

A neo-Vygotskian comparative analysis of the availability of simple scientific concepts in science in the English National Curriculum Year 1 and the South African National Curriculum and Policy Statement Grade 1

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Compulsory Declaration

I declare that this work is my own. Every contribution and quotation from other works in this dissertation have been attributed to the rightful creators and authors through citations and references.

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Date: 24th November 2021

Abstract

South Africa continues to lag behind other countries in mathematics and science in benchmarks tests such as the TIMSS tests. The importance of teaching science early in the school curriculum has been established in research. However, some research indicates that the scientific concepts made available to teachers and students in the Foundation Phase are lacking in depth and are, in fact, not full scientific concepts (Morris, Hardman & Jacklin, 2016). In a bid to establish to what extent scientific concepts are made available to students and teachers, this study analysed and compared the availability of “simple scientific concepts” on the topic of plants for children in their first year of formal schooling in the South African and English National Curricula, as well as educational materials from these countries. This study is continuing the work conducted by Morris, Hardman, and Jacklin (2016), who analysed the prevalence of simple scientific concepts in the Grade R curriculum and materials in South Africa. The notion of a simple scientific concept is derived from Neo-Vygotskian elaborations on scientific and everyday concepts, where simple scientific concepts are the foundations for the development of more complex scientific concepts. A rating scale based on these ideas was used to analyse the materials for simple scientific concepts. The findings of the current study found that in both countries’ curricula and materials are largely composed of “potential scientific concepts”, which are concepts that have the potential to be translated from an everyday concept into a scientific concept by the teacher (if they have sufficient knowledge). Overall, the findings are of concern as studies show that teachers in both nations feel ill-equipped and are lacking in confidence to teach science, and since there are so many potential scientific concepts the teachers must be knowledgeable in order to translate them into scientific concepts for their students. In conclusion, the implications of this study are that the curricula and materials for Year/Grade 1 children in these nations are not conducive to them acquiring simple scientific concepts.

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Chapter 1: Introduction

1.1. Introduction

In 2014, Anya Morris submitted her dissertation analysing the Grade R *Curriculum and Assessment Policy Statement* (CAPS) in South Africa. Her findings along with Joanne Hardman and Heather Jacklin were later published in the *Journal of Education* (2016). The study was based on Neo-Vygotskian elaborations on Vygotsky's theories on everyday and scientific concepts. The authors created an analytic framework based on these elaborations and used it to assess the Grade R *Curriculum and Assessment Policy Statement* and three textbooks created by the Department of Basic Education. The study found that the Grade R curriculum was lacking in simple scientific concepts and raised concern for children's scientific understanding and development (Morris, 2014; Morris, Hardman, & Jacklin, 2016). As part of my master's degree I submitted an essay using the analytic framework and criteria from Morris et al. (2016) to analyse a textbook from my field of work, which was a Year 1 Science textbook based on the English National Curriculum (NC). I analysed the section on Plants both in the NC and the textbook and found that these provided mostly potential scientific concepts (concepts which have the potential to prompt a teacher to translate an everyday concept as a scientific one; discussed further in Chapter 3) and not simple scientific concepts. The aim of the current study was to expand on my previous findings by comparing the availability of simple scientific concepts in South African and English teaching materials, such as textbooks and curricula, for teaching the science topic "plants" to children in their first year of formal schooling. The objective was to analyse to what extent simple scientific concepts are made available in both countries' materials on plant science for the first formal year of primary education, and compare the results between the two countries.

1.2. Context and Rationale

This thesis focuses on the first year of science education for children, but there is an argument for introducing science earlier in pre-school years. In England, science has only been included in primary schools relatively recently in the history of schooling, and in the past few decades there has been a push by government policy for an education for all learners but science is not necessarily as central to the primary curriculum in the same way that Maths and English are (Harlen, 2017). This trend of not having science as central as

maths and literacy is also seen in the South African CAPS, where the science study curriculum for Grades R through 3 is called “Beginning Knowledge” and is placed within “Life Skills” and not distinguished by itself as “Natural Sciences and Technology” until Grade 4 (Department of Basic Education, 2011). This is not to say that science is not valued in these national curricula, as one of the strongest themes in national science standards is that all children are able to learn science and should have the opportunity to learn science (Lind, 1998). However, in order for this to happen then children must be introduced to the key experiences of scientific enquiry from an early age, which is not always the case in the countries discussed in this dissertation (Lind, 1998).

Children have been described as natural scientists in educational theories due to their natural curiosity about the world around them (Mantzicopoulos, Patrick, & Samarapungavan, 2008). However, young children rarely receive much time learning about science in schools, with just 6-13% of instruction time in school spent on science in grades one to four (Mantzicopoulos et al., 2008). In a recent report from the Office for Standards in Education in England (Ofsted), there was a worry that science was being “squeezed” out of the curriculum as there no longer is a national curriculum test for science (Ofsted, 2021). This concern is supported by a 2020 survey that found that an average of one hour and 24 minutes was being spent on science education weekly in primary schools in England (Ofsted, 2021). Furthermore in 2018, children leaving primary school were tested and just 21.8% of the 8139 children had reached the expected standard in science (Ofsted, 2021). In the South African CAPS document, “Beginning Knowledge” is only allocated one hour of instructional time a week (Department of Basic Education, 2011). A worry about science literacy performance is also seen in South Africa, where the Trends In International Mathematics And Science Study (TIMSS) reported that only 28% of the 11903 participants at the grade 4/5 level had acquired basic science knowledge (Reddy et al., 2019). This is a concern, since research has shown that when children attend pre-school and have an effective primary science education, it can have positive effects many years later into their secondary/high school science attainment (Novak, 2005; Sammons, Sylva, & Melhuish, 2011). The lack of time spent on science in early education could be due to traditional psychological theories from individuals such as Piaget who believed that children could not learn beyond their developmental stage (Morris et al., 2016). Current research suggests that traditional theorists under-estimated the capabilities of young children, and that they can in fact

engage with some abstract knowledge and scientific concepts (Gelman, 1979; Kidd, Pasnak, Gadzichowski, Ferral-like, & Gallington, 2008; Novak, 2005; Winkler-Rhoades, Carey, & Spelke, 2013). It is evident from this research that there are benefits to providing young children with productive science instruction and should be given enough time in the curriculum.

The results from my previous brief analysis and from Morris et al. are of concern as learning science in the early years of education is important for creating foundations for more complex scientific knowledge learned in later education (Morris et al., 2016). Morris et al. (2016) had concerns surrounding the lack of scientific concepts due to the lack of training that Grade R educators receive in science instruction, and so may not be able to translate the concepts at an everyday level or translate it incorrectly. This concern is extended by other research which found that Foundation Phase (grades 1 to 3) teachers also had poor science knowledge and had challenges teaching science lessons (James, Beni, & Stears, 2019). There is a similar concern with this in England, as the National Curriculum has limited information on scientific concepts which requires the teachers to find and/or learn the scientific concept themselves from other resources (such as the internet). This is a worry in England as many teachers expressed a lack of confidence in teaching science, specifically regarding content knowledge, and there is a need for more teacher training to build up confidence in teaching science (Appleton, 2003; The Wellcome Trust, 2014). This is also an issue in South Africa, where research has found that natural science teachers have gaps in their subject content and pedagogical knowledge (Bantwini, 2019). Morris et al. (2016) believe that this potential lack in early science knowledge development in young children could be a contributing factor to the current situation of 60% of South African students not finishing their schooling, and high schoolers underperforming in science. There has been a review of the NC that supports my previous findings that in comparison to other countries there is a lack of clarity on key knowledge, content, and concepts that should be taught in science in England (Oates, 2011). This research on South Africa's and England's worries around poor performance in science is part of the rationale behind this current thesis. The issues in science education may lie within the first point of science education, the National Curriculum and CAPS, hence why it would be of value to assess whether these documents make scientific concepts available to teachers and students.

Both the National Curriculum in England and the National Curriculum Statement in South Africa have been through a number of reforms, with the most recent updates coming out around the same time, the National Curriculum Statement in South Africa was published in 2011 and the National Curriculum in England in 2013 (Department for Education, 2013; Department of Basic Education, 2011). The rationale behind analysing both of these curricula is that I have been educated and taught science in both countries and have an interest in how these curricula compare with each other. It was of interest to see what similarities and differences these curricula have considering they will most likely have been influenced by similar educational theories that were popular ten years ago. In this thesis, the two year/grade 1 science curricula on plants is analysed, as well as educational materials such as textbooks and lesson plan resources, to answer the questions: to what degree are scientific concepts made available in these documents, and how do these two countries compare in this regard?

1.3. Theoretical Framework

The theoretical framework for this study is based on the Neo-Vygotskian theories of early science acquisition that Morris et al. used in their study. These theories were used as this thesis, like Morris et al., will be analysing for simple scientific concepts in the context of early science education. Morris et al. focused on theories from “first wave” Neo-Vygotskians such as Davydov and “second wave” theorists like Hedegaard and Fleer. These researchers extended upon Vygotsky’s ideas of development and learning, specifically the dialectical and opposing relationship between spontaneous (everyday) concepts and scientific concepts (Morris et al., 2016). This relationship is dialectical in the sense that one concept cannot be viewed in absence of the other, and both concepts are necessary for developmental learning (Morris et al., 2016). Everyday knowledge involves randomly organised isolated ideas which can be perceived through the senses, whereas scientific concepts are units of scientific (abstract) knowledge that are hierarchically organised in a system of other scientific concepts, requires higher order thinking (abstraction, generalisation, and systemisation), are expressed through academic language, and acquired through school instruction (Morris et al., 2016). Neo-Vygotskians looked at the relationship between scientific and everyday concepts in the context of school knowledge. Their elaborations explained briefly are: scientific concepts are made up of constant and inherent essential

attributes (for example a rectangle has four sides) and non-essential attributes (such as the size of the rectangle), scientific concepts contain content and procedural knowledge (the essential attributes of a scientific concept and the application of the concept in practice), and scientific concepts are acquired through schooling which frames the knowledge within the context of the purpose to educate children (Morris et al., 2016). Based on these elaborations, Morris et al. created a conceptual framework for simple scientific concepts, and is summarised as such: 1) a simple scientific concept is defined as: having essential and non-essential attributes, uses simple scientific language, is interrelated to other scientific concepts within an hierarchal knowledge system, and can be transferred across contexts; 2) scientific concepts have content knowledge and procedural knowledge, 3) complex scientific concepts are underpinned by simple scientific concepts. This was then used to develop an analytic framework and language of description to examine for simple scientific concepts and was used to answer the question of what degree simple scientific concepts were made available in the national curricula and educational materials from South Africa and England.

1.4. Research Design

The research in this study was a document analysis of relevant education documents, while document analysis is typically a complement to other research methods within qualitative studies it can also be used by itself (Bowen, 2009). The documents that were analysed are the sections on Plants and Seeds for Grade 1 and Year 1 in the CAPS and NC documents, because these are the standards that are created by the government and hence the expected outcomes for most children in these countries. The education resources that were selected are: the plant and seed section of the workbook created by the South African Department of Education: *Grade 1 Life Skills in English Book 2 Terms 3 & 4*; free lesson plans created by English education charity Hamilton Trust: "*Science Year 1 What's Growing In Our Gardens?*"; and the section on plants in workbooks (teacher book and student book) published by Cambridge University Press for Grade 1 in South Africa (Study & Master Life Skills Grade 1) and Year 1 in England (Cambridge Primary Science Year 1). They were created by professionals or published by the government and are based on the curriculum of their country. These will therefore be a good reflection of the science experience of many children in Grade/Year 1 in South Africa and England. The analysis was conducted using the rating scale created by Morris, and this language of description is based

on her analytic framework and conceptual framework which is derived from Neo-Vygotskian elaborations on scientific concepts and school science knowledge. The rating scale contains six criteria, which are based on the three aspects from conceptual framework described in the previous section. These were translated by Morris (and edited by me to fit the question of this current thesis) into three analytic indicators: AI1. How does the Year/ Grade 1 curriculum and educational materials represent the defining features of a science knowledge concept? AI2. How does the Grade/ Year 1 science curriculum and educational materials represent the structure of a science concept with regards to the relation between content and procedural knowledge? AI3. How does the Grade/ Year 1 curriculum and educational materials represent science concepts with regards to the relation between simple and complex concepts? (A. Morris, 2014). These were then developed into six criteria and each criterion has a score of two, where if the criterion was met completely it was given a score of two, if it was partially met then a score of one, and zero if it was missing from the extract or there were errors. All of the document extracts were rated using the rating scale and given a score out of 12, and if they received a full score it was considered a simple scientific concept. After the documents were rated, the complimentary documents' scores were compared (NC and CAPS scores compared, free online/government resources compared, and Cambridge textbook scores compared).

1.5. Study Outline

The next chapter reviews the literature surrounding early science education and young learners, research on Vygotsky's theory of learning and development in science education, and studies on the South African and English curricula. The third chapter discusses the theoretical framework of this study based on Vygotskian and Neo-Vygotskian theories, as well as the findings from Morris et al.(2016). The fourth chapter expands on Morris' analytic framework and criteria ranking scale. The fifth chapter covers the results and analysis of the documents and their scores, as well as comparing the complementary documents results. The final chapter discusses the findings and the implications of early science education in South Africa and England.

Chapter 2: Literature Review

2.1. Introduction

The aim of this section is to provide a discussion of the literature on previously researched topics similar to this current thesis such as young children's cognition, Vygotsky and science education, and curriculum reviews. The chapter begins with research on young children's capabilities, then moves to research on the impact of learning science early in a child's education, followed by research using Vygotskian theory in teaching science, and finally research on science curricula in South Africa and England.

2.2. Research on young children's capabilities

In traditional development theories there was the assumption that young children's cognition is perceptual and not abstract (Gelman & Brenneman, 2004). For example, Piaget believed that young children were egocentric, in that they could not take on the perspective of others (Gelman, 1979). He also believed that children below the age of 7 were only able to engage in preoperational sensori-motor thought, and so incapable of applying abstract classification schemes. A second example is Vygotsky who believed that young children were just capable of pre-concepts (Gelman & Brenneman, 2004). It is during the preschool years that Vygotsky believed the first higher functions begin to emerge through play, such as perception (Bodrova & Leong, 2003). However, he also believed that other mental functions like memory, imagination, and attention only begin to develop in primary school. This is where Vygotsky and Piaget are similar, in that they describe pre-school children's cognitive functioning as tied to perception, and mental functions like memory and thinking are not yet separated from it (Bodrova & Leong, 2003). Vygotsky contrasts pre-schoolers cognition as "thinking is remembering" to school age children cognition as "remembering is thinking" (Bodrova & Leong, 2003). Consequently, these ideas lead to the assumptions that many science experiences were developmentally inappropriate for young children. Recent research over the past several decades has revealed that young children possess more potent cognitive competencies than traditional theorists previously maintained (Gelman & Brenneman, 2004). This next section looks at the research on the capabilities of young children.

As mentioned, traditional theorists under-estimated the capabilities of young children, and recent research has focused on examining their potential for abstract thought.

The first example is from Winkler-Rhoades, Carey, and Spelke (2013) who sought to investigate whether young children without much experience with using abstract depictions could derive spatial information from metric maps. They conducted two experiments, in which the 2.5-year-old children were presented with maps consisting of 2D geometric patterns showing an arrangement of three objects seen from above. The maps were different in orientation, dimensionality, perspective and size from the arrays, and they were never simultaneously in view (Winkler-Rhoades et al., 2013). This was done so that the maps only provided geometric cues to reference. Accordingly in the first experiment all the objects in the array were identical and represented on the maps by three identical markings and in the second experiment they were represented by a single triangular outline (Winkler-Rhoades et al., 2013). The results of their investigation was that the children were able to interpret the abstract 2D markings as references to 3D objects which were individuated solely by their relative spatial positions to each other (Winkler-Rhoades et al., 2013). This result implies that children as young as 2.5-years old are capable of more than just perceptual cognition and can furthermore engage in abstract thought.

Gelman (1979) also conducted research into young children's mental capabilities, where they modified Piaget's number conservation task to study young children's cognition in order to reveal young children's concealed cognitive abilities. In the number conservation task children often fail due to their belief that the number of items in a row changes when the objects are moved closer or further away from each other. This was modified into the magic task by Gelman and her colleagues. This involved two phases, where in the first children are shown two sets of given values which are repeatedly covered and uncovered. The sets are then covered and the children are asked which is the winner or the loser (rather than ambiguous terms of more or less) and asked to explain their answer once they uncover a display. The first phase shows that young children are able to decide by themselves that numerical value is the determinant for winning (Gelman, 1979). The second phase involves the experimenter changing the display without the child knowing, which could involve addition, subtraction, change in colour, or displacement of the objects. The children who encounter a change in number can identify this change and those who encounter a change in other elements (such as just colour) can say that the number of elements is as expected. These findings show that young children are able to understand

less ambiguous scenarios that involve number conservation, and more able than Piaget had believed (Gelman, 1979).

Young children can engage with more abstract mathematical concepts than traditional theories believed, in fact they are even able to acquire higher-order generalization based on evidence self-generated from robust free play (Sim & Xu, 2017). The findings from these studies also suggest that the assumption that learning science is developmentally inappropriate is erroneous, and that educators should not underestimate young children's abilities to engage with abstract concepts. Furthermore, given young children are as mentioned curious and have been described as little scientists who are engaging with their surroundings and developing scientific understandings, it is important to support them in their science learning journeys as early as possible (Fleer & Hedegaard, 2010).

2.3. The impact of teaching science early

As discussed above, there is research that shows that science has a significant impact on young learners, and in fact can help development in other areas such as reading comprehension (Vitale & Romance, 2012). This next section will discuss research on the impact of science education during the early years of education.

Science in the early years is important because children begin engaging with science as early as infancy where they explore the world through their senses (Lind, 1998). Children begin to form their own concepts and ideas about their world, and often these ideas are incorrect as seen from the Science Processes and Concept Exploration (SPACE) project (Harlen, 2001). Harlen collected children's ideas on various science topics (for example germination and growth of beans) and found that many had based their reasonings from their limited experiences of observations rather than thinking in abstractions and mental models. This research highlights the importance of teaching to promote conceptual development (Harlen, 2001). This follows Vygotsky's ideas that children cannot be expected to rediscover scientific laws, and that the development of children is special in that adults can teach them these laws (Karpov & Haywood, 1998). For children to acquire scientific concepts, there must be some teaching or presentation of precise verbal definitions which are linked with procedural knowledge (knowledge of methods to solve domain-specific problems) (Karpov & Haywood, 1998). Research has also shown that early science education

has a positive impact on later science learning, as seen from Novak's (2005) 12-year longitudinal study and results from Sammons, Sylva, and Melhuish (2011) Effective Pre-school, Primary and Secondary Education Project (EPPSE). The purpose for Novak's study was to challenge Piaget's stage theory and his ideas that children did not benefit from instruction of abstract concepts believed to be beyond a young child's understanding. In order to do this, Novak designed an instruction method that follows Ausubel's assimilation theory of learning where the teacher ascertains what a learner knows and then adjusts the teaching accordingly (Novak, 2005). The participants in the study were in grades 1 and 2 (ages ranged from 6 to 8), and they were given audiotapes which taught concepts that were beyond what the children typically learned in their science classes. The results of the study were that the children in the instruction group outperformed those in the non-instruction, and the difference in performance increased as the children progressed through middle and high school (Novak, 2005). These studies support the idea that young children are underestimated by those who create curricula, and that the children greatly benefit from early introduction to basic science concepts (Novak, 2005). Novak's study is supported by the Effective Pre-school, Primary and Secondary Education Project (EPPSE) which is a longitudinal study that began in 1997 and follows the cognitive development of children from the age of three up until 13 in England. In this paper the researchers looked at how pre-school and primary education influenced academic outcomes in Year 9 students. They found that children who received effective pre-school and primary school science education had higher attainment in science in Year 9 than students who did not have this experience (Sammons et al., 2011). This study highlights the importance of providing enough support to schools (through a clear and comprehensive curriculum), as children who did not get access to effective science education in their early years are being outperformed in secondary school by those who did have access.

These studies show that it is beneficial to introduce science early to children in an appropriate manner. The next section looks at studies which investigated science education for young children, and utilised Vygotskian frameworks.

2.4. Vygotsky's theories and science education

This current thesis used a conceptual framework created by Morris (2014) which is based on Vygotskian and Neo-Vygotskian ideas (this is discussed in greater detail in chapter

3) and was influenced by other researchers who used Vygotsky's theory to study pre-school and school science. This next section will discuss some different researchers who have used Vygotsky's ideas in their conceptual frameworks to investigate science education.

