A COMPARATIVE STUDY OF PROGRESSION IN THE TOPIC MATTER AND MATERIALS ACROSS THE NCS, THE NCS WORK SCHEDULE AND THE CAPS

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DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature: ______________________________ ***Date:*** ____________________

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ABSTRACT

The following research report is based on a project that compares progression in the topic of Matter and Materials in the Natural Sciences Grade R-9 content framework as it is represented in the National Curriculum Statement (NCS), the NCS Work schedule and the Curriculum and Assessment Policy Statement (CAPS). The research done for the purposes of this project utilises five concepts derived from current literature on sequence and progression in curricula as well as vertical and horizontal knowledge structures. These concepts are: Depth, Curriculum Focus, Curriculum Ordering, Classification (the nature of the boundary between science and other subjects), Classification (the nature of the boundary between science knowledge and everyday knowledge) and Breadth. These concepts were used to analyse the Matter and Materials statements in each curriculum document. The nature of each statement was also analysed in terms of whether it is a generic statement, a statement specific to science or a statement relevant to the sciences and other subjects. The two main purposes for this research is to assess whether the issues raised in recent research with regards to the NCS have been dealt with through the design of the CAPS, and whether the particular issue of the lack of visible sequence and progression in Natural Sciences has similarly been responded to in the design of the Natural Sciences content framework of the CAPS. One of the key findings of this research project is that the design of the Matter and Materials content framework of the NCS hindered progression and that the NCS Work schedule and the CAPS are much better designed for the internal knowledge structure of the topic, Matter and Materials. Another key finding is that certain changes that will be implemented in the new CAPS document visibly hinders progression in the topic. One of the main arguments that this project provides is that visible progression articulated in the content framework of subjects with a vertical knowledge structure such as Natural Sciences is crucial. Hindering progression in these subjects cause gaps in the internal knowledge structure of the subject.

CHAPTER 1: Introduction

Introduction

In a continuous struggle to equalize education and establish South Africa in the global market, national curricula designed for the education system since the fall of *Apartheid* have been reviewed on an ongoing basis. The purpose of these reviews has been mainly to determine where the Department of Education failed to meet the needs of South African schools and uphold a standard within the curriculum that could enable the country to become a better role player in the global market; as well as to determine how the curriculum can be improved. One such review has led to the design of the new *Curriculum and Assessment Policy Statement (CAPS)*, to begin implementation early in 2012. The new policy document aims to address problem areas in the *National Curriculum Statement (NCS)* and the *National Curriculum Statement Work schedule* highlighted by review teams and is thus considered to be a new, improved curriculum.

In an article that tracks curricula reform in South Africa since the fall of *Apartheid*, Hoadley (2011) describes the curriculum reform path in terms of particular moments, or times in history where knowledge, knowers and knowing have been in a constant process of either integration or division. The first critical moment of curriculum reform, according to Hoadley (2011), was the introduction and implementation of Curriculum 2005 which was defined primarily by an outcomes-based education (OBE) approach. Curriculum 2005 was also designed in relation to the National Qualifications Framework. This curriculum was based on broad, generic skills. The aim was that learners who were at school during the time of Curriculum 2005 would become, as a result of the type of curriculum they were instructed from, a particular type of citizen who would be a representation of the new South Africa- a free, critical thinker who values democracy and human rights. Curriculum 2005 carried with it a strong political agenda (Hoadley 2011).

The second reform moment occurred when Curriculum 2005 was reviewed and amongst the concerns that were raised about this curriculum, was specifically, its design. It was found that large amounts of content were removed from subjects and were replaced by generic skills. The curriculum expected subject teachers to use their own content knowledge and through the design of the curriculum, facilitate learning in the classroom. This failed hopelessly, because the majority of teachers in South Africa did not have the content knowledge the curriculum required them to have and without specified content in the curriculum, learning stopped in the classroom. As a result of this review, the National Curriculum Statement (NCS) was launched and implemented in schools in 2002.

The third and most recent curriculum reform moment Hoadley (2011) describes in her article occurred when the NCS was reviewed in 2009. The Review team of the NCS strongly suggested that outcomes-based education be discontinued and argued that "...by focusing on attitudes, dispositions and competencies...[the NCS]...fails to give adequate specification of essential learning" (Hoadley 2011:153). Once again, content had been underspecified and unclear for the purposes of generic skills. As a result of an unclear and underspecified curriculum, the NCS Work schedules were implemented in an attempt to provide greater content specification and guidelines for teachers on what to teach. These Work schedules can be seen as a stepping stone to the CAPS.

