations of easy words or hyphenated words, or (iii) two-syllable verbs made into three with -es and -ed endings. Step 4: Divide this number by the number or words in the sample passage. For example, 25 long words divided by 100 words gives you 25 Percent Hard Words (PHW). Step 5: Add the ASL from Step 2 and the PHW from Step 4. Step 6: Multiply the result by 0.4. Formula: Grade Level = 0.4 (ASL + PHW) where

	ASL = Average Sentence Length (i.e., number of words divided by the number of sentences) PHW = Percentage of Hard Words The underlying message of Gunning's Fog Index formula is that short sentences written in Plain English achieve a better score than long sentences written in complicated language. The ideal score for readability with the Fog index is 7 or 8. Anything above 12 is too difficult for most people to read.
Flesch-Kincaid Grade Level Readability Formula	It was originally developed for the US Navy but is now best suited to the field of education. Method: Step 1: Calculate the average number of words used per sentence. Step 2: Calculate the average number of syllables per word. Step 3: Multiply the average number of words by 0.39 and add it to the average number of syllables per word multiplied by 11.8. Step 4: Subtract 15.59 from the result. Formula: FKRA = (0.39 x ASL) + (11.8 x ASW) - 15.59 where FKRA = Flesch-Kincaid Reading Age ASL = Average Sentence Length (i.e., the number of words divided by the number of sentences) ASW = Average number of syllables per Word (i.e., the number of syllables divided by the number of words) Analysing the results is a simple exercise. For instance, a score of 5.0 indicates a fifth grade school level. This score makes it easier for teachers, parents, librarians, and others to judge the readability level of various books and texts for the students.
The Coleman-Liau Index	This formula was designed to calibrate the readability of all textbooks for the public school system in the US. This formula relies on characters instead of syllables per word. Instead of using syllable/word and sentence length indices, it was developed based on the assumption that computerized assessments understand characters more easily and accurately than counting syllables and sentence length. Formula: CLI = 0.0588L – 0.296S – 15.8 where L = the average number of letters per 100 words. S = the average number of sentences per 100 words. The result indicates the grade at which the text is pitched, e.g. a score of 8.6 would be rounded up to 9, and reflect a grade level of ninth grade.
The SMOG Index	This readability formula estimates the years of education a person needs to understand a piece of writing. Method: Step 1: Take the entire text to be assessed. Step 2: Count 10 sentences in a row near the beginning, 10 in the middle, and 10 in the end for a total of 30 sentences. Step 3: Count every word with three or more syllables in each

	group of sentences, even if the same word appears more than once. Step 4: Calculate the square root of the number arrived at in Step 3 and round it off to nearest 10. Step 4: Add 3 to the figure arrived at in Step 4 to know the SMOG Grade, i.e., the reading grade that a person must have reached if he is to understand fully the text assessed. SMOG grade = 3 + Square Root of Polysyllable Count The SMOG Formula is considered appropriate for secondary age (fourth grade to college level) readers.
Automated Readability Index (ARI)	This is a readability test designed to assess the understandability of a text. The ARI formula outputs a number which approximates the grade level needed to comprehend the text. ARI is derived from ratios representing word difficulty (number of letters per word) and sentence difficulty (number of words per sentence). Formula: $4.71\left(\frac{\text{characters}}{\text{words}}\right)+0.5\left(\frac{\text{words}}{\text{sentences}}\right)-21.43$ ARI outputs a number that approximates the age needed to understand the text. As a rough guide, US grade level 1 corresponds to ages 6 to 8.
Linsear Write Readability Formula	This is a readability formula used to score the difficulty of English text. The US Air Force first developed this formula to help calculate the readability of their technical manuals. Like many readability formulas, the Linsear Write calculates the US grade level of a text sample based on sentence length and the number of words with three or more syllables. Method: Step 1: Find a 100-word sample from your writing. Step 2: Calculate the easy words (defined as two syllables or less) and place a number '1' over each word, even including a, an, the, and other simple words. Step 3: Calculate the hard words (defined as three syllables or more) and place a number '3' over each word as pronounced by the dictionary. Step 4: a) Multiply the number of easy words times '1.' b) Multiply the number of hard words times '3.' Step 5: Add the two previous numbers together. Step 6: Divide that total by the number of sentences. Step 7: a) If your answer is >20, divide by '2,' and that is your answer. b) If your answer is <20 or equal to 20, subtract '2,' and then divide by '2.' That is your answer. Because sentence length and 3+ syllable words influence the results of this formula, you can use shorter sentences and less complex words (1 or 2 syllable words) to lower the score (grade level).

(Readability Formulas, 2018)