There are a number of studies researching science education in early years, and a prominent researcher in this field is Fleer and was an influence on Morris et al.'s work. Her work is included in this literature review because it is also based in Vygotskian theories. Her research largely focuses on early years; however, it is still relevant to this current thesis as the children entering Year/Grade 1 will have just experienced an early year's education. Additionally, they may benefit more from an early years type of setting than that based on methods used in primary and secondary school which research has indicated are learning environments more suited for children 8 years old and older (Fleer, 2017). Much of her work looks at how pre-school science can be meaningful through incorporating science learning into children's play (Fleer, 1993, 2017; Gomes & Fleer, 2017, 2018).

An example of Fleer's (2017) work is her research into linking imaginative play and science as a means for pre-school teachers to teach scientific concepts. The conceptual framework of this study adopts three of Vygotsky's ideas: cultural-historical conception of play (where an object's meaning is changed through play); interpsychological and intrapsychological functioning (play is at first created jointly, and then independently enacted as the social moves towards the child's personal understanding); and cultural-historical conception of imagination in science (children engaging in thought experiments, visualising big ideas by creating models when playing, and imagining the relationships between the observable and non-observable) (Fleer, 2017). Fleer studied three schools where the teachers had received training in the Playworlds approach, where a teacher is involved in children's play, and a problem scenario is foregrounded as part of constructing a play narrative (Fleer, 2017). The aim was to understand how teachers engaged children in scientific play and how imaginative play promotes scientific learning. The results of this study were that the Scientific Playworlds could have the potential to support teachers in taking an intentional role in supporting imagination in science (Fleer, 2017). Fleer argued that for this approach to develop scientific narratives, these five key pedagogical characteristics are needed: building collective narratives with discourses of wondering; everyday practices where changed into scientific narrative and engagement through the pedagogical principles of creating scientific problem situations collectively; using a cultural

device which mirrors the science experience; constructing imaginary scientific situations; and imagining the relations between non-observable concepts and observable contexts (Fleer, 2017).

Another study from researchers in Sweden also looked at preschool children's play and science learning and were influenced by Vygotsky's theories and Fleer's work (Åkerblom, Součková, & Pramling, 2019). Their aim was to investigate how preschool children understood basic features of chemistry (concepts of water, molecule and 'chemistry') before and after engaging in playfully dramatized education activity (Åkerblom et al., 2019). They based their investigation on Vygotsky's theories on the dialectic relation between scientific and everyday concepts, that both of these concepts originate in the social plane, and that a verbal thought is formed through the interaction of thinking and language (Åkerblom et al., 2019). Everyday concepts are developed through experience and practical associations, whereas scientific concepts are developed through deliberate instruction with socially agreed meanings (Åkerblom et al., 2019). Based on this, the researchers were interested in the children's verbal thoughts, since through verbalisation the thought is then conceptualised (Åkerblom et al., 2019). This idea is also based on Vygotsky's notion of children learning new words, and them becoming more generalised once they form more relations between the reference (the word) and the representation (the object). The children were first introduced to the concepts of water-molecules through a dramatization by a teacher, then the children were asked to represent molecules in a 'molecule-dance, and finally the children took part in an experiment with dissolving sugar into different temperatures of water. What they found was that the conceptions that the children had prior to the activity were closely related to what they grasped from the activity. The children could also begin to discuss the concepts in terms of pseudo-concepts, where the children are aware that a word denotes something specific and can give examples but are not exactly sure of the exact meaning or common conceptual basis (Åkerblom et al., 2019).

The next study that will be discussed also investigates the combining of play and learning scientific concepts, however this study is researching the possibilities of introducing this approach in a primary school context (Sliogeris & Almeida, 2017). This study based their theoretical framework on the cultural-historical theory of learning, where there is an emphasis on the relationship between everyday life and learning (Sliogeris & Almeida,

2017). They are influenced by Hedegaard and Chaiklin's 'double move', an approach where teachers create learning experiences which support the development of scientific thinking and connect it with the everyday lives of their students (Sliogeris & Almeida, 2017). This is described as 'conceptually orienting' by Fleer in her work with teachers connecting everyday and scientific knowledge in preschool play (Sliogeris & Almeida, 2017). Sliogeris and Almeida wanted to expand on previous research with preschool children and aimed to understand what learning occurs during play-based science experiences, how these experiences support a child's science learning, and what influence does the teacher have on play-based science learning experiences. They studied a class of children in their first year of schooling and implemented a 'learning sequence' about small invertebrates. The objective for this sequence was for the children to understand the core concept of the relationship between animals, their needs and habitats with the aim of the children developing awareness and scientific understanding of this concept as applied to worms (Sliogeris & Almeida, 2017). There were four parts to the sequence, an introduction session, child-guided play sessions, one teacher-guided play session, and a reflections session. Their results found that children did use and explore science concepts during their child-guided play when the concepts were introduced explicitly in previous teacher-guided play. Their study supports Fleer's hypothesis about young children in their first years of schooling benefitting from this approach of play-based science learning.

These three studies from Fleer, Åkerblom et al., and Sliogeris and Almeida indicate that play and science education can be combined to introduce children to scientific concepts. A common thread within the investigations is the relation between everyday and scientific concepts, and that when this relationship is properly understood and utilised, teachers and researchers can guide children into forming more abstract ideas around science through play. Vygotsky's theory of everyday and scientific concepts will also be used in the conceptual framework of this thesis and explained in more detail in the next chapter.

2.5. Research into school science curricula

This current thesis analysed two curricula: the South African National Curriculum and Policy Statement (Grade 1 Plants and Seeds), and the English National Curriculum (Year 1 Science-Plants). This next section will therefore discuss other studies and papers which have investigated these curricula. The research selected for this section are all post 2011 (for South Africa) and 2014 (for England) as this is after the current curricula were introduced.

The first paper that will be discussed is a review of research on the South African Science curriculum from 1990 to 2015. This paper is less concerned with the content of the curriculum and more focussed on the language of instruction for the curriculum, hence the research they review spans over a few years of curriculum reforms. More specifically, the focus of the research is on the role of language and teaching science in South Africa, and reviews research that has been conducted on this to address what the role of pedagogical language has on science learning and what the implications are for language practices in science education (Msimanga, Denley, & Gumede, 2017). They found 27 papers that investigated the pedagogical role of language in science, and through a frequency count of references of the specific language focus area for each of the studies. From there they conducted a thematic analysis of the findings of all the papers to answer their guiding questions. Their review found that there is an implicit debate happening in the science education research community in regards to language (Msimanga et al., 2017). On one side there are questions about how home languages being used to help students who speak English as a second language engage with difficult science concepts, and on the other side there are questions about whether using the home languages in this manner may hinder the students' proficiency in English (Msimanga et al., 2017). This latter question is based on the concern on the students' needs to be proficient in English for assessments. They conclude overall that more research is required into the implications of the language of learning and teaching in science education.

The second study investigated how four foundation phase teachers (grade R, 1, 2 and 3) in a working class area in South Africa implemented the science curriculum in their classroom (James et al., 2019). The researchers built on their previous research from 2017 where they found that the teachers did not receive sufficient guidance from the curriculum in what and how to teach natural science. The researchers observed the four teachers' choice of science lessons, analysed children's workbooks, and interviewed the teachers post-observation. What they found was that all three teachers (one was excluded as she did not teach science during observations) had challenges in teaching science concepts. For example, they had limited scientific knowledge and were unable to correct misconceptions and even taught incorrect information. The researchers believe that since science education for younger children is not foregrounded in the curriculum, the teachers then do not see it as important as other subjects. Hence, they do not take the initiative to learn about the

topics and methods before teaching them. They also believe that the lack of support from the curriculum in what and how to teach, as well as the lack of science components in initial teacher training may also compound this lack of knowledge and confidence (James et al., 2019).

From the two studies one can observe that in South Africa there is an interest in understanding how the curriculum is understood and taught by the teachers, and that there is some need for research in how to reform it to improve science education.

In England, the governing body Ofsted (the Office for Standards in Education), which inspects and evaluates schools, published a review of literature on science education where the aim was to identify elements that would advance school science curricula (Ofsted, 2021). Based off the literature, the review argues that students should have 'expertise' in science education, which means domain-specific knowledge which is developed through a connected knowledge base. This is achieved by teaching new knowledge which is integrated with knowledge they already have so that it becomes meaningful, and so in science students' knowledge has to be organised around the most key scientific concepts in order to allow for prediction of other phenomena (Ofsted, 2021). Although not cited in the review, this description is similar to Vygotsky's ideas of how everyday and scientific concepts are connected, and Davydov's ideas around learning key concepts and essential attributes (described in more detail in the next chapter). The review argues that an ambitious curriculum consequently must identify the most important concepts for learning, and over time teach how the concepts are related so that the students develop an explicit understanding of the logical structures of the different science disciplines (Ofsted, 2021). The review then moves on to state that a functional framework for science curricula would make the distinction between two knowledges: substantive knowledge and disciplinary knowledge. Substantive knowledge is described as the knowledge of the 'products of science', such as concepts, models, laws, and theories and in the national curriculum is referred to as scientific knowledge and conceptual understanding (Ofsted, 2021). Disciplinary knowledge on the other hand is described as the knowledge of how science knowledge is created and develops, and in the national curriculum is called 'working scientifically'. These two knowledges are reminiscent of Davydov's (1990) ideas of content knowledge and procedural knowledge, briefly explained respectively are the scientific concepts and applying the concepts in practice (a more detailed description is in chapter 3).

The review argues for this distinction in knowledges as it reflects how knowledge is used and arranged in the sciences (Ofsted, 2021). As with Davydov's procedural and content knowledge, the review believes that despite disciplinary and substantive knowledge being distinct from one another, they cannot be taught separately. They argue that disciplinary knowledge should be embedded in the substantive, in order to avoid curricula that only focus on one or the other (Ofsted, 2021). Once again, this is similar to procedural and content knowledge, as it is described as an integral two-part structure and there can only be procedural knowledge if there is content knowledge (Davydov, 1990; Morris et al., 2016). The review then moves onto how to address how to best avoid student's developing or maintaining misconceptions in science and continue with the notion of 'expertise' in science as the best way to avoid this. They state that this has two implications on curricula development. Firstly, to avoid misconceptions a student needs not only to know why a scientific idea is correct but also why their misconception is wrong. Secondly, the curriculum must offer repeated instances where students engage with the scientific concept, in different contexts, and repress their misconception (Ofsted, 2021). They also highlight that misconceptions cannot be challenged too early, as this may result in children relying on their misconceptions to make sense of the scientific concept. Hence Ofsted argue that the curriculum should build knowledge incrementally and consider what knowledge children may bring in from their own lives. This again is similar to the Vygotskian ideas of everyday and scientific concepts and their dialect relation. Notably, the two different studies (the review and this current paper) reach similar conclusions but are not necessarily based on the same theorists. It is encouraging that this review has similar concerns and views on improvements for the national curriculum as this current thesis, especially since Ofsted is a department within the English government (relevance) and has significant influence.

There is an obvious omission in this section of curriculum research, and that is the work from Morris, Jacklin and Harman (2016), but this is because it is explored in more detail in the theoretical framework. The three studies discussed in this section reveal that there are certain issues with both national curricula from South Africa and England and would benefit from research analysing their content.

2.6. Conclusion

In conclusion, recent research has shown that young children do have the competencies to engage in some abstract concepts and therefore understand some

scientific concepts. Furthermore, early instruction of science is beneficial in children's understanding and development of scientific concepts in later education. Research on the curricula from South Africa and England indicate that there is a concern in the content and implementation in the classroom. The following section looks at the theory behind scientific concepts as developed by Lev Vygotsky.

Chapter 3: Theoretical Framework

Introduction

This section looks at the theories which influenced Morris' study. It first discusses Vygotsky's theories of learning and development, then moves onto Neo-Vygostkian elaborations of his theory, and finally Morris, Hardman and Jacklin's study on simple scientific concepts and their analysis of the Grade R science curriculum.

3.1. Vygotsky and knowledge

To understand Vygotsky's theory of scientific concepts, this section takes a top-down look at his theory. It begins with his conceptualisation of the zone of proximal development as this led into his ideas of instruction and then into scientific knowledge. Vygotsky's view on knowledge sits in his theory that human mental processes are mediated by psychological tools which are representations of the history of human culture and their accumulated experience (Karpov, 2005b). The process of acquiring and mastering the psychological tools has two components; the first component is social mediation where an adult, or culturally more competent 'other, introduces the psychological tool to the child and the second where the child internalises the tool and masters it (Karpov, 2005b). The social process of children developing higher mental functioning gives rise to Vygotsky's theory of the zone of proximal development (Vygotsky, 1978). Vygotsky describes the zone of proximal development as:

"the distance between the actual developmental level determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance" (Vygotsky, 1978, p. 86).

It is in this theory as well where Vygotsky is in contrast with other developmental psychologists, where he believes that there should be a necessary minimum level of development for learning but development in fact lags behind the learning process (Vygotsky, 1962, 1978). From here one can move onto his criticisms of Piaget, as this is where he explains his theories of scientific and everyday concepts which Morris (2016) elaborates on in her analytic framework (Morris et al., 2016; Vygotsky, 1962). His first criticism is of Piaget neglecting the social aspect of learning, and that instruction is an important part of a child's total mental development as this is where children have the adult

guidance necessary moving them through their ZPD and where scientific concepts are produced (Vygotsky, 1962).

He further criticizes Piaget for holding spontaneous (everyday) and non-spontaneous (scientific) concepts separately, and that instead these concepts are related and influence each other. He describes that everyday concepts makes a path for scientific concepts through the creation of structures needed for the evolution of a concept's elementary parts, it acts as a foundation for them (Karpov, 2005a). The scientific concepts provide structures for the everyday structures to develop upward towards consciousness (Vygotsky, 1962). Vygotsky provides an analogy of a child learning a foreign language for the relationship between scientific and everyday concepts. The learning of the grammar and phonics rules are conscious and deliberate in the foreign language (scientific concepts) but are unconscious in their native language (everyday concepts). However, the child can transfer meanings and systems he has learned in the foreign language to his native (for example a more formal understanding of the grammatical tense he is using), and vice versa (Vygotsky, 1962). In summary, spontaneous concepts act as foundations for scientific concepts, and scientific concepts transform spontaneous concepts by making them structured and conscious (Karpov, 2005a).

Scientific concepts and everyday concepts work together, but they are inherently different from one another. The first difference is in how the concepts are acquired. Scientific concepts are acquired through classroom instruction, and everyday concepts are acquired through the child's personal experiences of the world (Vygotsky, 1962). Vygotsky emphasized that the instruction of scientific concepts to students should be in the form of precise verbal definitions instead of the students constructing the concepts themselves (Karpov, 2005a). Secondly, scientific concepts are organized into a hierarchical system of interrelationships, and thirdly since they are in this hierarchical structure it implies that a concept is mediated by some other concepts "within a system of concepts". The presence of the system in scientific concepts and absence of it from everyday concepts is the cardinal difference between the two concepts. The system of scientific concept arises from the hierarchical relationship of generality between concepts (Vygotsky, 1962). To illustrate this point, Vygotsky uses the example of a child learning the word "flower" and then the word "rose" to explain generalization and systematization. At first both are interchangeable, but once the child learns more subordinate concepts (such as daisies), the relationship between

“flower” and “rose” changes, and “flower” becomes more generalized and a system begins to take shape (Vygotsky, 1962). Vygotsky considered this generalization and systematization as a complex psychological process and which is a feature of forming scientific concepts. Another aspect of forming scientific concepts is the abstraction of concepts from their immediate sensory understanding (Vygotsky, 1962).

Morris et al. (2016) summarized five key features of Vygotsky’s notion of scientific concepts:

- Scientific concepts are typically acquired through school instruction.
- Scientific concepts are expressed through academic language.
- Scientific concepts are formed through higher order thinking such as generalization, systematization and abstraction.
- Scientific concepts sit in “hierarchical knowledge structure systems” where they are mediated by other scientific concepts
- The scientific concepts are systematically interrelated within their hierarchical structures.

These features that distinguish scientific concepts from everyday concepts were highlighted by Morris et al. (2016) as they are relevant in terms of early science education where young children are beginning to engage with scientific concepts while immersed in everyday thinking. Furthermore, these features are elaborated on by Neo-Vygotskian theorist, and are then developed into the theoretical and analytic framework by Morris et al. (2016).

3.2. The three Neo-Vygotskian extensions

Morris et al.’s (2016) ideas were drawn heavily from several Neo-Vygotskian scholars that researched early child development and knowledge, whose work will be explored in this section. This section will explore three ways that the Neo-Vygotskians extended Vygotsky’s notion of scientific knowledge: firstly scientific concepts have essential and non-essential attributes, secondly scientific concepts comprise of content and procedural knowledge, and thirdly scientific concepts are acquired through schooling where schooling is a specialised context of acquisition within which there is a knowledge progression from simple scientific concepts to more complex concepts (Morris et al., 2016).

Essential and non-essential attributes

Morris et al.'s study draws heavily upon Davydov as seen from their referencing to him in regard to his work on elaborating Vygotsky's notions of scientific concepts. In his writing he describes a concept as such:

"A combination of two, three, or more abstract and general attributes which is formed by the significance of a certain word (most often by means of a definition) is usually called a concept. Generalization and abstraction are indispensable conditions for forming it. The group of generalized attributes of an object is the content of the concept." (Davydov, 1990, p. 7)

He furthers this definition by including that concepts are not just groupings of common attributes, but of 'essential' attributes. In his notion of scientific concepts there are essential attributes and also non-essential attributes. Features of essential attributes are that they are stable, constant and retained by a group of objects, whereas non-essential attributes can change and are an invariant (Davydov, 1990). For example, the essential attribute of a mammal is having mammary glands, and a non-essential attribute would be number of legs.

It is the essential attributes that allows for a person to differentiate objects and set these essential attributes forth into a concept. These attributes allow for differentiation between dissimilar and similar objects, as they are the common properties of a group of objects that are sufficient and necessary for differing the group from others, and hence why they were named 'essential' (Davydov, 1990). An example of this would be a person classifying animals and knowing that although dolphins and whales have certain non-essential attributes that make them similar to fish (such as "lives in water"), their essential attribute of having mammary glands would actually classify them as mammals and not a fish.

Essential attributes make up the content of a concept, and the collection of objects which the concept can be applied to is its scope (Davydov, 1990). Establishing what the content and scope of a concept is are major logical operations. Through 'defining' one establishes the essential attributes that are within the content of a concept (Davydov, 1990). The process of defining a concept by finding all of its essential attributes would be time-consuming and difficult process, therefore the technique is used where one finds a concepts closest 'genus' and then finds the attribute which distinguishes the concept most from other 'types' in the genus (Davydov, 1990). Davydov provides the example of the

concept a square, where its genus is a rectangle and its differentiating type is that all sides are equal. In the dolphin mammal example, the dolphin (concept) is a mammal (genus) that has the essential attribute of having specialised teeth which are sharp and conical (type).

A concept can be considered a 'type' or a 'genus' depending on the scope of its content. An individual can go through a system of concepts where they go from a broader scope to a narrower scope, or vice versa. The act of narrowing a scope is called 'delimitation', this is when attributes are added to a generic concept and makes it richer in content than that for the genus (Davydov, 1990). An example of this would be if the attribute of 'lives in fresh water' was added to the concept of 'dolphin' the scope would narrow the concept to 'river dolphins'. The opposite of this of widening the scope and making more general concepts is called 'generalization'. This involves reducing the content of the concept, and results in a transition to a 'higher' genus which is poorer in content. For example, one can generalize the concept of river dolphin as such: Dolphin- Cetacea - Mammalia - Chordata- Animalia.

Morris et al. highlight this quote from Davydov to summarise the key details of essential and non-essential attributes of scientific concepts:

"Science strives to advance from the mere description of phenomena to the discovery of the essence of their internal connection. It is well known that essence has a content that is distinct from the immediate given properties of objects or phenomena" (Davydov, 2008, (p.76) as cited in Morris et al., 2016)

The following section will discuss the second Neo-Vygotskian extension which will further explore the structure of scientific concepts in terms of its content knowledge and procedural knowledge.

Content knowledge and procedural knowledge

The second extension to Vygotsky's scientific concept is that it is an integral two-part structures that are made of content knowledge and procedural knowledge (Morris et al., 2016). As previously described, the content of a scientific concept is its essential attributes. This definition is complicated as there may not be just one group of essential attributes to define a concept. This is further complicated by the fact that the 'essence' of an object is typically interpreted as something general, and so essential attributes are general but non-essential attributes can be general sometimes as well (Davydov, 1990). This complication results in the difficulty of deciding how to distinguish what common attributes are essential

and non-essential. Difficulties in deciding what attributes are essential and non-essential are part in creating a curriculum, as seen in Morris et al.'s (2016) analysis of the Grade R curriculum and creation of their analytic framework. This is seen in their example of birds and that their ability to fly is not an essential attribute.