With the elimination of generic skills in the CAPS and the strong suggestion from review teams for greater content specification, it is thus appropriate to analyse the CAPS in relation to other curricula (such as the NCS and the NCS Work schedule). Doing this might enable one to grasp the content specification and progression of knowledge across these curriculum documents and determine how the CAPS differ from previous curricula and other reform moments. The research outlined in this dissertation aims to do this in terms of one topic in one subject: namely Matter and Materials in Natural Sciences.

<u>Purpose and Rationale</u>

The review report of C2005 indicated that the integration of learning areas in the design of this curriculum made the curriculum more practical for every day life and work (Chisholm, 2000). The attention to integration in this curriculum, however, led to less attention given to the need for conceptual coherence and a clear indication of progression. The report of the review team provides a clear distinction between lateral and vertical demarcation. Lateral demarcation indicates how units or clusters of knowledge are demarcated from each other whereas vertical demarcation refers to how knowledge units (within demarcated knowledge clusters) need to be taught in a sequence and at a particular level of competence (Chisholm, 2000). The report showed a clear lack of vertical demarcation of knowledge in the curriculum, especially in science subjects. Another problem areas for which past curricula have been under severe criticism is the idea of knowledge gaps (Muller, 2006;

Hugo and Dempster, 2006). Research has shown that in many learning areas in the curriculum, knowledge that is crucial to connect the internal knowledge structure of a learning area is omitted. From this point of view, a learning area may thus never be represented in its entirety in that there are crucial bits of knowledge that are simply not in the curriculum. Another perspective of this specific problem is that the complete internal knowledge structure is represented in the curriculum, but the manner in which the knowledge is represented is not coherent. This means that units of knowledge that actually fit together and in this form creates understanding of the knowledge in the learning area are not represented together in the curriculum. Rather, they appear at different stages within a grade or they appear in two different grades. This dis-connectedness of knowledge units in a learning area creates problems for learning with regards to a specific learning area or subject (Muller, 2006).

Muller (2006) explained that the review team of Curriculum 2005 made an argument for this specific problem area in the following manner. They argued that subjects in the curriculum differed in relation to curricular coherence requirements and they differed in terms of the best possible way in which content and skills with regards to the subject, should be stipulated. Mathematics and science, as a result of being content and concept rich subjects where both content and concepts build upon each other, was argued to have a defined body of content that needed to be covered in a specific sequence in a specified amount of time. This means that in order for learners to understand the content knowledge of these subjects and to eventually gain a complete understanding of the subject matter, certain concepts need to be taught, and thus learned, before others. If a curriculum did not specify all the necessary content for a specific learning area or specify content in the right order and at the right pace, it resulted in learners having gaps in their knowledge about a certain subject in terms of its necessary concepts and content. This resulted in learners who, in the opinion of Muller (2006), become “structurally stunted” in their learning process and the internal structure of knowledge of a specific learning area is left with knowledge gaps (Muller, 2006:79).

As mentioned above, science is a subject that is rich in terms of concepts and content. For this reason, its representation in the curriculum needs to be conceptually coherent. The content in science also needs to be linked to and form a part of the internal structure of the concepts. Natural Science is a learning area that has been identified, particularly by Dempster and Hugo (2006), as being represented in an incoherent manner in terms of content and in terms of how and when concepts are represented in the NCS curriculum. Dempster and Hugo (2006), in research that refer to the representation of the theory of evolution in the NCS curriculum, argued that both the Natural Sciences and Life Sciences curriculum statements emphasize the need to recognise alternative ways of knowing. As a result of this, the theory of evolution which is considered to be the highest ordering principle in the Natural sciences, is a topic in the curriculum that “is being introduced implicitly and explicitly in the South African school curriculum, in ways that approach, but fall short of, achieving high levels of scientific literacy for all South African learners” (Dempster and Hugo, 2006:106). They argued that the curriculum statements mentioned “fail to integrate the various lines of evidence into an integrated Darwinian theory of evolution, they conflate different domains of knowledge, and they misrepresent key concepts such as natural selection” (2006:106). Muller (2009) explained the results of the research done by Dempster and Hugo (2006) in the following manner: “They found that the syllabus drafters had tried to be very sensitive in their handling of the scientific/religious debate, evolution and creationism, with the result that they had tried to accommodate both evolution and creationism...[T]he pedagogical result was that key resources of biodiversity were foregone, and most critically, the conceptual spine required to grasp evolution as a scientific theory was scrambled and the conceptual sequence skewed” (Muller, 2009:216).