Davydov (1990) has an attempt at reconciling this through the explanation that essential attributes mean that the general qualities are inherent in a specific range of objects, which differentiates it unambiguously from other objects. He includes this idea in his description of the constituent features of scientific concepts: first feature is the presence of essential attributes which allows for a class of objects to be differentiated clearly from other groups, second feature is that the meaning of the concept has a verbal expression, and the third feature is that the meaning can be abstract in character and does not need to be tied to a visual images (Davydov, 1990). The transition from perception through conception to concept mirrors the features as this transition goes from the sensory, the concrete and the individual (Davydov, 1990, p. 22).

Prior to the above description, Davydov highlights the importance that active involvement of students is important as their activity reaches its highest limit when they are taking part in something. Davydov also states that in order to master a concept, an individual cannot just know of its attributes but must also be apply to apply the concept in practice, which is procedural knowledge (Davydov, 1990). An example of this would be a child being able to apply the concept of "mammal" when taking part in an activity grouping different animals together by utilising the essential attributes of each group, for example cows and dolphins are in the same group because they have mammary glands, but chickens do not so are not grouped. In the example one can see that procedural knowledge is also reliant on essential attributes since they make up content knowledge, and procedural knowledge can be described as 'knowing how to work with a concept' (Morris et al., 2016).

Procedural knowledge is referenced implicitly by Davydov when he describes the journey from perception to concept as a transition from the concrete to the abstract, and that once students have reached this 'realm of generalization' they are able to affect the operation of classification in their school work. In other words, generalization and classification are integral to procedural knowledge (Davydov, 1990).

Davydov argues that there are different levels of generalization, as seen in pre-school children, which occurs at the level of immediate perceptions, and then on the level of

simple recollections. In these generalizations the essential attributes are mixed with non-essential ones. As the children come into schools the generalizations reach the level of representations, where the content is based on external and sensory qualities but are sufficiently complete and precise for generalizations requiring identifying, systematizing, and classifying objects. Also described as ‘generalization at the level of “elementary concepts”’ (Davydov, 1990). However, as seen in section 2.2. children are in fact capable of more than simply using their recollections or observations and are capable of applying more complex concepts in practice.

Vygotsky’s emphasis on school instruction as the mode of acquiring scientific concepts is supported by the difficulty in discerning what the essential and non-essential attributes of a concept are and the snowball effect this has on content knowledge and procedural knowledge. Without a more knowledgeable other to help with this differentiation could lead to the development of misconceptions and not scientific concepts. An absence of essential attributes would mean an absence of content knowledge and therefore an absence of procedural knowledge, and therefore no scientific concept formation (Morris et al., 2016). The next section will explore further the third Neo-Vygotskian elaboration on schooling as specialised sites of acquisition, empirical and theoretical concepts, and the progression of knowledge through schooling.

School and scientific concepts

The third elaboration by Neo-Vygotskian researchers is on Vygotsky’s ideas around the role of school instruction as a key feature in the acquisition of scientific concepts. There are three parts to the elaboration. The first part is that schools are specialised contexts for learning selected knowledge, the second is that schooling involves empirical and theoretical knowledge and learning, and the third is that there is a progression of knowledge through schooling (Karpov, 2005b; A. Morris et al., 2016)

Schools as specialised sites of acquisition

Schools are central in Vygotsky’s theory as this is where children first become acquainted with scientific concepts and characterises the development of school children (Hedegaard, 2020). Hedegaard (2007, p. 248) furthers the idea of scientific concepts in schools by explaining that they are academic and are ‘appropriated in relation to other concepts within a system of knowledge’. Once they are appropriated then a child can use them consciously, and this is seen in the schools where the different subjects are the

systems where a child can act intentionally in with concepts (Hedegaard, 2007). Involved in this process is also the school teacher who needs to work skilfully with both everyday knowledge and scientific knowledge (as they are dialectically related) to make school subject matter relevant to the children (Fleer & Hedegaard, 2010). Another part of the teaching process is that in any school what subject knowledge is being taught has been selected by someone, ranging from a government created curriculum to a teacher's lesson plan, who puts a value on particular knowledges (Fleer & Hedegaard, 2010; Morais, Neves, & Pires, 2004). The particular theories of thinking and knowledge that have been selected reflects the values of that society, and these values are represented in documents such as curricula, in resource designs like buildings or equipment, and in pedagogical theories taught in teacher training (Fleer & Hedegaard, 2010). The school is a specialised context where children are exposed to scientific concepts by their teachers, which have been selected dependent upon the values of their specific society.

Empirical and Theoretical knowledge and learning

Neo-Vygotskian researchers elaborated on the notion of scientific concepts as the content of school instruction by addressing that in schools there is both empirical learning and theoretical learning (Fleer & Hedegaard, 2010; Karpov, 2005a). Empirical and theoretical knowledge are two forms of societal knowledge with their own epistemological procedures (Hedegaard, 2012). Hedegaard explains that the distinction Davydov draws between theoretical and empirical knowledge can be viewed as different forms of societal knowledge. Davydov describes the two knowledges as closely related, and that they are two different levels of cognition; empirical knowledge is the external aspect of reality whereas theoretical knowledge is the internal being of objects (Davydov, 1990). This section will define empirical and theoretical knowledge and learning as well as their relationship.

Davydov (1990) further explains that external aspects of empirical relationships allow for the concept to be expressed verbally as a result of sensory observation. These observations are repeated, and because of this some of the classes of relationships need to be differentiated. Differentiation and classification are therefore functions of empirical concepts (Davydov, 1990). Empirical knowledge can also be acquired through observation, quantification and description (Hedegaard, 2007). Empirical knowledge is linked to sensory discrimination that can be trained and refined, and it is reflected in abstract concepts (Fleer & Hedegaard, 2010). Empirical knowledge presupposes that the world is represented

correctly and can be measured accurately resulting in factual knowledge (Hedegaard, 2007). It also presupposes the use of hierarchically organised categories for its representation, and the construction of these categories is built on the recognition of differences and similarities (Hedegaard, 2007). The use of categories creates order and simplifies experiences, which enables them to be transferred and applied to other contexts (Fleer & Hedegaard, 2010). Hedegaard writes that certain school subjects (mathematics, physics and biology) evolved from natural science, and this movement to outside of their problem areas created empirical knowledge and learning which now dominate schools (Fleer, 2009).

Empirical learning is consequently based on a child's comparison of different objects and selecting their common salient characteristic, and so discovering the 'general concept' of the group of objects (Karpov, 2005a). An issue with this type of learning is that the common salient characteristic that the child discovers may not be the common characteristic for all the objects in the group nor may they be the essential characteristic for the group (Karpov, 2005a). For example, a child classifying animals based on their own observations of animals may incorrectly discover the general concept that fins and tails are common characteristics for fish, and therefore would incorrectly classify whales and dolphins as fish. Another issue part of empirical learning is that children acquire concepts and skills from different subject areas that are difficult to relate to one another or to their everyday lives, due to the discrete subject stacking nature of empirical knowledge (Fleer & Hedegaard, 2010). However, these statements and examples from researchers are not here to dismiss empirical knowledge but rather to subordinate it to theoretical knowledge (Fleer & Hedegaard, 2010).

In contrast to empirical knowledge, theoretical knowledge is mediated, reflected and has an essential being (Davydov, 1990). Davydov furthers this by stating: "This thought is an idealization of the basic aspect of practical activity involving objects, and of the reproduction in that activity of the universal forms of things, their measures, and their laws." (Davydov, 1990, p. 116). In other words, the reproduction of this knowledge has the character of experimental exploration (Hedegaard, 2012). This knowledge is a series of connected phenomena that is communicated through models and cannot be acquired by solely verbal or literary means, it requires activity (Hedegaard, 2012). The central method of modelling in theoretical knowledge is a core model (which Davydov calls germ-cells), and these contain complementary and oppositional poles in a subject-matter area (Hedegaard,

2007). Theoretical knowledge creates symbolic tools that children use to understand and analyse the world, and it helps them to orient themselves to the general relationships found in phenomena (Fleer & Hedegaard, 2010). It also supports children in engaging with thought experiments, working out relational connections between elements in a system, and building mental models. These mental experimentation forms are the basis of theoretical thought, and they operate by scientific concept (Fleer & Hedegaard, 2010). Furthermore, theoretical knowledge is useful for children to make sense of their world and contribute to activities in meaningful ways, since this knowledge enables children to think about a whole system of relational concepts (Fleer & Hedegaard, 2010). This elaboration draws on Vygotsky's emphasis that learning concepts should not happen in isolation, but rather as a part of a system (Fleer & Hedegaard, 2010). An example of this type of learning would be a teacher introducing the scientific concept that 'all living things need water' and leading a discussion with the children and their idea of what would happen to living things if there was no water (Morris, 2014). Then, the class would conduct an experiment with growing seeds and only giving some of them water. After a few weeks of observations and measurements, the children can draw conclusions on the seeds and then transfer this knowledge to other living things (Morris, 2014).

The difference between empirical and theoretical knowledge is connected to the way Vygotsky differentiates between scientific and everyday concepts. Although, the differences are not identical since scientific concepts can also be empirical, an example given by Hedegaard is the periodic system in chemistry, which can be presented in an empirical manner (Hedegaard, 2012). Therefore, in schools' children's orientation to learning may remain on the empirical level. If teachers want children to acquire theoretical knowledge, then the cognitive method of instruction needs to characterize theoretical knowledge. If the cognitive method characterizes empirical knowledge (such as observation, memory, comparison, and categorization) then the children's acquisition will remain oriented at the empirical level (Hedegaard, 2012). Hedegaard (2012) believes that for theoretical knowledge to be acquired, children must be engaged in exploratory activity where the controlled task illuminates the contrasts in a phenomenon's fundamental relations.

Progression of Knowledge in schools

The final part of this elaboration is based on Morris et al. (2016) expansion on Vygotsky's ideas of school instruction. They suggested that knowledge within schools should progress from simple concepts to more complex concepts, where the simple concepts act as foundations to develop the more complex. This stems from Vygotsky's assertion that on the path to acquiring concepts individuals develop complexes and pseudoconcepts (Smagorinsky, Cook, & Johnson, 2003). Where a concept is defined as having individual elements that are unified by a single theme, complexes have individual elements that are associated but lack a single theme (Smagorinsky et al., 2003). An example of a complex would be learning that a canine is a dog, and then labelling all four-legged animals as dogs. A pseudoconcept has individual elements that seem to be unified but has internal inconsistencies, for example learning dogs are canines and then labelling any canine-like animal a dog (Smagorinsky et al., 2003). This movement from complex, to pseudoconcept, to concept is mediated by cultural practice, not just direct instruction but also engagement in activity (Smagorinsky et al., 2003).

Morris et al. explain the progression of knowledge in schools through the example of first learning that plants require water and sunlight to live, which underpins the more complex concept of the process of photosynthesis (Morris et al., 2016). The importance of this idea is recognised by Ofsted, and they also argue that starting from early years the curriculum should be organised so that knowledge of concepts develop in a way that follows the logical structure of the scientific disciplines, and lead to students learning how knowledge connects in science and the underlying conceptual structure (Ofsted, 2021).

The previous sections in this chapter have reviewed the literature and introduced some of the theories which informed Morris et al. (2016) work. The next section will focus on their development of the notion of simple scientific concepts and the findings from their analysis of the CAPS curriculum.

3.3. Morris, Hardman and Jacklin and simple scientific concepts

Morris et al. (2016) built upon the previous Neo-Vygotskian extensions to develop a conceptual framework which was then translated into an analytic framework to assess the South African Grade R curriculum for simple scientific concepts (the conceptual and analytic framework will be detailed further in section 3). The analytic framework was developed into a rating scale that consisted of six criteria which each had a score out of two. In order for a

data segment to be considered a simple scientific concept it needed to meet each criterion explicitly and entirely, gaining a score of 12/12. A score between 5 and 11 was considered a potential scientific concept, where the segment has features of a scientific concept and could implicitly lead a teacher towards representing a scientific concept. A score below 5 was considered an everyday concept (Morris et al., 2016).

They analysed 22 data segments from the National Curriculum Statement, CAPS Grade R Beginning Knowledge study area, and four Grade R learner workbooks from the Department of Basic Education. They also included two relational data sources from the CAPS science curriculum for older children (aged 7 to 12) because they needed to describe the relation that Grade R concepts had to more complex concepts that are learned later (Morris et al., 2016).

The findings of the study revealed that none of the data segments scored 12/12, and therefore did not meet the criteria to be considered scientific concepts. Of the fourteen topic statements, only seven met the criteria to be potential scientific concepts. In these statements, the job of translating the everyday concept into scientific concepts is left to the teacher. Morris et al. (2016) state that while this outcome is not made explicit in the CAPS document, but in order for the teaching to be developmental (moving student to cognitively new ways of knowing) then concepts cannot remain at the level of everyday as this would lead to empirical knowledge instead of theoretical knowledge. There was a concern surrounding the idea of Grade R teachers having to translate the everyday concepts. This was due to the fact that few Grade R educators are graduates and most educators' certification training for Early Childhood Education largely focused on health, safety and the emotional and social well-being of children (Morris et al., 2016). Therefore, they may have little knowledge of science pedagogy and may not have the ability to translate the potential scientific concepts into actual scientific concepts (Morris, 2014). In addition to this concern, the other seven topic statements were classified as everyday concepts, and so were either incomplete or in fact scientifically inaccurate.

Morris et al. discussed a concern that since the science subject areas for Grades 1 to 3 are also structured similarly to Grade R, that the problems found in Grade R will be seen throughout the whole Foundation Phase.

3.4. Conclusion

This theoretical framework was inspired by Morris et al.'s (2016) study and the influences on their conceptual and analytic framework. This discussion explored the literature surrounding the history of Vygotsky's scientific concepts and the three extensions by Neo-Vygotskian as highlighted by Morris et al. (2016). These theories are what was used to develop the analytic framework and criterion to assess the CAPS curriculum and used in this thesis. Finally, the findings of Morris et al.'s study was discussed, as the concern expressed from their Grade R findings inspired this thesis to analyse the availability of scientific concepts in the Grade 1 curriculum in South Africa and England.

Chapter 4: Design

4.1. Introduction

In this thesis I use Morris' (2014) analytic indicators to investigate the extent that simple scientific concepts of plants are made available in the Year/Grade 1 national curricula and educational materials of South Africa and England. The methodology and method of data collection for this study will be described in this order: first the data selected for this study, then the analytic indicators developed by Morris (2014), thirdly I will give an example of the language of description, and finally review the validity, reliability and ethics of the study.

4.2. Data

The data selected in this study is based on the criteria created by Morris (2014). The three criteria are:

1. The text is sanctioned by the country's Department for Education and is currently used by public schools.
2. The text is concerned with Grade/Year 1 school science education.
3. The text is most likely used by Grade/Year 1 teachers and is easily accessible and available (Morris, 2014).

I have altered the first criteria as in England the government does not typically sanction resources, and so I have made the following change:

1. The text is based on the National Curriculum created by the country's Department of Education and is currently used by schools.

Based on the three criteria, the following texts were selected for analysis:

1. *Science programmes of study: Year 1* created by the Department for Education in England. This is a sanctioned text and is a primary data source. The outcomes for each topic are statutory requirements that the children are expected to understand and develop the relevant skills for (Department for Education, 2013).
2. *National Curriculum Statement (NCS), Curriculum and Assessment Policy Statement, Beginning Life Skills, Foundation Phase Grade R-3*. This text was created by the Department of Basic Education and is a government sanctioned document, which is followed in public schools. There is not a specific science section but science topics

are covered in the section *Beginning Knowledge*, which also covers social sciences and technology (Department of Basic Education, 2011).

3. The workbook *Grade 1 Life Skills in English; Book 2 Terms 3 & 4* (Appendix C p.85-91) was also selected as this is a free and sanctioned resource that has been created by the South African Department of Education to support the CAPS curriculum (Department of Basic Education, 2017).
4. Whilst there is not an official government sanctioned resource¹ in England for teaching science, the *Hamilton Trust* is a charity that provides free lesson plans and resources to schools based on England's NC. Therefore, the Hamilton Trust planning documents: "*Science Year 1 What's Growing In Our Gardens?*" (Appendix A p.72-77) was deemed to be a suitable equivalent to the South African workbook as they are both free supporting resources based on their country's curriculum, as illustrated by the six lesson plans covering Plants (Hamilton Trust, 2020).
5. The next texts selected are workbooks published by Cambridge University Press. There are teacher files and a student book that have been created for both countries, based on their national curricula. These are not free books but were selected due to my previous paper analysing the availability of scientific concepts in a textbook. England does not typically use textbooks or workbooks in primary school science, and so there are no government sanctioned or distributed textbooks. This book was selected again as there was a South African equivalent and are both based on their respective countries' national curriculum. The English Cambridge Primary Science extracts and the South African Study & Master Life Skills from Cambridge University Press extracts can be found in Appendix B (p.77-82) and Appendix D (p.92-99) respectively (Board & Cross, 2019; Cozens & Parker, 2012)

Due to the size of the current study, the analysis of the different texts was limited to the topic of *Plants* and *Plant and Seeds*. This topic was selected after comparing the topics covered in each national curriculum. In CAPS there is not a specific science curriculum, but there are science topics explored in the *Beginning Knowledge* section of *Life Skills*. The topics identified are: healthy habits, weather, my body, pets, plants and seeds, food, water,

¹ This has since changed; the English government now recommends the STEM website and lesson plans for at home learning to catch-up any learning lost due to COVID-19. This resource falls outside the scope of the current thesis but will be included in any publications emerging from the thesis.

and the sky at night. The topics covered in England's *Science programme of study* are: plants, animals including humans, everyday materials, and seasonal changes. From the comparison one can see that the topics that best overlap between the two curricula are *Plants and seeds* and *Plants*.

School science is concerned with settled and agreed upon knowledge whereas scientists in the field deal with knowledge production and 'unsettled' knowledge (Morris, 2014). In order to help with bridging the gap between these two kinds of science, Morris consulted a scientific dictionary (the Academic Press Dictionary of Science and Technology (C. G. Morris, 1992)) that she deemed reliable and consistent to be a source for scientific definitions for her study. Therefore, this study also consulted this dictionary for the definition of plants:

Botany. 1. Any member of the kingdom Plantae, generally characterized by the ability to produce food by photosynthesis, thick cell walls containing cellulose, a lack of power of locomotion, and a relatively open growth pattern. (C. G. Morris, 1992, p. 1664)

And:

Botany. The plant kingdom; in most systems, ... organisms that have cellulose cell walls, are capable of producing their own food, are not capable of spontaneous movement, and lack obvious nervous or sensory organs...(C. G. Morris, 1992, p.1664)

A second resource for scientific definition was also consulted, it comes from Cambridge Primary Science Teacher's Resource 1 which provides a definition couched in simpler terms and a school setting:

"A plant is a living thing that can make its own food using sunlight and water (through a process called photosynthesis). Plants have roots, stems, leaves, and flowers which can sometimes become fruit which have seeds. Seeds are the part of the plant that can grow into a new one, it needs to be warm and wet to grow. Look at some different plants outside, label its parts. Find out what happens when plants are left in the dark/light or with/without water" (Board & Cross, 2019, p.44).

These definitions were used to create a benchmark definition for the simple scientific concept of plants to which the other texts were compared to when being rated according to the criteria.

The data selected were organised according to Morris' study, where there are three types of data segments: primary data, supporting data, and related data. The primary data

are the two data segments from the topic of Plants in the NC and Plants and Seeds from CAPS. These relate to the three data source criteria and are the basis for the other data segments. The supporting data are the workbook, textbooks and planning document as they are based on the national curricula, elaborate on the brief descriptions in the curricula, and act as “internalising agents” for the primary data. The final type is related data which has to do with the progression of knowledge in schools, and these texts are the outcomes for the topic of plants later on in the primary school curriculum. Due to the size constraints of this thesis, the related data will not be analysed. The primary data segments are listed in table 4.1.

Text	Outcomes/Targets
CAPS Grade R-3 Life Skills- Term 3 Grade 1	Topic: Plants and seeds - 4 hours <ul style="list-style-type: none"> • Why we need plants - include food, shade, shelter for animals • What plants look like - roots, stem, leaves, flowers • Different plants - similarities and differences • Seeds and where they come from • What plants need to grow • Growing a plant from a seed - such as a bean or a lentil (Department of Basic Education, 2018)
English NC Science Programme of Study Year 1	<p><u>Statutory requirements:</u> Pupils should be taught to: • identify and name a variety of common wild and garden plants, including deciduous and evergreen trees • identify and describe the basic structure of a variety of common flowering plants, including trees.</p> <p><u>Notes and guidance (non-statutory):</u> Pupils should use the local environment throughout the year to explore and answer questions about plants growing in their habitat. Where possible, they should observe the growth of flowers and vegetables that they have planted. They should become familiar with common names of flowers, examples of deciduous and evergreen trees, and plant structures (including leaves, flowers (blossom), petals, fruit, roots, bulb, seed, trunk, branches, stem). Pupils might work scientifically by: observing closely, perhaps using magnifying glasses, and comparing and contrasting familiar plants; describing how they were able to identify and group them, and drawing diagrams showing the parts of different plants including trees. Pupils might keep records of how plants have changed over time, for example the leaves falling off trees and buds opening; and compare and contrast what they have found out about different plants. (Department for Education, 2013)</p>

Table 4.1: Primary data

The other data that has been selected can be seen in the appendices A to D (p. 71-99), as the supporting data from the textbooks are mostly pictures and the related data are quite detailed and sizeable.

4.3. Analytic Indicators

Morris created her analytic indicators based on the conceptual framework she based on Neo-Vygotskian elaborations which was explored in the literature review. Morris' (2014) conceptual framework is reproduced below.

1. A simple scientific concept is defined by the following criteria:
 - a. A simple scientific concept has two or more essential attributes
 - b. Although a simple scientific concept is couched in language that is likely to be understood by six-year-olds, simple scientific concepts also employ specialised terms that are universally understood to represent the same thing
 - c. A simple scientific concept is part of an ordered, hierarchical knowledge system within which concepts are systematically interrelated.
 - d. A simple scientific concept is transferable across contexts
 2. Each simple scientific concept has two integral parts:
 - a. Content knowledge
 - b. Procedural knowledge i.e. the mental processes and activities related to the acquisition of the content knowledge.
 3. A simple scientific concept underpins more complex scientific concepts.
- (Morris, 2014)

This framework was then translated into three questions to create the analytic indicators (AI). The AIs are numbered in relation to the conceptual framework (i.e. AI1 relates to number 1 in the conceptual framework). To meet the needs for this study the phrase “Grade/Year 1” has been swapped in for “Grade R”:

- AI: 1. How does the Grade/ Year 1 curriculum and educational materials represent the defining features of a science knowledge concept with regards to:
- a) It’s essential attributes?
 - b) The degree of specialisation of language?
 - c) Its relation to other concepts?
 - d) Its relation to context?
- AI: 2. How does the Grade/ Year 1 science curriculum and educational materials represent the structure of a science concept with regards to the relation between content and procedural knowledge?
- AI: 3. How does the Grade/ Year 1 curriculum and educational materials represent science concepts with regards to the relation between simple and complex concepts? (Morris, 2014)

Using these indicators, Morris created three descriptions for Grade R school science knowledge concepts, that are drawn on in this study to describe Grade/Year 1 science: simple scientific concept, potential scientific concept, and an everyday concept (Morris, 2014).

The notion of a simple scientific concept was developed by Neo-Vygotskians, which is based on three ideas: firstly Vygotsky's idea of a mature concept, in that scientific knowledge can be separated into a range of concepts in terms of complexity; secondly the idea of every concept having content and scope, which establishes the idea that concepts are always related to other concepts and is on a knowledge continuum; and thirdly that science strives to move from descriptions of phenomena to revealing the essence of the internal bonds, which relates to the essential attributes of concepts (Morris, 2014). It is the first two ideas which build the notion of a knowledge continuum where at the beginning there are simple scientific concepts that move towards more mature concepts (Morris, 2014). For example, learning that plants need sunlight and water to grow in Grade 1 and then learning about photosynthesis in Grade 6. Simple scientific concepts have been differentiated from other concepts in three ways: having an explicit and unique definition with two or more essential attributes so that it is different from other concepts, described in simple scientific terms, and having a description of position in relation to other concepts on the scientific knowledge continuum (Morris, 2014). As with scientific concepts, simple scientific concepts also have content and procedural knowledge, and can be transferred to other contexts, but is unique in that it underpins more complex scientific concepts (Morris, 2014).

Morris (2014) created the term 'potential scientific concept' for her study, and this kind of concept is one that has parts of or infers the features of a scientific concept. This kind of concept is intended to guide a teacher towards imparting new scientific knowledge. The use of 'potential' is in relation to the pedagogical, and not developmental as in the case of Vygotsky's idea of potential concept (Morris, 2014). It has to do with the probability and ability of the educator to interpret the potential concept and realise it as a simple scientific concept by providing more scientific knowledge (Morris, 2014).

The Neo-Vygotskians explain everyday concepts as descriptions which define ideas in personal everyday context-dependent sensory observations (Morris, 2014). Everyday concepts are considered as scientifically unacceptable as they are not couched in scientific

terms, not transferable across contexts, and do not contain the essence of a concept (Morris, 2014). Furthermore, everyday concepts can also be incorrect (dolphins are fish because they have fins) or empirical (birds fly).

The next section will look at how the rating scale was created, which is used to assess the degree of alignment between the analytic indicators and the three concept descriptions.

4.4. The rating scale

Morris created the rating scale and benchmarks based on the conceptual framework. Six rating criteria were developed and stem from the six features of a simple scientific concept. Each criterion was allocated a score out of two, where a full score (2/2) indicates that the criterion is explicitly and entirely seen in the text, a score of one means that the criterion is implied or partially seen in the text, and a score of zero means there is no evidence of the criterion in the text or the text has errors (Morris, 2014). Once each criterion has been rated, the total score is calculated and measured against a benchmark score. A total score of 12 is a simple scientific concept, a score between 5 and 11 indicates a potential scientific concept, and a score of 4 or less is considered an everyday concept.

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Contains two or more essential attributes that uniquely defines and differentiates the concept from all other concepts.	Employs two or more specialised terms.	Described in relation to other concepts on the scientific knowledge curriculum.	Transfers across contexts.	Structured as two integral parts i.e. content knowledge and procedural knowledge.	Underpins more complex scientific concepts.
/2	/2	/2	/2	/2	/2

Table 4.2: The Rating Scale Criteria

An example is given in this section in order to show how the rating scale works, how the curriculum description created by the analytic indicators depends on the data segment, show the differences in knowledge types, and demonstrate that this is a normative analysis since Morris has created a language of description for the science curriculum in terms of the Neo-Vygotskian notion of school science concepts (Morris, 2014). The section on Plants and Seeds from the Grade 1 Life Skills curriculum has been selected as an example.

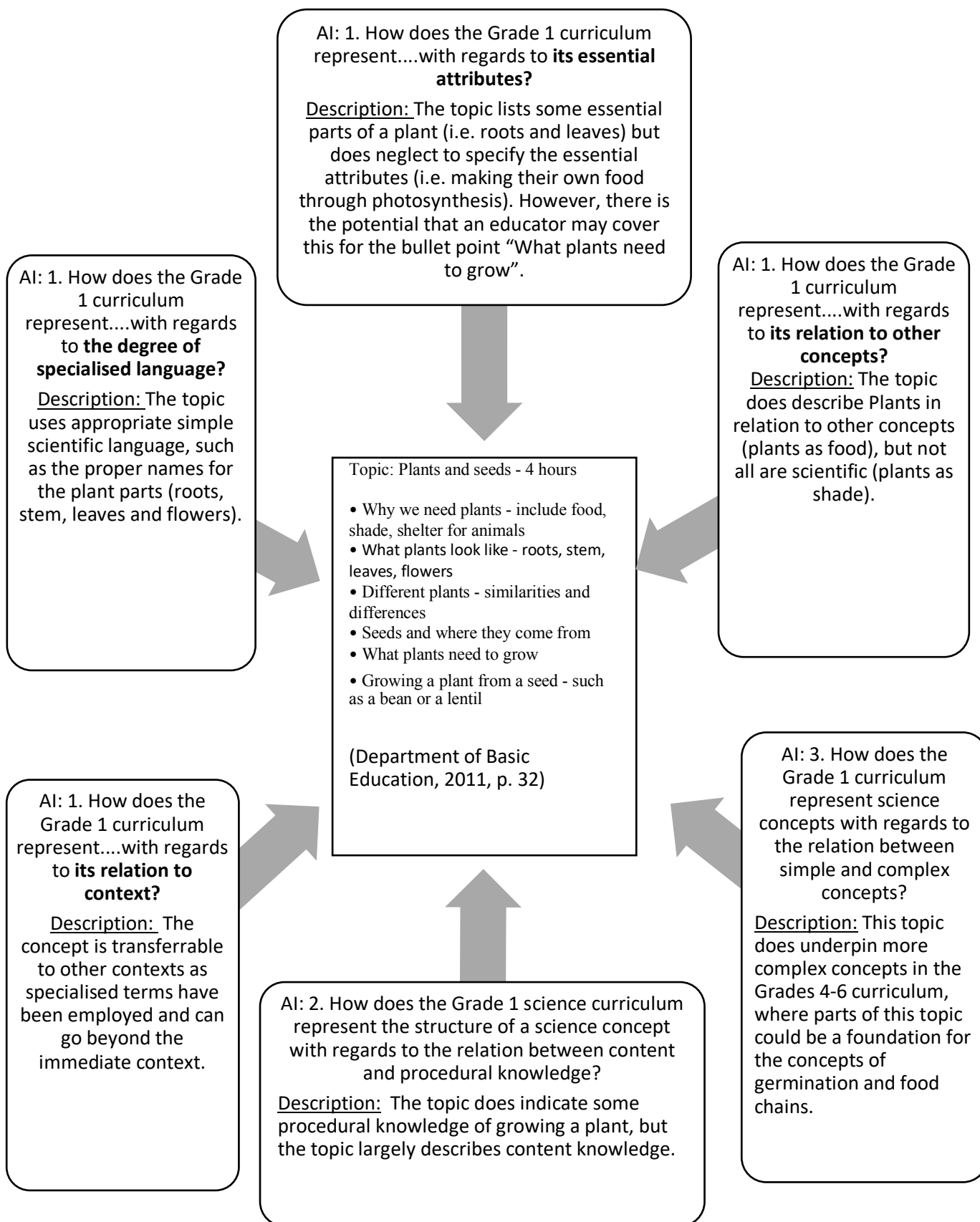


Diagram 4.1: Analytic indicators generating a description for the topic "Plants and seeds"

The analytic indicators have generated a description of the topic of “My Body” as a potential scientific concept as it only partially meets the criteria to be a simple scientific concept. This is evident in the analytic indicator of essential attributes, because this topic is talking about humans and neglects to mention the distinctive characteristics of humans as mammals and have mammary glands, hair, and are born alive. These attributes may be communicated as the topic did not specify exactly what “different parts of the body” should be covered, hence this indicates that this indicator is only partially met. When described by the rating scale, this would be scored 1/2 for criterion 1. The analytic indicators and rating scale will be used to generate descriptions for all the data that has been selected in chapter 5.

4.5. Validity, Reliability and Ethics

As this study is based off of the design created by Morris, it also followed her three guiding recommendations : 1) the research design has detailed information, 2) the analysis has a rich description, 3) more than one datum source is used for the selection of texts, 4) provide data that is credible, relevant, representative, and accurate, and 5) have an approach which shows sensitivity and objectivity (Morris, 2014). The previous sections in this chapter provide evidence that these recommendations have been followed. To minimize the threat to theoretical validity the analytic framework was based on a conceptual framework which was created from peer-reviewed and seminal texts (Morris, 2014). There is a threat of researcher subjectivity, as someone trained in England I am more familiar with the English National Curriculum and therefore have a better understanding and bias towards these documents. However, due to the explicit and detailed analytic indicators this bias is minimised as it will allow for a fair analysis of all data and subsequent comparison. The reliability of this current study lies in its ability to be replicated by others (as evident from this study replicating Morris’ work), which is possible due to the comprehensive conceptual framework and the explicit analytic framework that was created by Morris. The data used in this study is largely accessible through online databases, and those which are less accessible (purchased workbooks) are copied exactly in the appendices. There are few ethical concerns in this thesis, as this is a document analysis and follows the University of Cape Town’s code of ethics.

4.6. Conclusion

This chapter has introduced the design of this study which was created by Morris for her own study on the Grade R curriculum. There have been very few changes to this design as it has been found to be applicable in the new context of Year 1 and Grade 1 curricula as children in these year groups are still dealing with simple scientific concepts. This framework will be used in the next chapter to analyse the seven data segments selected and the scores from the two countries will be compared.

Chapter 5: Results

5.1. Introduction

In this chapter, the data are analysed with a view to answering the following research questions: to what extent are simple scientific concepts made available in England's and South Africa's national curriculum for Grade/ Year 1 Plant science, and their supporting data? How do these two countries compare in regard to availability of simple scientific concepts? The analysis is divided into separate sections, first are the ratings of the texts from England, and then those from South Africa, and then the results from both nations will be compared.

5.2. England

5.2.1. National Curriculum

Below is the rating that England's National Curriculum on Year 1 Plants received. The extract features "statutory" and "non-statutory" information and both have been consulted in the rating.

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Contains two or more essential attributes that uniquely defines and differentiates the concept from all other concepts.	Employs two or more specialised terms.	Described in relation to other concepts on the scientific knowledge curriculum.	Transfers across contexts.	Structured as two integral parts i.e. content knowledge and procedural knowledge.	Underpins more complex scientific concepts.
1/2	2/2	2/2	1/2	1/2	2/2

Table 5.2.1: Rating of England's National Curriculum on Year 1 Plants

The data received a score of one for the first criterion due to the fact that it did not describe the essential attributes of deciduous and evergreen trees but did for flowering plants. It receives full marks for the second criterion because it used two specialised terms for the trees and plant parts. For the third criterion it is scored a two, because the extract mentions the scientific concept of plants in habitats for animals, and evergreen and deciduous trees which relates to the scientific concept of classification. A score of one is

given to the fourth criterion as the information is partially transferable across texts as there is insufficient information on the essential attributes of deciduous and evergreen trees. Criterion five also has a score of one, as there is an emphasis on the procedural knowledge of ‘working scientifically’ but it cannot be given full marks as the content knowledge is lacking. For the final criterion six, it is awarded a score of two because it underpins more complex concepts of labelling flower parts and classification of different types of plants such as deciduous and evergreen. The total score is nine and therefore this is considered a potential scientific concept.

5.2.2. Hamilton Trust

Hamilton Trust is an online teaching resource which provides lesson plans for teachers. There are six ratings for this data segment, as there are six lesson plans for the topic on Plants.

Session 1: Going and growing outside

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	2/2	1/2	0/2	2/2

Table 5.2.2: Rating of Hamilton Trust: Session 1 (Appendix A p. 71)

The first extract mentions that plants need water to grow, however it does not explicitly mention the other essential attributes for plant growth (soil and sunlight) and mentions non-essential attributes such as growing fruit (that is gymnosperms do not grow fruit), so criterion one is given a score of one. In the key vocabulary section of the plan, the extract mentions some specialised terms such as plant, water, living, grow and leaf, therefore criterion two has a score of two. The third criterion also has full marks because the concept is described in relation to other concepts, the lesson plan refers to plants as habitats and food for animals. The essential attribute that plants need water is transferable across contexts, however not all plants grow fruits and so the criterion has one mark. For criterion five, the activity that is described asks the children to draw detailed images of the fruits and vegetables, however this activity is not structured within the essential attribute presented of plants needing water but is structured in the everyday knowledge that fruits and vegetables grow on/are plants. Since the activity is not structured within the essential attribute, and therefore it is not related to the content knowledge, it is considered erroneous and given a score of zero. The sixth criterion is given a score of two because the

concepts mentioned (such as fruit) underpin more complex concepts within the plant life cycle, and the need for water plays a role in plant respiration. The overall score is eight and the extract is a potential scientific concept.

Session 2: One Potato, two potato

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	1/2	1/2	2/2	2/2

Table 5.2.3: Rating of Hamilton Trust: Session 2 (Appendix A p. 72)

The extract provides some information about essential attributes of potato growth that they can be “cloned” because tubers can be replanted to produce more potatoes rather than have potatoes go through sexual pollination, it is mentioned that the children do not need to know this amount of detail but is available to the teacher. The extract also mentions that “potato seeds” (the tubers) require water to grow, so the first criterion receives two points for these two essential attributes of potatoes. The extract has at least two specialised terms in it (for example pollination, tubers, and seed) so criterion two is given a score of two. A score of one is given to criterion three because the extract mentions that potatoes are food and the implication is that this could be linked to the digestive system, however the description in the lesson plan focuses mostly on different ways potatoes can be prepared to be eaten (for example fries and mashed) which is not a scientific concept as it is not an essential attribute to potatoes or digestion. This extract is focussed on potatoes and therefore is not entirely transferable beyond this context, but the concept of seeds and growth is implied which is why criterion four scored one mark. Criterion five is given a score of two because the activity involves growing a potato based on the essential attributes of potatoes, and so the concept is structured as two integral parts. The concept of plant growth presented in this extract underpins more complex scientific concepts such as pollination, germination and respiration, so criterion six is given two marks. This extract has an overall score of 10, which classifies as a potential scientific concept.

Session 3: Garden centres and seeds

Session 3: Garden centres and seeds	
Science curriculum area (1P):	<p>Content (1P)</p> <p>i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees</p> <p>ii. identify and describe the basic structure of a variety of common flowering plants, including trees</p>
Working Scientifically (KS1 WS)	<p>Working Scientifically (KS1 WS)</p> <p>i) asking simple questions and recognising that they can be answered in different ways</p> <p>ii) observing closely, using simple equipment</p> <p>iii) performing simple tests</p> <p>iv) identifying and classifying</p> <p>v) using their observations and ideas to suggest answers to questions</p> <p>vi) gathering and recording data to help in answering questions</p>
Teaching Objectives	<ul style="list-style-type: none"> To share knowledge about gardens and gardeners. To design and set up a garden centre in the classroom. To plant a bean in a bag and keep it in the classroom garden centre. To predict the outcomes of the bean and seeds and set up a diary to observe the growth over time. To consider what seeds need in order to be able to grow and how you can keep seeds healthy.
Key Vocabulary: plant, leaf, grow, weed, change, living, water, healthy, different, seeds, garden centre	
Resources	<p>Different gardens resource, examples of classroom garden centres, How to grow a bean in a bag, My bean in a bag diary, things for setting up a garden centre in the classroom - small plants, role play cakes, till, baskets, plastic food, paper, pens, card for signs etc., dried bean seeds, paper towels, stapler, plastic bag (the A4 sized kind which seals at the top works best), ruler.</p>
Weblinks	<p>https://www.youtube.com/watch?v=F2lJW7TaF18 - Lowden Garden Centre;</p> <p>https://www.youtube.com/watch?v=PfMSKMsU5U - information video for teachers on sprouting bean seeds;</p> <p>https://www.youtube.com/watch?v=EKx4ZwoJqXY - time lapse video of a sprouting bean seed (3.26 mins).</p>
<p>Before the session: collect the necessary items for the chn to set up a mini garden centre in the classroom. This need only be the size of a table and could be very temporary.</p> <p>Whole class: Show the chn the images showing different types of gardens. Ask them if they have a garden and what it is like. Explain that all gardens are different - different shapes, locations, climate, plants and design. Then ask if they have been to a garden centre before. Play them the clip of a large garden centre, typical of many in the UK. Before you play it, tell the chn that you will be asking them to tell you what they can do at a large garden centre, so they must try and remember as many different things as they can. Then show them the items you have collected and challenge them to set up a mini garden centre in a space in the classroom (there are examples in resources).</p> <p>Activities: When the chn have set up the classroom garden centre, bring them together and tell them that they are going to grow a bean plant from a bean seed in a freezer bag. Show them the resources and talk through what they need to do. Ask them to work in groups with an adult, following the resource sheet. When they have finished, they may tape the bean into the garden centre or peg onto a washing line. Ask each child to predict what they think will happen to the bean. Give them the 'bean in a bag diary' sheet and ask them to fill in the first section.</p>	
Plenary	<p>Say to the chn: <i>What have you noticed about our beans? What is missing from our bean growing, that we definitely had when we were planting potatoes? (Soil.) Do you think the bean seeds will grow? What have they got that is the same as the seed potatoes? (Water, warmth.)</i> Watch the time lapse clip of a sprouting bean seed (3.26 mins).</p>
Outcomes	<p>Children will</p> <ul style="list-style-type: none"> Understand what a garden is and how varied they are Design and set up a garden centre in the classroom Plant a bean seed in a bag and consider what seeds need to be able to grow Predict the outcomes of the bean seeds and set up a diary to observe the growth over time

Extract 1: Hamilton Trust Session 3 (Hamilton Trust, 2020)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	1/2	2/2	2/2	2/2

Table 5.2.4: Rating of Hamilton Trust: Session 3

This extract states the essential attributes of seed growth which are warmth and water, and that they do not need soil like the potato from the previous session, therefore criterion one has a score of two. The specialised terms of seed, soil, water and warmth are mentioned for seed growth, and so criterion two also has a score of two. The extract briefly

describes the differences between growing the new seeds to the potatoes, and so criterion three is given one point. The information given in the extract allows for the concept to be transferable across contexts, accordingly criterion four has two marks. Even though there is a lot of time spent discussing garden centres which is everyday knowledge, part of the activity in the lesson is to grow bean seeds, and then observe and record what is happening. This is couched within the content knowledge provided about seed growth so criterion five has two marks. Criterion six is scored a two, because the information provided about seed growth underpins more complex scientific concepts such as germination. The total score is 11 and is classified as a potential scientific concept.

Session 4: What lives in the Garden

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	2/2	2/2	1/2	2/2

Table 5.2.5: Rating of Hamilton Trust: Session 4 (Appendix A p.74)

The extract received a score of one for the first criterion because it describes pollen as “part of how new plants are made” which is one essential attribute of pollen described in quite simple terms. The extract has the specialised terms of pollen and flower, and so criterion two has been scored two marks. Criterion three is given two points, because the lesson involves the children identifying plants and leaves which have been eaten, which links to the concept of insects and habitats. The fourth criterion is given a score of two because the extract provides enough information (which were simple description, images of different flowers’ pollen) to allow for it to be transferable across contexts. The fifth criteria is given a score of one, because the extract suggests that the teacher only challenges the “more able” students to consider the function of spikes or hooks on pollen in the activity of creating clay models of different kinds of pollen. The activity of creating clay models of pollen without considering what it should look like does not structure the content and procedural knowledge as two parts, and the content knowledge is only meant to be accessed by some of the children. The concept presented in the extract (pollen) underpins more complex scientific concepts of plant reproduction and parts of plants, therefore criterion six is scored a two. The total score is 11 and is considered a potential scientific concept.

Session 5: What is inside a flower?

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	2/2	2/2	2/2	2/2

Table 5.2.6: Rating of Hamilton Trust: Session 5 (Appendix A p.75)

The first criterion is rated two for the extract as the essential attributes of parts of the plant are covered and their basic functions as well. The second criterion also received a score of two, as more than two specialised terms are utilised (such as roots, stem, flower, leaves, reproduction, etc.). The third criterion is rated two as well because the parts are related to other concepts to do with their function such as making energy and reproduction. The content is transferable across contexts as the essential attributes are described, and therefore the fourth criterion has a score of 2. The procedural knowledge of labelling a flower's parts and creating flowers is structured with the content knowledge of the parts and functions of the parts, and so criterion five is scored two. Criterion six is given two marks, because the parts and functions of plants underpin more complex scientific concepts such as more detailed parts of plants and respiration, reproduction and germination. The total score for the extract is 12 and is a simple scientific concept.

Session 6: What is inside a tree?

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	2/2	2/2	2/2	2/2

Table 5.2.7: Rating of Hamilton Trust: Session 6 (Appendix A p.76)

The first criterion is scored two marks because there is mention of more than two essential attributes, such as evergreen trees keep their needle-like leaves in winter, deciduous trees have flat leaves that change colour and fall in autumn, and trees have roots, bark, trunks, leaves, and branches. The second criterion is also given a score of two because more than two specialised terms are utilised. Criterion three is given a score of two as well, the extract refers to the water cycle (they mention water evaporating from leaves of trees). The extract is transferable to other contexts, as the information can be used to label most trees, so the fourth criterion is scored two. The fifth criterion is scored two because there is procedural knowledge and content knowledge structured as two parts, the activity of labelling the tree parts is based on the content knowledge. The sixth criterion also receives

two marks because the extract underpins more complex concepts such as water movement in plants, and tree life cycles. The total score for the extract is 12 and is a simple scientific concept.

5.2.3. Cambridge Textbook

The Cambridge textbook has four ratings: teacher’s background information, topic 2.1 Plant Parts, topic 2.2 Growing Seeds, and topic 2.3 Plants and Light. The ratings for the three topic extracts reflect both the learning outcomes from the teacher’s book and the related activity section in the learner book.

Teacher Background

Teacher Background	<p>The life cycle of a flowering plants start with a seed that grows a root, then a stem and leaves. The roots collect water from the soil and the leaves collect carbon dioxide from the air. The leaves then use the water and carbon dioxide, and energy from light, to make food for the plant. Without this light energy, the plant cannot make food and will eventually die. This process is called photosynthesis.</p> <p>Germination is when a seed begins to grow. At this stage the plant has no leaves and is often underground in the dark. Therefore the plant cannot make its own food to grow. The seed itself contains a store of food that it uses until it reaches the light and grows leaves. Learners don’t need to be taught germination at this stage.</p> <p>The function of a flower is to allow the plant to reproduce... To produce seeds the flower needs to be pollinated. This means the female part needs to receive pollen from the male part of another plant of the same kind.</p> <p>Pollen can be transferred by wind and by insects who are attracted by the colourful petals and sweet nectar of the flowers. Once pollinated, the flower gross into a fruit which contains seeds... (Board & Cross, 2019)</p>
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Extract 2: Cambridge Primary Science English: Teacher’s Resource (Board & Cross, 2019, p.44)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	2/2	2/2	0/2	2/2

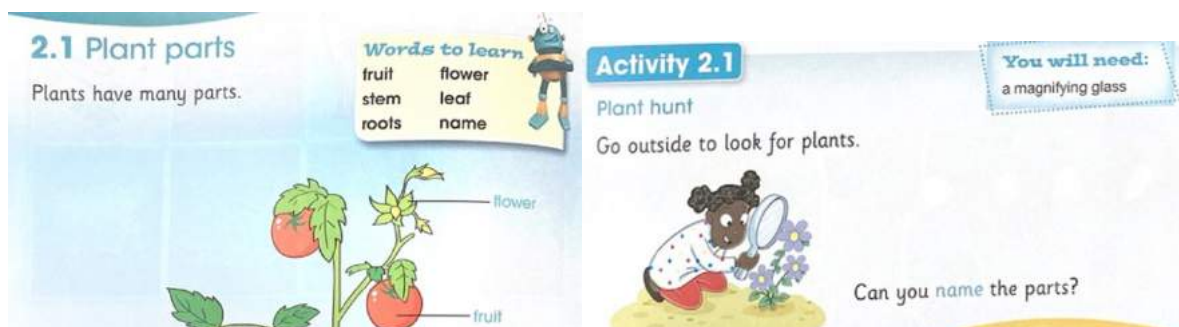
Table 5.2.8: Rating of English Cambridge Textbooks: Teacher Background Information

The Teacher Background extract received full points for the first criterion because it describes the essential attributes of plants, such as stems, roots, and leaves. It also scored full points for the second criterion as it has more than two specialised terms (which were

photosynthesis, germination, and the parts of the plant). Since the extract has described the essential attributes and used specialised terms, it can be transferred across different contexts and underpins more complex scientific concepts, such as respiration, and therefore the third and fourth criteria received two points each. The fifth criterion is the only one that does not receive any points as it did not mention any procedural knowledge, and so it is not structured as two integral parts. The sixth criterion is scored two, as there is reference to other parts of the curriculum such as insects, light, and reproduction. The overall score for this extract is 10, and it is a potential scientific concept. Although this extract provides a lot of content knowledge, it cannot be considered a simple scientific concept without the fundamental procedural knowledge.

Topic 2.1 Plant Parts

Topic 2.1 Learning Outcomes	<ul style="list-style-type: none"> • Name the major parts of a plant, looking at real plants and models. • Try to answer questions by collecting evidence through observation. • Model and communicate ideas in order to share, explain and develop them. (Board & Cross, 2019)
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Extract 3: Cambridge Primary Science English: Learner Book Topic 2.1 Plant Parts (Board & Cross, 2019, p. 16-17)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	0/2	2/2	2/2	2/2

Table 5.2.9: Rating of English Cambridge Textbooks: Topic 2.1 (Appendix B)

The first and second criterion received scores of two because the learner book labels the essential parts of the plant, and uses specialised terms such as root, stem and leaf. The extract only focuses on labelling the parts of the plant, it is not described in relation to other parts of the curriculum (for example learn the function of the different parts) and the third criterion is scored zero. The extract provides the essential attributes and specialised terms

for labelling a plant and so is transferable across contexts, and the fourth criterion receives a score of two. The fifth criterion is also given two marks as the extract provides relevant ideas for procedural knowledge, such as using the content knowledge of plant parts to label plants in the school garden. This extract does underpin more complex concepts that will be learned later, for example more detailed labelling of the parts of the plant (like the stamen) and so the sixth criterion receives two points. The extract can be considered a potential scientific concept as it has a total score of 10.

Topic 2.2 Growing Seeds

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	0/2	2/2	2/2	2/2

Table 5.2.10: Rating of English Cambridge Textbooks: Topic 2.2 (Appendix B p.80)

The first criterion received two marks because the extract describes the essential attributes of seeds needing water to grow and seeds growing into plants. The second criterion also received two marks because more than two specialised terms were used; seed, root, and water. Like Topic 2.1, this extract also does not relate to other concepts in the curriculum (such as plants as food, or the involvement of animals in seed dispersal) and so is scored zero for criterion three. The activity in this topic required the children to look at different types of seeds and what their plants may look like, and so is transferable across contexts and scores two marks for criterion 4. The extract provides both content knowledge and procedural knowledge, as there are relevant activities for children to engage with to explore and test seed growth, so criterion five is given two marks. The sixth criterion is given a score of two because this topic underpins the more complex concept of seed germination. This extract is a potential scientific concept with a score of 10.

Topic 2.3 Plants and Light

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	0/2	2/2	2/2	2/2

Table 5.2.11: Rating of English Cambridge Textbooks: Topic 2.3 (Appendix B p.82)

The first criterion for Topic 2.3 scores two marks as it mentions the essential attributes of plants growing towards light and needing water. The extract employs two specialised terms of water and light, and so criterion two is scored two marks. It does not

relate the concept to other concepts, such as seeds not needing light, therefore it scores zero for criterion three. Criterion four has a score of two because the extract describes the concept of plant growth with the essential attributes of water and light, and so can be transferred to different contexts. The fifth criterion is scored full marks as the extract combines the content knowledge of plants needing light with procedural knowledge of growing plants in different conditions of light. Criterion six scored two points because the concept of plants needing light underpins the concept of photosynthesis. The total rating score is 10 and is a potential scientific concept.

5.3. South Africa

5.3.1 CAPS

This section presents the rating that is from the CAPS document on the grade 1 topic Plants and Seeds.

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	2/2	2/2	1/2	2/2

Table 5.3.1: Rating of South African CAPS Grade R-3 Life Skills- Term 3 Grade 1 Plants and Seeds

The first and second criterion are both scored two marks, because the extract mentions the essential attributes of the parts of the plant using the specialised terms roots, leaves, stem, and flowers, and the essential attribute that plants grow from seeds. The third criterion is also given two marks because the extract described plants as food and shelter for animals which relates to habitats, food chains and the digestive system. The fourth criterion is scored a two because the extract describes essential attributes with specialised terms which allows for the information to be transferred across contexts. The fifth criterion is scored a one because the procedural knowledge of “growing a plant” is only implied as it is based on the content knowledge of “what plants need to grow” which is not elaborated on in the extract. The sixth criterion is scored two because the parts of the plant in this extract underpins more complex scientific concepts of detailed plant labelling (like the stamen) and plant part functions. The overall score is 11 and is considered a potential scientific concept.

5.3.2 DBE textbook

The textbook from the DBE is based on the outcomes in the CAPS document, and there are four sections on plants and seeds in the learner workbook that are rated below.

Why we need plants

Extract 4: DBE Grade 1 Life Skills in English; Plants and Seeds Topic 41: Why we need plants (Department of Basic Education, 2018 p.18-19)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
0/2	1/2	2/2	1/2	0/2	0/2

Table 5.3.2: Rating of DBE Life Skills workbook: Why we need plants (41)

The first criterion received a score of zero because the extract does not explicitly mention two or more essential attributes of plants, it does imply that plants have flowering parts, but this is not enough for a mark. The extract uses one specialised term, the part of the plant “flower” and so it partially meets the second criterion and is scored one mark. The concept of plant is described in relation to other scientific concepts of food and as a habitat, and so the third criterion received two marks. Since there is a lack of essential attributes described and the information provided is largely everyday concepts, it is not very transferable across contexts and criterion four is scored one mark. The extract lacks content knowledge and therefore the extract cannot be structured as two integral parts, so criterion five is scored zero. This extract presents everyday concepts, and as there is a lack of

essential attributes and therefore scientific concepts, the final criterion is scored zero points. This extract has a total score of four and is an everyday concept.

What plants look like

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	1/2	2/2	1/2	2/2

Table 5.3.3: Rating of DBE Life Skills workbook: What plants look like (42) (Appendix C p.86)

The first and second criteria are scored two marks because the extract describes the essential attributes of the parts of the plant and uses the specialised terms of roots, flower, leaf, stem, and seedpod. The third criterion received one mark because the activity in the extract briefly refers to animals eating plants, and this links to topics such as food chains and the digestive system. As the extract has more than two essential attributes and specialised terms, the concept can be transferred across contexts and criterion four is scored full marks. The fifth criterion only has a score of one because the procedural knowledge of describing the similarities and differences of the different plants is based on the content knowledge of plant parts, but the pictures given do not show all the content knowledge taught like the roots and seed pods. This underpins the more complex scientific concepts of labelling detailed parts of plants (for example ovary) and therefore criterion six is scored 2 marks. The total score is 10 and so a potential scientific concept.

Seeds and where they come from

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
2/2	2/2	2/2	2/2	1/2	2/2

Table 5.3.4: Rating of DBE Life Skills workbook: Seeds and where they come from (43) (Appendix C p.88)

The extract largely focuses on seed dispersal which is a non-essential attribute of seeds, but it does mention two essential attributes that seeds come from the flower or fruit part of the plant and that seeds grow into new plants, and consequently criterion one is scored two marks. Criterion two is scored two marks as well, because the extract uses more than two specialised terms; flower, fruit, and seeds. The third criterion got two marks also because the concept is described in relation to the concept of plants as food for animals and links to scientific concepts of food chains as well as animal digestive systems (“seedpods get eaten by birds... then stay in their droppings”). Since the first two criteria received two

marks, this means that the information can be easily transferred across contexts and the fourth criterion can be scored two marks too. The fifth criterion was scored one point because the activity (procedural knowledge) the children are asked to discuss what the seeds should be like to spread by different methods which does link with the content knowledge of seed dispersal, but there is also an activity of moving coloured cloths around and witness its movement which is unrelated to the content knowledge. The sixth criterion received a score of two because the concept of seed growth underpins the more complex topic of seed germination. The overall score is 11, which means it is considered a potential scientific concept.

What plants need to grow

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	2/2	2/2	2/2	2/2

Table 5.3.5: Rating of DBE Life Skills workbook: What plants need to grow (44) (Appendix C p.90)

The extract mentions the essential attributes of plant growth are sunlight, water, and mentions “air” which could imply that a knowledgeable teacher could introduce the concept that plants use CO₂ to make food and produce oxygen that humans breathe. The reason why the first criterion scores one mark despite the essential attributes is the fact that the extract mentions “nutrients” and asks the question ‘Do plants also eat? If they do, what?’ which could lead to misconceptions that plants “eat” nutrients from the ground rather than producing their own through photosynthesis. The second criterion scored two marks because the specialised terms sunlight and water were employed. The third criterion scored two marks as well because the extract describes plant growth in relation to the scientific topic of living and non-living things. The extract describes plant growth in a manner so that it is transferable across contexts, and accordingly the fourth criterion has two marks. The fifth criterion also has two marks, because the procedural knowledge of growing plants is based within the content knowledge of what plants need to grow. This underpins more complex scientific concepts such as seed germination and respiration, so criterion six also has two points. This extract has a score total of 11 which makes it a potential scientific concept.

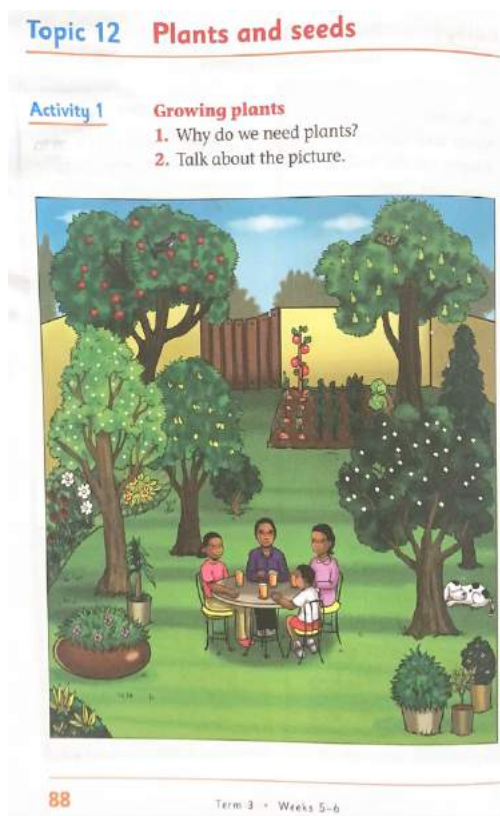
5.3.3. Study & Master Life Skills textbooks

The ratings in this section are based on the teacher’s book, and the learner’s book information together. The extracts for Activity 2 and Activity 3 refer to worksheets which have not been accessible for this current thesis, and so it is important to consider that perhaps the worksheets do provide more information and the ratings for these two extracts are not as accurate as the others.

Activity 1 Growing plants

Activity 1
Growing plants
Learner’s Book
page 88

- Resources: pictures and flashcards to emphasise the importance of plants
1. Let the learners turn to Activity 1 and read the question.
 2. Let them look at the picture and have a class discussion about why we need plants. Talk about things such as the following:
 - We need to breathe in oxygen, and this comes from green plants and trees.
 - Trees and plants provide food for both people and animals.
 - Trees and plants provide shade and shelter.
 - Trees provide timber, and timber provides paper, furniture and housing.
 - Trees and plants provide homes for some animals and insects.
 - Most people enjoy being close to trees and plants because it makes them feel good.



Extract 5: Study & Master Life Skills textbooks, Plants and Seeds Activity 1 (Cozens & Parker, 2012, p. 88)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	1/2	1/2	0/2	0/2	1/2

Table 5.3.6: Rating of Study & Master Life Skills textbooks: Activity 1 Growing plants

The title for the activity is called growing plants however the extract does not mention any essential attributes for the concept of growing plants. It is based on everyday knowledge of why we grow plants (such as for timber, food, makes you feel good), but it does mention that plants make oxygen and so is scored one for criterion one. The extract does mention the specialised term oxygen and so criterion two is partially met and is scored

one. The extract also states that oxygen comes from green plants and we breathe it which connects to the scientific concepts of respiration in animals and plants, and therefore criterion three is scored one. The extract lacks sufficient description of essential attributes to differentiate it from other concepts, and therefore also prevents it from being transferable across other contexts resulting in a score of zero for criterion four. The lack of essential attributes is also the reason behind criterion five receiving a score of zero, because there cannot be procedural knowledge without the content knowledge. The sixth criterion is partially met because the extract mentions the concept of plants producing oxygen, which as previously described underpins the more complex concept of respiration. This extract has a score of four, which means it can be described as an everyday concept.

Activity 2 How to plant

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	1/2	2/2	2/2	2/2

Table 5.3.7: Rating of Study & Master Life Skills textbooks: Activity 2 How to plant (Appendix D p. 96)

The extract alludes to the fact that plants need sunlight, water, air, and soil to grow (which are essential attributes for plant growth) however, the extract also mentions seeds but does not differentiate that seeds do not require sunlight for growth. Therefore the first criterion is scored a one, as the information presented could lead to misconceptions if the teacher is not knowledgeable enough to make the distinction themselves. The extract has more than two specialised terms, and so is scored two. The extract states that plants need air to grow, which could connect to the topic of respiration if the teacher is able to see the link. As it is not clearly stated, the third criterion is scored one. Criterion five is scored two, because the extract is structured as two integral parts, where the content knowledge of what is needed to grow plants is put into action as the children plant and care for their own plants. The concept of plant growth underlies more complex concepts of plant reproduction and seed germination, which is why criterion six has a score of two. The total score is 10, which means this is a potential scientific concept.

Activity 3 What plants look like

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	1/2	1/2	1/2	2/2

Table 5.3.8: Rating of Study & Master Life Skills textbooks: Activity 3 What plants look like (Appendix D p. 97)

The first criterion is only partially met because the extract tells the teacher to explain the different parts of the plant and asks the teacher to show a variety of food plants, root foods, bulb foods, stem and leaf foods, and fruit, from which the teacher can deduce what the essential parts of a plant are. As this is not very explicit, criterion one is scored a one. The extract lists more than two specialised terms like flowers, leaves, stem, and root so criterion two received two points. The third criterion is partially met (scored one) as the activity links to the concept of classification as it asks the children to differentiate the plants through asking them if all plants have the same parts. The fourth criterion is scored one because the essential attributes are not described clearly, and so there is the potential that the teacher may not teach the concept correctly and so may not be transferable across contexts. Much of the procedural knowledge remains on the everyday level (such as describing the plants in terms of colour and smell) but it does connect to the content knowledge by asking the children to describe what part of the plant each thing is, which is why the criterion is given a score of one. This concept underpins more complex concepts of classifying plants and labelling more detailed parts of plants, and so criterion six received two points. The total score is eight, which indicates that this is a potential scientific concept.

Activity 4 Trees

Activity 4 **Trees**

1. Why do we need trees?
2. Do all trees look the same?
3. Talk about the pictures.

Term 3 • Weeks 5-6 **91**

- Activity 4**
Learner's Book
page 91
- Resources:** flashcards with the following names of different tree types: eucalyptus, peach, oak, palm, poplar, weeping willow, aloe, apple, fir
1. Let the learners turn to Activity 4 and read the questions and instructions.
 2. Use the pictures to have a class discussion about trees.
Talk about:
 - why we need trees
 - whether all trees look the same
 - the various shapes of different types of trees.
 3. Have the names of the trees on flashcards. The trees shown in the Learner's Book are: eucalyptus, peach, oak, palm, poplar, weeping willow, aloe, apple and fir.
 4. Let each learner paint a picture of a tree.
 5. If possible, arrange a class visit to a botanical garden or a park where there are beautiful trees around.

Extract 5: Study & Master Life Skills textbooks, Plants and Seeds Activity 4 (Cozens & Parker, 2012, p. 91)

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
0/2	2/2	1/2	0/2	1/2	1/2

Table 5.3.9: Rating of Study & Master Life Skills textbooks: Activity 4 Trees

The extract does not mention any essential attributes that differentiates the concept of trees from all other concepts, and so the criterion one is scored zero. Criterion two has full points, because the extract employs the specific names of trees and so technically does meet the requirement of employing two or more specialised terms. The extract asks the teacher to discuss if the trees look the same and the different shape of the trees, which could lead to a discussion of grouping and classification, so criterion three is scored one point. There are no essential attributes mentioned and so the activity is bound to the specific context of the trees pictured in the learner book, and therefore criterion four was scored zero. The fifth criterion was scored one point because the procedural knowledge of the activity of painting a tree could lead to a discussion of the content knowledge of what the important parts of a tree are and what to include in their painting. The final criterion is scored one because the different parts of trees (which could potentially be discussed)

underpins the more complex concepts of the functions and more detailed labelling of tree parts. The score for this extract is five which makes it a potential scientific concept.

Activity 5 Making Comparisons

Rating Scale					
Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
1/2	2/2	1/2	1/2	1/2	2/2

Table 5.3.10: Rating of Study & Master Life Skills textbooks: Activity 5 Making Comparisons (Appendix D p.99)

The extract does not explicitly state the essential attributes that differentiates plants from other concepts but does state “let learners...focus on the stems, leaves, flowers...” but forgets roots, which is why criterion one only has a partial score. The extract mentions more than two specialised terms (as seen above) and so receives a full score for criterion two. The concept of plants is described in relation to the concept of classification because the activity asks the children to compare two plants, and so the third criterion receives a score of one. Criterion four is scored one, since the essential attributes are not very clearly described it is dependent upon the teacher’s knowledge, so the concept might not be transferable across contexts. The fifth criterion also has a score of one, because the procedural knowledge is only somewhat linked to content knowledge. The children are asked to fill out a table comparing the stem, leaves, flowers, colour, size and texture . The first three utilise some content knowledge, but the rest focus on everyday knowledge. This concept underpins the more complex concepts of classification and labelling plant parts, and so criterion six has full points. The total score for this extract is eight, and is a potential scientific concept

5.4. Comparison

The analysis of the above extracts found that the majority of the concepts presented were potential scientific concepts, a few simple scientific concepts, and two everyday concepts. The resources from the two countries scored quite similarly, and can be seen in the table below:

Data segment	English NC	Hamilton Trust	English Cam	SA CAPS	DBE workbook	SA Cam
Average Total Score out of 12	9	10.5	10.2	11	9	7

Table 5.4.1: Average total scores of each data segment

The average score for all the materials for the England is 9.9, and the average score for the South African materials is 9. In order to see if the means from these two samples were significantly different, an independent t-test was performed comparing the total scores of the extracts from each country. The table below shows the result of the t-test, equal variances are not assumed as the significance of the Levene's test is below 0.05, and therefore the second row of the significance was used. It states that the differences between the two country's scores are not significantly different.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Score									Lower	Upper
	Equal variances assumed	11.195	.003	2.259	20	.035	2.05000	.90754	.15691	3.94309
	Equal variances not assumed			2.106	11.309	.058	2.05000	.97363	-.08582	4.18582

Table 5.4.2: Results of an independent t-test

The next table shows the amount of each concept found in the extracts:

	Simple Scientific concepts	Potential Scientific Concepts	Everyday Concepts
England	2	10	0
South Africa	0	8	2

Table 5.4.3: Number of each concept per country

The table shows that there were only two simple scientific concepts and they were found in the England's materials. Whereas South Africa had two instances of everyday concepts. There were more extracts for the England, but by percentage one can see that the English and South African materials had similar rates of potential scientific concepts (83% and 80% respectively). The next table shows the average ratings for each criterion:

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
	Contains two or more essential attributes that uniquely defines and differentiates the concept from all other concepts.	Employs two or more specialised terms.	Described in relation to other concepts on the scientific knowledge curriculum.	Transfers across contexts.	Structured as two integral parts i.e. content knowledge and procedural knowledge.	Underpins more complex scientific concepts.
Average Total Score for England	1.8	2.0	1.3	1.8	1.4	2.0
Average Total Score for South Africa	1.1	1.8	1.4	1.3	1	1.6

Table 5.4.4: Average total scores for each criterion by country

England on average scored higher for each criterion except for criterion three, where the South African materials seem to describe the concepts in relation to other concepts on the scientific knowledge curriculum better than the English materials. Overall one can see that England's ratings were higher than South Africa's, but both largely contain potential scientific concepts.

5.5. Conclusion

The results indicate some concern for the science curricula and teaching materials on plants for Year/ Grade 1 in England and South Africa, as they largely contain potential scientific concepts. The two countries do not differ very much in their ratings, however none of the South African data had simple scientific concepts and did have two everyday concepts present, whereas England did not have everyday concepts in its data. The implications of these results will be discussed in the next chapter.

Chapter 6: Conclusion

6.1. Introduction

The first and second aims of this research were to examine the extent that simple scientific concepts are made available in the topic of plants for first year primary students in curricula and educational materials in 1) South Africa and 2) England; and the third aim was to compare the results obtained from both countries. The South African results on the availability of simple scientific concepts from this analysis are similar to the findings from Grade R by Morris et al. (2016), the Grade 1 plants topic from the South African national curriculum is lacking in simple scientific concepts. Although, the South African curriculum did have a high average total score of 11 out of 12 and was very close to being considered a simple scientific concept. The South African average score for all materials was brought down due to the poor scores of the supporting materials. The opposite is seen with Year 1 English materials. The national curriculum extract on plants did not score as well as the South African and was firmly considered a potential scientific concept with a score of 9 out of 12. England's supporting materials scored very well, and some were even scored as simple scientific concepts, raising the English average score. The two nations are very similar in regard to the availability of simple scientific concepts, in that the majority of the concepts present in the materials and curricula are potential scientific concepts. This next section discusses and concludes the implications of the findings and recommendations of next steps for research.

6.3. Findings and Discussion

The findings from this research reveals that children in Year/Grade 1 in England and South Africa have little access to simple scientific concepts on the topic of plants. This may be due to the fact that the individuals who created the educational materials and curricula think children this age cannot or should not engage with scientific concepts yet. This is incongruous with the research reviewed in chapter 2, that young children are capable of abstraction and benefit from engaging with complex concepts. It is assumed that the creators think the children are incapable because the concept of Plants presented in the materials were considered potential scientific concepts and this was largely due to a lack of scientific content for both countries. The idea that children in Year/Grade 1 should not be taught certain scientific concepts is seen clearly in the English Cambridge Teacher's book

where it says that there is no need for children at this stage to learn about germination (Board & Cross, 2019). However, children are learning about how plants grow from seeds and germination is an essential part of this, and so many of the activities in the different materials have the children growing their own plants from seeds. The South African DBE textbook also seems to think that children in Grade 1 are not competent enough to explore scientific concepts as they suggest activities like waving ribbons and playing hide and seek rather than activities exploring concepts. This is of concern because as discussed in Chapter 2, early science education has a great impact on later science education and not having access to effective science education can put children at a disadvantage. This may already be happening, as studies from both countries have found that children in later years are currently underperforming in science (Ofsted, 2021; Reddy et al., 2019; Sammons et al., 2011).

The scores for criterion 5 (content and procedural knowledge) were low for South African and the English curricula due to a lack in content knowledge, which leads to an assumption that in both of these countries there is an expectation for either the teacher to already know the details of the topic or for them to research it for themselves. As previously discussed, this is a worry as teachers from both countries have gaps in their knowledge and do not feel confident teaching science (Appleton, 2003; James et al., 2019; The Wellcome Trust, 2014). Although this has not been researched, the lack of knowledge and confidence may be related to the absence of information in the curricula. Even though it is speculation, the absence of information certainly does not help alleviate these issues around teacher confidence.

The supporting educational materials seemed to focus more on activities for the children (which often were not relevant to the scientific concept being presented) rather than providing sufficient content. The English NC also has a large focus on the children 'working scientifically' with practical activities. The South African NC does not have as much focus on 'working scientifically', it does make a recommendation for an activity for the children to engage with but mostly presents the information that should be taught. Both of the countries' supporting documents follow the lead of the English curriculum, and focus on providing activities and not very much scientific content.

The English curriculum states:

“It is also vitally important that they develop secure understanding of each key block of knowledge and concepts in order to progress to the next stage. Insecure, superficial understanding will not allow genuine progression...(Department for Education, 2013, p. 3)”

However, this goal cannot be achieved when the curriculum also specifically pushes for children to ‘work scientifically’, which they describe in terms of scientific learning for Year 1 should be through first-hand practical activities where children answer their own question from observations (Department for Education, 2013). From a Neo-Vygotskian perspective (as discussed in Chapter 3) this type of knowledge that the children in the English are acquiring would be considered empirical knowledge. This is a concern, as previously discussed children may not be able to find the essential characteristic for plants from just their observations (Karpov, 2005b). In order to be in line with the Neo-Vygotskian perspective of children developing theoretical knowledge, there needs to be more support in the curricula and educational documents to help teachers create exploratory activities for the children to engage in and where they can see a phenomenon’s essential relations. For example, the activity described in the English NC of children grouping and contrasting different types of plants based on observations has the potential to be more than just children’s empirical observations. This could be done if the NC also provided the educator with the essential characteristic of deciduous trees (shed their leaves) and evergreens (do not shed) and from there the children can explore this model through observing and recording the trees in autumn and winter.

The findings for the South African curriculum and educational materials are similar to those of Morris et al. (2016), where there are no simple scientific concepts present. There is a slight difference in that there are fewer everyday concepts, but the continuation of missing simple scientific concepts in Grade 1 is a worry, and it begs the question of when does the curriculum present simple scientific concepts for primary students? Morris et al. (2016) explained that CAPS promotes experiential learning of concepts through play and exploration in Grade R and this is problematic in that it assumes that everyday and scientific concepts are separate and not dialectically linked. This is seen in Grade 1 as well, where many of the learning activities are games that do not elaborate on the scientific concept being presented (for example waving scarves, playing hide and seek). This type of learning will prevent children from acquiring scientific concepts and may instead develop

misconceptions as they are relying on empirical knowledge rather than theoretical knowledge (Morris et al., 2016).

As discussed in Chapter 2, Ofsted conducted a review of the science curriculum in England and argued that some changes need to be made and that there needs to be an interplay between disciplinary and substantive knowledge (Ofsted, 2021). In other words, as described in this project, a link between procedural and content knowledge. The focus on practical work in the English curriculum has been criticised, as practical work has shown to be not as effective in promoting learning as once believed (Needham, 2014). This is due to the fact that with some practical work it is not clear what the link is between the activity and the knowledge (Needham, 2014). The focus on collaborative practical work is similar to an American method of instruction known as guided discovery. These two methods are similar in that guided discovery also promotes that children work collaboratively in a shared activity and construct scientific knowledge by themselves with little to no direct instruction of scientific concepts (Karpov & Haywood, 1998). Karpov and Haywood reviewed the guided discovery method and believed that with this method children may not always form concepts correctly by themselves and may reject correct concepts in favour of their incorrect concept that they formulated (Karpov & Haywood, 1998). Therefore, this could also be a worry for the English science curriculum. Karpov and Haywood acknowledged that this incorrect concept formation could be intercepted by teachers, however as stated some teachers may not have the scientific proficiency to be able to fix the problem. Ofsted thinks that to solve this issue of ineffective practical activities lies in better elucidating the link between the procedural and conceptual knowledge, but this thesis thinks it goes deeper to the link between the everyday and scientific concept. As with the South African materials, the English materials have the problem of not seeing the everyday and scientific knowledge as dialectically linked and having too much focus on practical activity. This results in children engaging in activities at an everyday level (such as pretending to visit a garden centre) where the link to the scientific concept is not apparent.

While the results for the two countries' material were not as severe as the previous study (mostly potential scientific concepts rather than everyday), it is still worrying. Morris et al. argued that the Grade R science content contributes to the poor-quality education at that level. Since this trend of poor-quality science education continues into Year/Grade 1,

this thesis believes that the poor science performance scores from both countries in later years may be influenced by the deficiencies in their science content for young children.

6.4. Recommendations

Recommendations from this thesis would be for more research to be conducted on both curricula for the presence of simple scientific concepts in the primary years in order to see whether any year groups actually have access to simple scientific concepts before they face complex scientific concepts in later education. Furthermore, there should be research into how teachers feel about teaching science when provided with a more comprehensive science curriculum to follow, whether this helps them feel more confident in teaching the material or if it is impractical.

Chapter 7: References

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Chapter 8: Appendices

Appendix A: Hamilton Trust

Session 1

Session 1: Going and growing outside	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> To examine, draw and taste a range of fruits and vegetables that could be grown in a garden. To talk about experiences of growing plants or about someone they know who has a garden. To identify, label and sketch growing plants. To make a map of the garden plot, identifying the plants and predicting what they will turn into when they are fully grown. Label the map with any recognisable mini-beast habitats or sketches of mini-beasts found in the area.
Key Vocabulary: plant, leaf, grow, weed, change, living, water, healthy, similar to, different from	
Resources Local fruit and vegetables, chopping boards, knives, sketch books, clipboards, camera, images and close-up drawings of fruit, magnifying glasses, large sheet of card, marker pens.	Weblinks https://www.youtube.com/watch?v=oHdCznRDFvE - Mr Tumble grows things in his garden.
<p>Before the session: Bring into school a range of fruit and vegetables that could be found in a garden local to your school. Place a variety of them on tables, along with chopping boards and plates. You may also want to invite a local allotment owner or gardener to talk about growing fruit and vegetables.</p> <p>Whole class: Ask the chn to sit in groups and to look at the (whole) fruit and vegetables on the tables. Ask them if they recognise any of them and if they know anyone who grows them. Give the chn some time to discuss together and share ideas about the fruit and vegetables. Encourage questions such as: <i>What sort of plant does this grow on? Would this be an easy thing to grow? How much water do you think it would need? How long do you think it would take to grow?</i> Ask the chn to feel and smell the fruit and veg. Ask them to guess what they look like inside. Ask the adults to go to the groups and to cut open the different fruits and vegetables.</p> <p>Activities: Make sure all the groups have an adult supervising them then invite the chn to try a little piece of the fruit or vegetable. Encourage the use of ambitious adjectives and descriptive phrases. Say to the chn: <i>We are going to draw the food that you can see, but not in the usual way we might draw an apple or a carrot. We are going to be drawing in a very special way. We will be pretending that we are tiny people and we are looking really closely at a piece of fruit or vegetable. Can you imagine that? Can you look closely at a section of the food? Look really closely, as if you were tiny. Does it have hairs? Or little droplets of juice? Or bumps? Can you draw that view in your sketchbooks?</i> Show chn the resource with the close-up images of fruit. These images concentrate on a small section or slice and look carefully at its colour and structure. Encourage them to consider their own ways of recreating the food they have in front of them. Take close-up photographs of these fruits and vegetables to display later, along with the drawings. When the drawings are complete, explain to the class that everyone will be going outside to look carefully at the plants in the school grounds and to draw close-ups of outside plants in the same way as the fruit and vegetables. Look around the outside area, talk about the plants you can see growing and what their names are. Give the chn time to settle and look carefully at the tiny details of each plant. You may want to give them magnifying glasses or just encourage them to look closely with their own eyes.</p>	
Plenary	Bring the chn together when they have completed their close-up drawings of the outside plants. Share their drawings together and then draw out a large outline of the school building and garden plot on the big sheet of card. Mark in doors, play equipment and other noticeable features, and then ask the chn if they can work out where the plant they drew is on the map. Mark all the plants in, with labels, and ask the chn to predict what their plants will look like in the winter or next summer, after another season of growing. Also label the map with any recognisable mini-beast habitats and known areas of shade, sun and windy spots (from the learning in the previous term). Once back inside, play the chn the Mr Tumble episode .
Outcomes	Children will <ul style="list-style-type: none"> Discuss a range of fruit and vegetables and make close observations and drawings Identify and closely observe plants outside the school building Make a collective map of the garden plot, labelling the plants and predicting what they will turn into when they are fully grown

Session 2

Session 2: One potato, two potato	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> • To share knowledge about potatoes, including how they are grown and in what forms we can eat them. • To look at and compare different types of potato. • To prepare tubs, plant chitted seed potatoes and make predictions. • To consider what we need to do to encourage our seed potato to grow and produce lots of potatoes.
Key Vocabulary: plant, leaf, grow, weed, change, living, water, healthy, similar to, different from, potato, chitting	
Resources Different varieties of potatoes, chopping boards, potato masher, chitted potatoes, tubs, bags or large cardboard boxes, soil, spades, lolly sticks, How to chit potatoes sheet.	Weblinks http://how-to-grow-potatoes.co.uk/how-to-grow-potatoes/how-to-chit-potatoes/ - Information on how to chit and grow potatoes; https://www.youtube.com/watch?v=G8kYhHxS0ag – Small potatoes clip.
Before the session: Bring in different varieties of potato and place them on the tables.	
Whole class: Ask the chn to sit in groups and to look at the potatoes. Ask them if they know what they are and have seen them in this raw form before. Draw a large potato outline on the board and ask each group to offer facts and experiences about potatoes for you to write inside the large drawing. Encourage statements such as 'chips are made out of potatoes, we grow them at home, they grow in the ground' etc. Ask them if they can also list the different things we do with potatoes and write these on the large drawing (e.g. mashed potato, chips, shepherd's pie, crisps). Show the chn the potato masher and explain how to make mashed potatoes. Ask any adults in the room to cut up the different potatoes for the chn to see inside and to smell. Give them time to do this, explaining that different sorts of potatoes are used for different things. Some make better mash whilst others make really good chips. Ask the groups to describe the differences and similarities between the different varieties. Then explain that the chn are going to grow potato plants from seed potatoes and learn to look after them.	
Activities: <i>(The nature of the potato flower and seed is such that the sexual pollination produces seed with very different features, even if no cross-pollination of a different cultivar is allowed. This fact explains why farmers prefer to "clone" potato tubers, that is replant the tubers, rather than start with true seed. Young children just need to know that the chitted potatoes or tubers are 'seed potatoes').</i> Show the chn the chitted potatoes. Ask them what they think are the little things poking out of the main potato and explain that seed potatoes have to have starting growing before you plant them in soil (buy chitted potatoes from a garden centre or prepare them using the instructions on the resource sheet). Show the chn the bags and the soil. In groups, and using spades, fill each of the bags with soil until about two thirds full. Then place the chitted seed potatoes, shoot side up, into the soil, about 10 cm apart and 2-5cm deep. Remind the chn to be careful with the shoots. They mustn't break them off otherwise the potato plant won't grow. Water the seed potatoes when planted and ask the chn to draw labels to say what variety is growing there, what date it was planted and who planted them. Laminate these labels and stick into the soil on lolly sticks. Ask the chn to predict what will happen and how long it will take the potatoes to grow.	
Plenary	Ask the chn: <i>What do we need to do, as a team, to encourage our plants to grow and produce lots of potatoes?</i> Make a rota with the chn organising who is going to water and tend the potato plants each week. Play the chn this little Small Potatoes clip . Talk about how potatoes can be grown at home, school and in allotments but sometimes farms plant large amounts of potato plants and sell their potatoes all over the world to make chips, crisps and all the potato products.
Outcomes	Children will <ul style="list-style-type: none"> • Share what they already know about potatoes, including how they are grown and in what forms we can eat them • Consider the different types of potato, including their similarities and differences • Work in teams to prepare tubs and plant chitted potatoes • Consider what each team needs to do to look after the potato plants

Session 3

Session 3: Garden centres and seeds	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> To share knowledge about gardens and gardeners. To design and set up a garden centre in the classroom. To plant a bean in a bag and keep it in the classroom garden centre. To predict the outcomes of the bean and seeds and set up a diary to observe the growth over time. To consider what seeds need in order to be able to grow and how you can keep seeds healthy.
Key Vocabulary: plant, leaf, grow, weed, change, living, water, healthy, different, seeds, garden centre	
Resources Different gardens resource, examples of classroom garden centres, How to grow a bean in a bag, My bean in a bag diary, things for setting up a garden centre in the classroom - small plants, role play cakes, till, baskets, plastic food, paper, pens, card for signs etc., dried bean seeds, paper towels, stapler, plastic bag (the A4 sized kind which seals at the top works best), ruler.	Weblinks https://www.youtube.com/watch?v=F2IJW7TaF18 - Lowden Garden Centre; https://www.youtube.com/watch?v=PfMSKMI5U5U - information video for teachers on sprouting bean seeds; https://www.youtube.com/watch?v=EKx4ZwoJqXY - time lapse video of a sprouting bean seed (3.26 mins).
Before the session: collect the necessary items for the chn to set up a mini garden centre in the classroom. This need only be the size of a table and could be very temporary. Whole class: Show the chn the images showing different types of gardens. Ask them if they have a garden and what it is like. Explain that all gardens are different - different shapes, locations, climate, plants and design. Then ask if they have been to a garden centre before. Play them the clip of a large garden centre , typical of many in the UK. Before you play it, tell the chn that you will be asking them to tell you what they can do at a large garden centre, so they must try and remember as many different things as they can. Then show them the items you have collected and challenge them to set up a mini garden centre in a space in the classroom (there are examples in resources).	
Activities: When the chn have set up the classroom garden centre, bring them together and tell them that they are going to grow a bean plant from a bean seed in a freezer bag. Show them the resources and talk through what they need to do. Ask them to work in groups with an adult, following the resource sheet. When they have finished, they may tape the bean into the garden centre or peg onto a washing line. Ask each child to predict what they think will happen to the bean. Give them the 'bean in a bag diary' sheet and ask them to fill in the first section.	
Plenary	Say to the chn: <i>What have you noticed about our beans? What is missing from our bean growing, that we definitely had when we were planting potatoes? (Soil.) Do you think the bean seeds will grow? What have they got that is the same as the seed potatoes? (Water, warmth.)</i> Watch the time lapse clip of a sprouting bean seed (3.26 mins).
Outcomes	Children will <ul style="list-style-type: none"> Understand what a garden is and how varied they are Design and set up a garden centre in the classroom Plant a bean seed in a bag and consider what seeds need to be able to grow Predict the outcomes of the bean seeds and set up a diary to observe the growth over time

Session 4

Session 4: What lives in the garden?	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> To explore the school garden (or a selected area of the playground). To examine plants for signs of them having been eaten. Consider what may have eaten the plants and what else might be living in that place. To look carefully at pollen and understand more about the role it plays in the growing of plants. To create large pollen sculptures out of clay. To use the scientific vocabulary associated with plants.
Key Vocabulary: plant, leaf, grow, weed, change, living, water, healthy, pollen, flower	
Resources Who's eaten the plant? resource, What is pollen? resource, How to make a clay pollen grain, clipboards, pencils, cameras, sketchbooks, air-drying clay, clay board, tools	Weblinks
Whole class: Take the chn out into the garden or playground, with the 'Who's eaten the plant?' sheets, clipboards and pencils. Ask them to look carefully for any plants or leaves that look like they have been eaten or nibbled at by something. Encourage them not to touch them, but to draw what they see, in the boxes on the sheet 'Who's eaten the plant?' They will need to look for leaves with holes or edges that look nibbled, little shoots that look like the tops have been taken off and small plants with incomplete leaves and flowers. Ask the chn: what has nibbled these things? What else is living in this place? There is a second version of the resource sheet, with an extra challenge for the more able to think of reasons why they think the leaves and plants have been eaten (rough edges, holes in the middle, not symmetrical, etc.). Then ask the chn to look carefully at any flowers in the playground. They may want to draw them on the back of their sheet, in their sketchbooks or take photographs of them. Then go back inside and show them the 'What is pollen?' resource, explaining what pollen is and looks like. The resource also explains the role of pollen in the growing of plants. Explain to the class that they are going to make a large pollen out of clay and show them the 'How to make a clay pollen grain' sheet and the materials.	
Activities: Ask the adults in the room, and the chn, to follow the resource sheet 'How to make a clay pollen' to create their own pollen sculpture. Remind the children that pollen is usually round, so they need to roll the clay into a ball. Then, after that, all pollen grains are different, so they needn't worry about whether their sculpture is right or not. Challenge the more able to make a pollen grain with spikes or hooks, and to tell you why these are important (to attach more effectively onto insects).	
Plenary	When the sculptures are finished, leave them to dry on the tables and go on a Pollen Parade. Take the chn around the models, pointing out different shapes and designs and encouraging everyone in the amazing work they have produced. Display the sculptures, along with the images of pollen grains and facts about them, in the classroom.
Outcomes	Children will <ul style="list-style-type: none"> Examine plants for signs of them having been eaten and consider what is eating them Understand what pollen is and the role it plays in helping to make new plants Appreciate the wide variety of pollen grain designs and create large pollen sculptures out of clay

Pollen



Pollen is the dusty stuff on flowers. It is often yellow. It gets stuck on insects when they fly near.



Insects, like bees, move the pollen from flower to flower when they fly around. Tiny pollen grains landing on flowers is part of how new plants are made.



Pollen is very tiny but looks amazing under a microscope. Sometimes pollen grains can be beautiful and symmetrical.

Session 5

Session 5: What is inside a flower?	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> To find flowering plants and carefully examine them with a magnifying glass. Sketch and photograph them. To take a flowering plant to pieces and label the parts. To model a flowering plant using junk modelling materials. To understand the basic structure of a flower and the basic function of the main parts.
Key Vocabulary: plant, leaf, grow, deciduous, evergreen, roots, stem, leaves, flower	
Resources Flower Song, ideas for junk flowers, cut flowers, flowers from the playground, magnifying glasses, sketch books, chopping boards, white paper, lots of junk modelling materials (tubes, boxes, cardboard, pipe cleaners, tape, etc.).	Weblinks http://www.bbc.co.uk/news/science-environment-16983115 - Interesting article for teachers on the insects view of a flower.
Before the session: bring flowers into the classroom and arrange in vases on the tables. Whole class: Take the chn outside to find flowering plants in the school grounds. Give the chn a magnifying glass and ask them to look closely at the flowers. Ask them to describe what they see and compare them, spotting the similarities and differences. Then take the chn back into the class and let them look at the flowers on the tables. Ask them to share what they see, encouraging the use of ambitious adjectives and descriptive language. Then allow them to choose a flower, with stem, each and gently pull it apart, laying all the pieces of it on the white paper. Write these words on the board: 'stem', 'roots', 'leaves' and 'flower'. Ask the chn to have a go at writing the right words on the white paper next to the right parts. The cut flowers won't have roots but the chn could draw roots on the paper. Move around the groups, making sure the chn are labelling the correct sections. Then gather the chn together and teach them the 'Flower Song' from the resource sheet. Explain what each of the four parts of the flower do, as you go through each verse. Arrange to sing it to another class if you feel the chn are ready for doing that.	
Activities: After several renditions of the flower song, tell the chn that they will be able to work in groups to make a model of a flower plant using junk modelling materials. Show the chn the images in the resource sheet 'Ideas for junk flowers'. Encourage the groups to think carefully about the shape of each part they want to create, perhaps using strips of paper for the roots, tubes for the stem, etc. Help the less able by giving them more adult focus. Allow the chn some time to paint their junk models in the week.	
Plenary	Place the junk models on the carpet, like a 'garden'. Ask the chn to look at each other's work and admire the junk flowers. See if the different groups can spot the different parts of the 'junk' plants made by other groups. Display them, with labels, in the classroom.
Outcomes	Children will <ul style="list-style-type: none"> Carefully examine flowers with a magnifying glass and become familiar with the inside of a flower Make a large model of the inside of a flower using junk modelling materials Understand the basic structure of a flowering plant and the basic function of the main parts

“Flower Song”

Roots take in lots of water from the soil,
roots take in lots of water from the soil,
roots take in lots of water from the soil,
early in the morning.

*These are the parts of a flower,
These are the parts of a flower,
These are the parts of a flower,
Early in the morning.*

The stem helps to hold all the main plant up,
the stem helps to hold all the main plant up,
the stem helps to hold all the main plant up,
early in the morning.

*These are the parts of a flower,
These are the parts of a flower,
These are the parts of a flower,
Early in the morning.*

The leaves use sunlight and turn it into energy,
the leaves use sunlight and turn it into energy,
the leaves use sunlight and turn it into energy,
early in the morning.

*These are the parts of a flower,
These are the parts of a flower,
These are the parts of a flower,
Early in the morning.*

The flower helps the plant to reproduce,
the flower helps the plant to reproduce,
the flower helps the plant to reproduce,
early in the morning.

Session 6: What is inside a tree?	
Science curriculum area (1P):	Content (1P) i. identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ii. identify and describe the basic structure of a variety of common flowering plants, including trees
Working Scientifically (KS1 WS)	Working Scientifically (KS1 WS) i) asking simple questions and recognising that they can be answered in different ways ii) observing closely, using simple equipment iii) performing simple tests iv) identifying and classifying v) using their observations and ideas to suggest answers to questions vi) gathering and recording data to help in answering questions
Teaching Objectives	<ul style="list-style-type: none"> To note a variety of trees and discuss their similarities and differences. To take bark and leaf rubbings using paper and wax crayons. To represent a tree through playground art and record their art pieces. To invite another class to see their art work.
Key Vocabulary: plant, leaf, grow, deciduous, evergreen, roots, stem, leaves, flower, trunk, bark	
Resources Images of trees, Tree measuring challenge, leaves from deciduous and evergreen trees, wax crayons, paper, tape measures or paper rulers, chalk, coloured paper, strips of material (browns, greens, orange), skipping ropes, bags, large pieces of fabric.	Weblinks
Before the session: collect leaves of deciduous and evergreen trees, pieces of bark and logs Whole class: Show the chn the images of evergreen and deciduous trees resource. Talk about trees the chn are familiar with, in their gardens or the playground. Ask them: <i>Do they lose their leaves in the winter? Can you remember? Do they stay green all year round? If we don't know, can we guess by looking at the shape of their leaves? Are they evergreen or deciduous?</i> Go into the playground and count how many deciduous and evergreen trees there are outside. If possible, look closely at a deciduous and evergreen tree, and take wax crayon rubbings of the bark and leaves. If it is not possible to do this outside, stay inside and look carefully at the bark and logs. Ask the chn to do wax rubbings and to explore the textures in front of them. Make sure they use the long, flat side of the wax crayon.	
Activities: Take the chn outside and explain the 'Tree measuring challenge' sheet. Show the chn how to measure the girth of a tree and then split the chn into groups. Working with the less able group, let the more able chn have a go at measuring the girths of trees in the playground. Give them chalk to write the girth size in cm on the ground near the tree. Then move on to measuring the height of the trees, following the instructions in the resource sheet. Make a note of these measurements in case you want to measure the trees again later in the year. Collect all the pieces of fabric and scraps you have for the Big Art Project and spread them out in the hall or playground. Explain to the chn that you would like them to make a tree out of the stuff in front of them. Tell them the tree must have five things: roots - to hold the tree in the ground so that the wind cannot blow over it and so it can take water from the soil; bark - the skin of a tree; a trunk - the strongest part of the tree and takes water from the roots to the leaves; branches - has leaves, flowers, or fruit growing on them and leaves - they make the food for the tree and also evaporate water which helps to keep the surface of the leaf cool. Spend time with the chn moving and arranging the materials and scraps into a large tree with the five elements present. You may want to make one large tree or several smaller ones, depending on the size of groups and availability of adults and resources. Whilst you are working with the chn, talk to them about what the different parts of a tree do and look like.	
Plenary	Take photos of the Big Art, preferably from as high as place as possible. You could use a selfie stick to achieve an almost aerial shot of the art installation. Invite others from a different class, or parents/members of staff, to see the artwork and encourage the chn to talk about the roots, bark, trunk, branches and leaves. Congratulate the chn on all that they are learned and worked on in this block of work. Use the 'Quiz the Visitor' sheet in resources to help assess the chn's understanding of the key vocabulary used in this block.
Outcomes	Children will <ul style="list-style-type: none"> Explore the outdoor area, looking specifically at the trees Discuss and become familiar with the similarities and differences between evergreen and deciduous trees Represent a tree through playground art, using cloths, chalk and found materials Show an awareness of the role of the roots, bark, trunk, branches and leaves of a tree

Appendix B: Cambridge Primary Science England:

Teacher's Resource and Learner Book

Teacher's Resource Unit 2: Growing Plants

Deciduous trees

Deciduous trees have flat leaves that change colours in the autumn, fall off in the winter, and grow back in the spring.



<p>Teacher Background</p>	<p>The life cycle of a flowering plants start with a seed that grows a root, then a stem and leaves. The roots collect water from the soil and the leaves collect carbon dioxide from the air. The leaves then use the water and carbon dioxide, and energy from light, to make food for the plant. Without this light energy, the plant cannot make food and will eventually die. This process is called photosynthesis.</p> <p>Germination is when a seed begins to grow. At this stage the plant has no leaves and is often underground in the dark. Therefore the plant cannot make its own food to grow. The seed itself contains a store of food that it uses until it reaches the light and grows leaves. Learners don't need to be taught germination at this stage.</p> <p>The function of a flower is to allow the plant to reproduce... To produce seeds the flower needs to be pollinated. This means the female part needs to receive pollen from the male part of another plant of the same kind. Pollen can be transferred by wind and by insects who are attracted by the colourful petals and sweet nectar of the flowers. Once pollinated, the flower gross into a fruit which contains seeds... (Board & Cross, 2019)</p>
<p>Topic 2.1 Learning Outcomes</p>	<ul style="list-style-type: none"> • Name the major parts of a plant, looking at real plants and models. • Try to answer questions by collecting evidence through observation. • Model and communicate ideas in order to share, explain and develop them. (Board & Cross, 2019)
<p>Topic 2.2 Learning Outcomes</p>	<ul style="list-style-type: none"> • Explore how seeds grow into flowering plants. • Know that plants need light and water to grow. • Make predictions. • Record stages in work. • Make comparisons. (Board & Cross, 2019)
<p>Topic 2.3 Learning Outcomes</p>	<ul style="list-style-type: none"> • Know that plants need light and water to grow. • Make predictions. • Explore and observe in order to collect evidence to answer questions. • Make comparisons. (Board & Cross, 2019)

2 Growing plants

2.1 Plant parts

Plants have many parts.

Words to learn

fruit	flower
stem	leaf
roots	name

The diagram shows a tomato plant with several red and green tomatoes. Labels with lines pointing to the parts are: 'flower' at the top, 'fruit' for a red tomato, 'leaf' for a green leaf, 'stem' for the main vertical part, and 'roots' for the white root system in the soil. A small cartoon character with a blue body and orange hat is standing on the right side of the page.

2.2 Growing seeds

This is how a seed will grow into a plant.

Words to learn
seed grow
water

The roots grow first.
Then the stem and leaves.

18 2 Growing plants

Activity 2.2

Growing seeds

Ana and Marta are growing seeds.



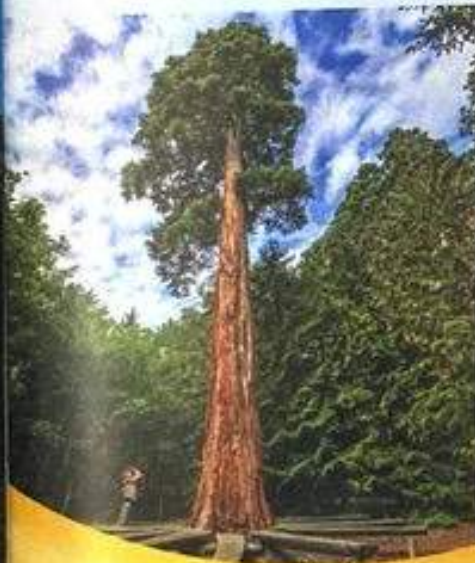
You will need:

two clear containers
a roll of paper • seeds
a watering can

Ana gives her seeds some water. Marta forgets to water her seeds.

What do you think will happen?

Grow some seeds to find out.



Small seeds can grow into big plants.

What you have learnt

- Seeds grow into plants.
- Seeds need water to grow.

2.3 Plants and light

Why is this plant bent?



Words to learn

light ask
question



It is growing towards the light.

Activity 2.3

Do plants need light to grow?
Ali wants to ask a question.

You will need:

two small plants • a box
to cover one plant



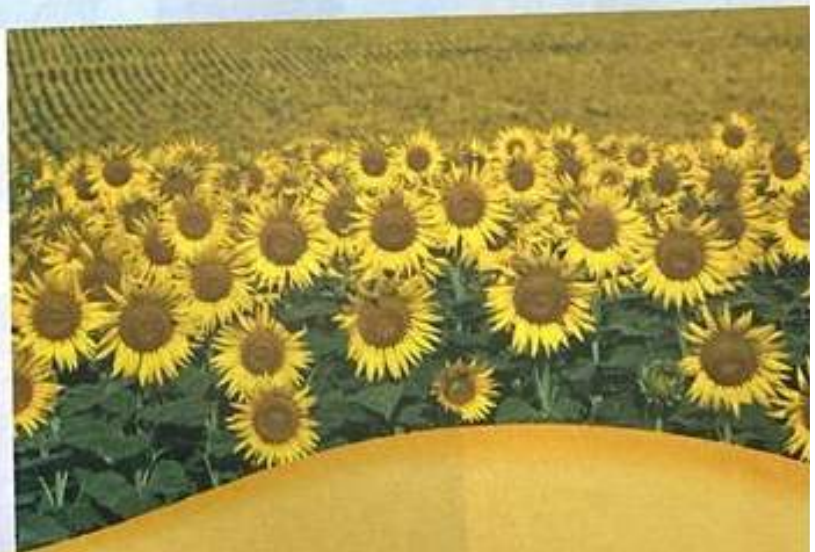
Do plants need light to grow?

Ali covers one plant with a box.
He leaves the other one in
the light.

What do you think will happen?

Try this yourself to find out.

Why are these
plants all facing
the same way?



What you have learnt

☺ Plants need light to grow.

41

Term 3 – Week 5

Why we need plants

Let's talk Look around you. Which things do you see that come from plants?
Talk to your friend and see how many you can think of.
Tell your teacher what plants you thought of.

Let's read



Some plants and trees give us shade.



Some plants give us food and juice.

Some plants give us flowers to put in our homes.



Some plants and trees give shelter to animals.

18

Date:



We need grass for our sports fields.



We use cotton to make clothes.



We use reeds to make baskets and cover roofs.



We use wood from trees to make furniture.



Let's talk

With your friend, choose the three most important ways in which we use plants.

Can we make plants die if we use them too much?
Talk about this question as a class.





Term 3 - Week 5

What plants look like

Let's write

Plants are made up of different parts. Use words from the boxes to label these plants. Compare your words with your friend's words.

roots

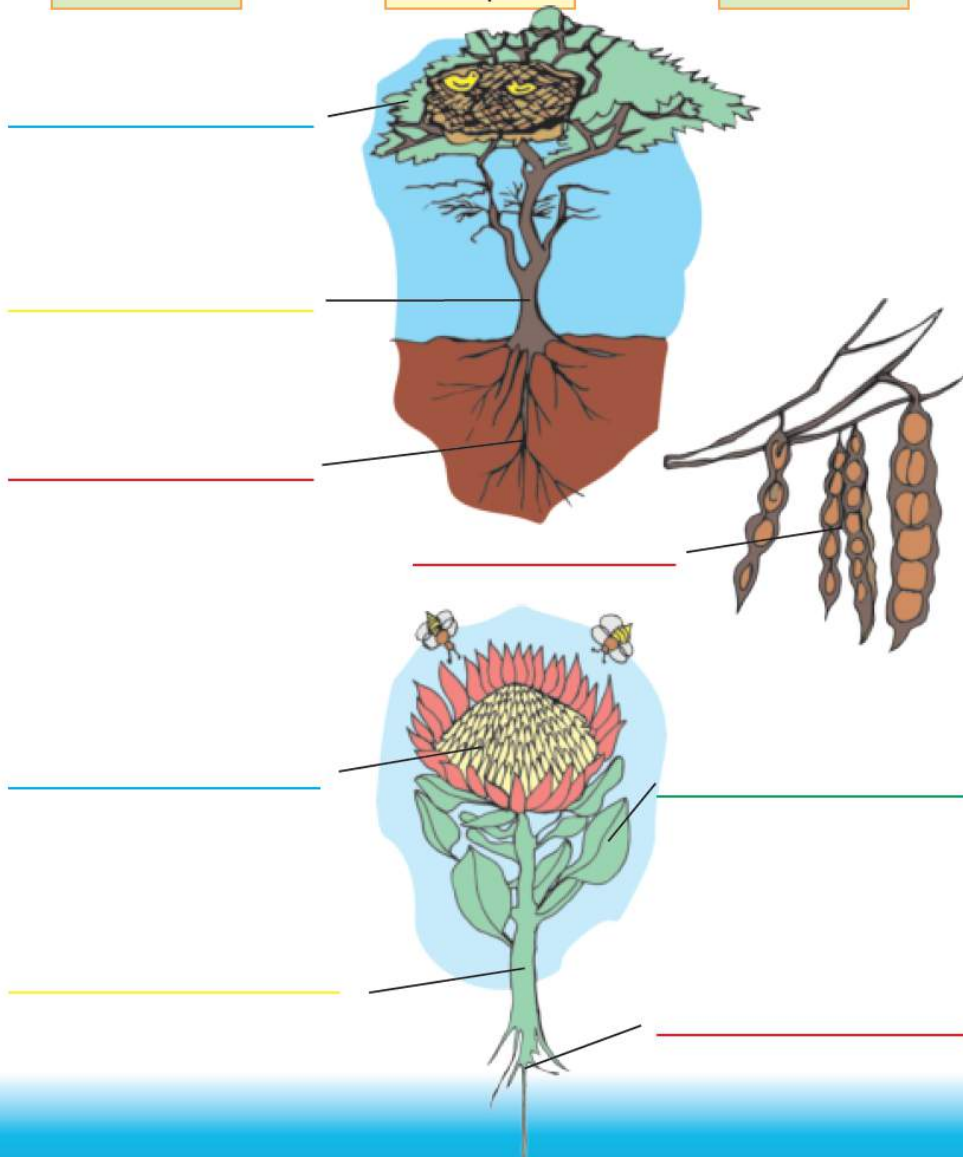
trunk

leaf

flower

seedpod

stem



Date:



Let's move

Divide the class into garden bugs and gardeners.

- The gardeners should try to stop or catch the bugs.
- Swop roles after 2 minutes.
- Repeat a number of times.



Let's play

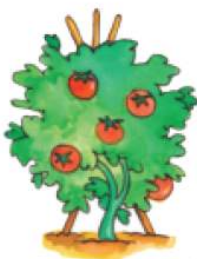
Play hide-and-seek.

The bugs are hiding underneath or behind plants and the gardeners have to find them before they eat all the plants.



Let's talk

Different kinds of plants look very different. But they are also the same in many ways. Look at these pictures. Talk with your friend about the plants. What is the same and what is different?



Let's do

Draw or paint a bug or an animal that wants to eat your bean plant. It doesn't need to be a real bug or animal. Use your imagination. Draw or paint with clear, strong lines and forms.





Seeds and where they come from

Term 3 - Week 6



Let's read

Some plants have seeds that are hidden in the flowers or in the fruit.

We can also plant these seeds to grow new plants.

Seeds fall off from the plants to start new plants.

Some seeds are spread by the wind or by people, insects and other animals. Some seedpods get eaten by birds and the hard parts then stay in their droppings. These seeds are dropped somewhere else and begin to grow there.



Let's talk

How are the seeds spread in each of these pictures? What should each seed be like to be spread in this way? Discuss with your friend.



If you want to grow your own plants from seeds, you can use the seeds of plants in your garden. Or you can buy seeds from a shop.





Let's talk

Learn this poem and movements.

Date:

Life after the plant

This is a teeny weeny seed:
 Let's quickly plant it in the ground!
 It grows a stem and a flower
 With a lovely smell all around.
 Busy bees buzz in the flower –
 And soon the pretty flower dies.



But please don't worry and don't cry
 Nothing else in nature cries.
 Look well, see, a wonder happens:
 The flower died, but, spread around
 Its dead stem and under brown leaves
 The living seeds wait in the ground!



Let's move

Enjoy these movements
 Hold a coloured cloth
 or long ribbon in your
 dominant hand.
 Move your arm, to make
 different patterns in the
 air or on the ground with
 your cloth or ribbon.

Teacher's note
 Use a rope, sash and
 ribbon.



If there's a tree nearby, see how we can use it to play. Swing
 from a strong rope that has been tied securely to it.
 First do it with both hands, then with your dominant hand and
 then with your non-dominant hand.

Teacher: _____
 Sign: _____
 Date: _____



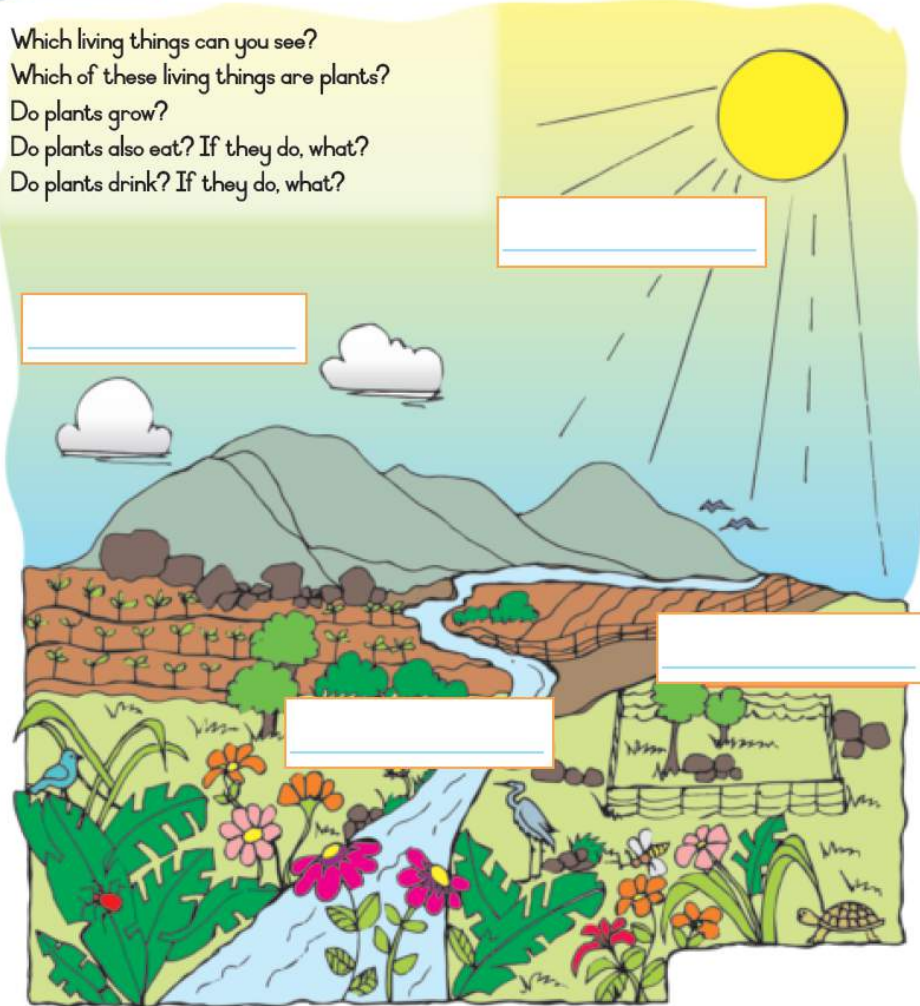
Term 3 - Week 6

What plants need to grow



Let's talk Look at this picture. Is everything in it alive?

- Which living things can you see?
- Which of these living things are plants?
- Do plants grow?
- Do plants also eat? If they do, what?
- Do plants drink? If they do, what?



Let's write

Now write each of these words into the blank boxes in the picture above, to show what plants need to grow. Show your teacher what you have written.

sunlight

water

nutrients

air



Let's do

It is easy to grow your own plant.
You are going to grow a bean plant.

Date:

You will need:

Follow these steps:

Step 1:

Cover 3 beans between 2 pieces of cotton wool. Put them in an empty saucer or bowl.



water



beans



a bowl



cotton wool

Step 2:

Pour water over the cotton wool and make sure it is wet.



Step 3:

Place the saucer or bowl on a windowsill or in a place where there is enough sunlight.



Step 4:

After a few days, see how your plant is growing. Water it once a week to keep the cotton wool damp.

Day 1



Day 2



Day 3



Day 4



Step 5:

Once your plant has roots and two leaves, you can plant it in soft soil.



Step 6:

Water your plant regularly to keep the soil damp. After a few weeks, you will be able to pick your own beans.



Topic 12: Plants and seeds

In this topic, we look at the importance of plants in our lives. The learners start to look at the parts of a plant in more detail and then compare the differences and similarities among different kinds of plants. The learners will also get an opportunity to develop the skill of planting a seed themselves and nurturing it to grow.

Activity 1 Growing plants

Learner’s Book
page 88

Resources: pictures and flashcards to emphasise the importance of plants

1. Let the learners turn to Activity 1 and read the question.
2. Let them look at the picture and have a class discussion about why we need plants. Talk about things such as the following:
 - We need to breathe in oxygen, and this comes from green plants and trees.
 - Trees and plants provide food for both people and animals.
 - Trees and plants provide shade and shelter.
 - Trees provide timber, and timber provides paper, furniture and housing.
 - Trees and plants provide homes for some animals and insects.
 - Most people enjoy being close to trees and plants because it makes them feel good.

Assessment

Observe the learners and record your observations:

- Can the learners give reasons why we need plants?

Activity 2 How to plant

Learner’s Book
page 89

Resources: flashcards with the following words: soil, sunlight, seeds, water; seeds, plants, foam trays, soil, containers for seeds to be planted in, water,

1. Let the learners turn to Activity 2 and read the first question.
2. Let the learners work in small groups of four. Ask the groups to use the pictures to talk about the things that plants need in order to grow.
3. Have a class feedback session on the group discussions. Use flashcards to emphasise the important terms.

Note: The next part of the activity can be done inside or outside the classroom.

4. Have a variety of seeds on trays (foam trays) for each group to observe and explore.
5. Give each group a tray of various seeds for observation. Ask the learners to look at the seeds and to talk about the differences in the shape, size, colour, smell and texture of the seeds.
6. Have a class feedback session, in which the learners say what they noticed about the seeds.
7. Have a variety of plants for the learners to explore.

8. Give each group one plant and let them notice its shape, size, colour, smell and textures.
9. Have a class feedback session. You can make use of flashcards and charts or posters to facilitate the discussions.
10. Let learners read the points in step 3 on the Learner's Book page.
11. Give clear instructions for them to go ahead and plant their seeds. Let each learner plant his or her own seed.
12. Have a feedback session for the learners to share their experiences of planting.
13. Remind the learners to nurture the plant. Provide time daily for the learners to nurture their plants.

Worksheet 1 Explain what the learners need to do on the worksheet. Make sure everyone understands.
 Workbook page 97

Assessment

Observe the learners and record your observations:

- Can the learners identify what plants need in order to grow?
- Are they able to grow plants from seeds by following instructions and nurturing their plants?

Activity 3
What plants
look like

Learner's Book
 page 90

Resources: a variety of plants, flowers, leaves, seeds, foods that grow above and below the ground

1. Let the learners turn to Activity 3 and read the questions.
2. Look at the pictures and have a class discussion about the different parts of a plant.
3. Have a variety of plants, flowers, leaves and seeds available. Also bring in foods that grow, such as root foods (carrots), bulb foods (onions, potatoes, butternut) stem and leaf foods (celery, parsley, lettuce, cabbage) and fruit (apples, strawberries, pumpkins, tomatoes).
4. Let the learners work in small groups. Give each group one or some of the foods you brought. Let them describe these items in terms of shape, size, colour, smell, texture, what they look like and what part of the plant each one is.
5. Have a feedback session with the whole class.
6. Explain the different parts of a plant. Include the parts above the ground, as well as under the ground.
7. Explain that most food we eat grows either above the ground or under the ground. Show the examples as mentioned above, and others not mentioned, such as beetroot, peas, and so on.

Worksheets 2, 3 Explain what the learners need to do on the worksheets. Make sure everyone understands.
 Workbook pages 98, 99

Assessment

Observe the learners and record your observations:

- Can the learners identify the different parts of a plant?

Activity 4
Trees

Learner's Book
page 91

Resources: flashcards with the following names of different tree types: eucalyptus, peach, oak, palm, poplar, weeping willow, aloe, apple, fir

1. Let the learners turn to Activity 4 and read the questions and instructions.
2. Use the pictures to have a class discussion about trees.
Talk about:
 - why we need trees
 - whether all trees look the same
 - the various shapes of different types of trees.
3. Have the names of the trees on flashcards. The trees shown in the Learner's Book are: eucalyptus, peach, oak, palm, poplar, weeping willow, aloe, apple and fir.
4. Let each learner paint a picture of a tree.
5. If possible, arrange a class visit to a botanical garden or a park where there are beautiful trees around.

Activity 5
Making comparisons

Learner's Book
page 92

1. Let the learners turn to Activity 5 and read the instructions and the questions.
2. Choose two plants in the class to compare. Put the plants where all the learners can see them and have access to them.
3. Explain what it means to compare something.
4. Let the learners look at how the plants are the same and how they are different. Let them focus on the stems, leaves, flowers, colour, size, texture and shape of the plants.
5. Explain the table that they need to draw in their exercise books. Make sure that the learners know how to fill in the table.

Assessment

Observe the learners and record your observations:

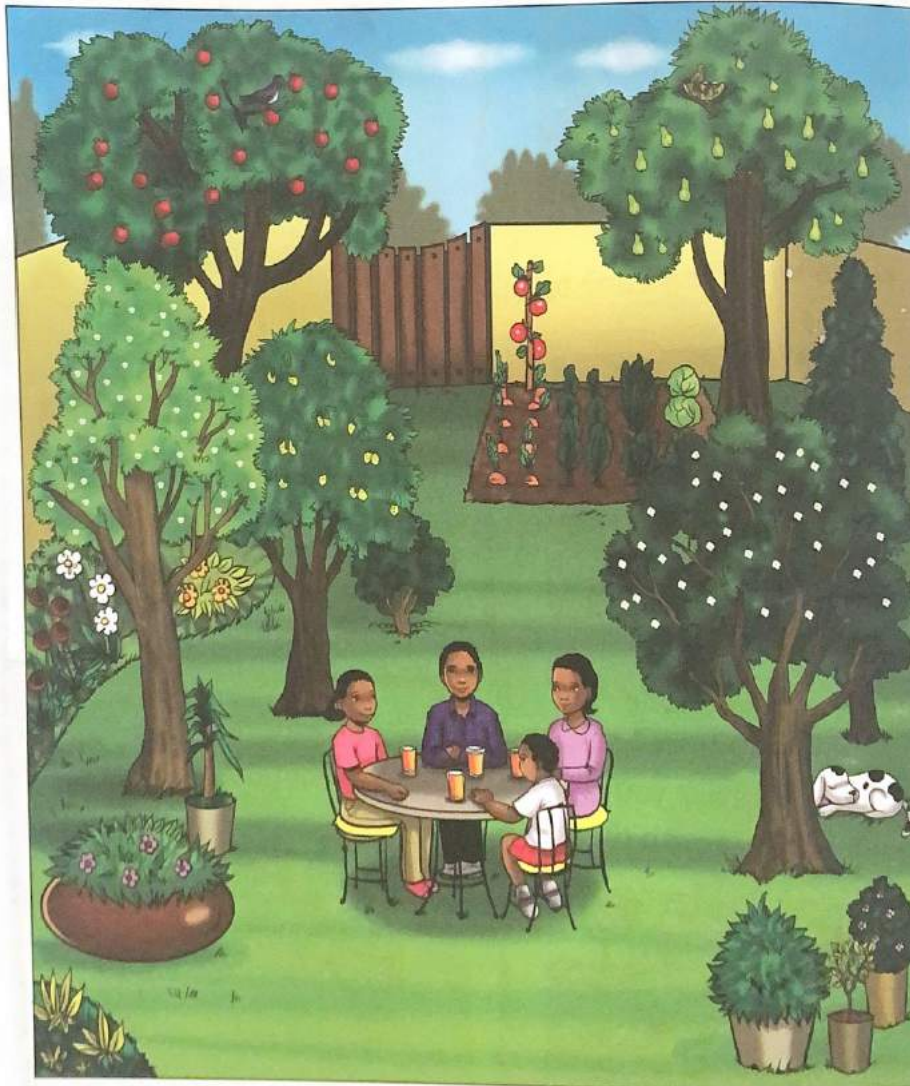
- How well are the learners able to describe the differences and similarities between different plants?

Topic 12 **Plants and seeds**

Activity 1

Growing plants

1. Why do we need plants?
2. Talk about the picture.



Activity 2

How to plant

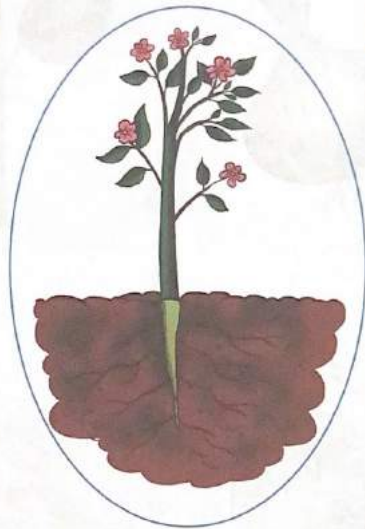
1. What do we need to grow plants?



soil



seeds



sunlight and air



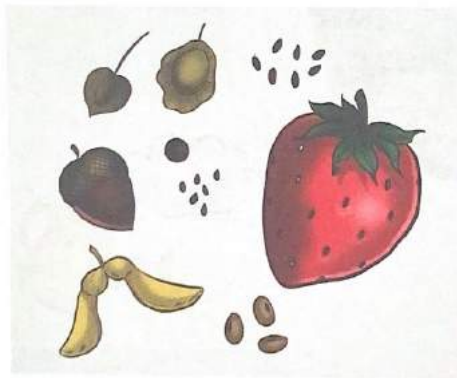
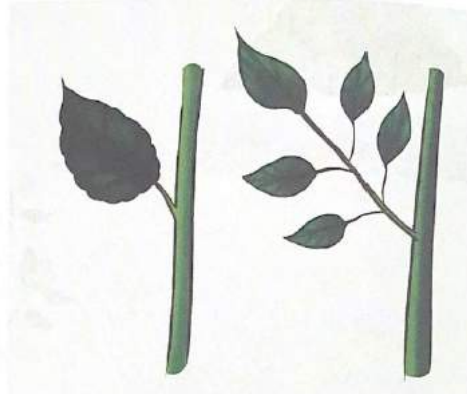
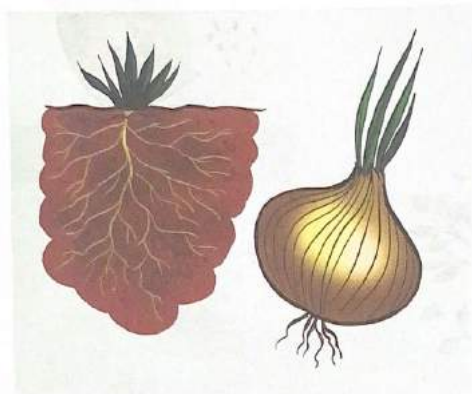
water

2. a) Talk about different seeds.
b) Talk about different plants.
3. Grow a plant:
 - a) Gather your items to plant a seed.
 - b) Plant your seed and water it.
 - c) Put it in a sunny spot.
 - d) Look after it every day and watch it grow.

Activity 3

What plants look like

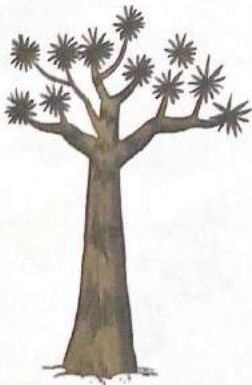
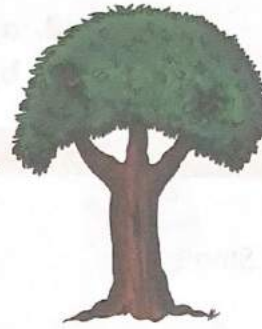
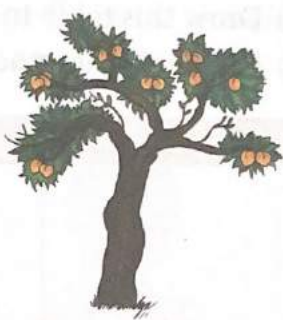
1. What do the different parts of a plant look like?
2. Do all plants have the same parts?



Activity 4

Trees

1. Why do we need trees?
2. Do all trees look the same?
3. Talk about the pictures.



Activity 5

Making comparisons

1. Compare two plants:
 - a) Choose two plants to compare.
 - b) How are they the same?
 - c) How are they different?
2. a) Draw this table in your book.
b) Complete the spaces.

	Plant 1	Plant 2
Stems		
Leaves		
Flowers		
Colour		
Size		
Shape		