The research referred to above, accompanied by the explanation offered, exemplifies a critical concern for not only the design of the NCS curriculum, but also for the effects of such a curriculum on individual learners in the classroom as well as the system of education as a body. A critical concern for the scientific knowledge and skills acquired by learners at school and the disparity between this knowledge and the knowledge required for success at university level is also derived from the research referred to above. Contained in the research report by Dempster and Hugo (2006), there is a brief description of the low levels of scientific literacy amongst South African students. Their research indicates that even though South African students in general, pass science subjects, they are unable to apply the knowledge they gained at school to contexts outside of school and particularly to the university environment. Further research argues that the National Curriculum Statement specifically, is a contributing factor to the low levels of scientific literacy amongst South African students (Le Grange, 2007).

Soon however, the *National Curriculum Statement (NCS)* and the *NCS Work schedule* will be in the South African past and the *Curriculum and Assessment Policy Statement (CAPS)* will be our future. With this in mind, I was led to ask the question whether the new curriculum deals with the issues and concerns raised by many researchers, and teachers alike, with regards to the NCS and NCS Work schedule. I was specifically led to ask whether the problem areas with regards to science were seen to in the design of the CAPS and whether there is a clear indication of sequence and progression in the CAPS that supports the vertical knowledge structure of the learning area instead of inhibiting it, as suggested by former research. I formulated a research topic which aimed to compare the topic of Matter and Materials in the NCS, the NCS Work schedule and the CAPS for Grade R-9. The research question for this dissertation is framed as follows:

Do the CAPS show progression of knowledge for the topic 'Matter and Materials' from Grade R to Grade 9 in comparison to progression for the same topic in the NCS and the NCS Work schedule, Grade R to Grade 9?

I aimed at doing a comparative study between the NCS for Natural Sciences, the NCS Work schedule for Natural Sciences and the CAPS for Natural Sciences. I wanted to compare the representation of the topic Matter and Materials in all three curricula from Grade R to Grade 9. As discussed above, the subject Natural Sciences has an internal knowledge structure that is vertical (Bernstein, 1999). Concepts thus form the core of this knowledge structure and both concepts and content need to be hierarchically related in a specific sequence when represented in the curriculum. Previous research suggests that certain topics in the NCS curriculum for science, and thus Natural Sciences, are not represented in a manner that enhances understanding of the subject matter and of the learning area. I thus planned to do research that could determine how Matter and Materials is represented in the NCS and comparatively, how it is represented in the NCS Work schedule and the CAPS. I started my investigation by establishing the sequence offered in the NCS for the Matter and Materials content framework to determine whether the sequence offered is hierarchical and whether units of knowledge within this sequence articulate in terms of the internal structure of the knowledge area. I did the same for the NCS Work schedule and then finally for the Matter and Materials content framework of the CAPS. Secondly, I established whether there were any changes that had been introduced into the three content frameworks mentioned and the positive or negative influences these changes have had on the indicated progression of the knowledge area, Matter and Materials. My main concern however, was: *Do the units of knowledge within the topic Matter and Materials in the NCS for Natural Sciences Grade R-9 show progression? Comparatively, do the units of knowledge within the topic Matter and Materials in the NCS Work schedule and in the CAPS for Natural Sciences Grade R-9, show* *progression?*

As a Natural Sciences teacher, I was (and still am) interested in the idea of progression in the curriculum. Matter and Materials forms one of the core components of Natural Sciences in the GET Phase (General Education and Training Phase) and as I wanted to focus on science, I decided to focus on this core component to be in a position to grasp the focus and depth of this topic across the curricula documents specified, for science. Focusing on one core component of science enabled me to do an in-depth analysis, as well as provide a platform for further research into the other core components of science, or even other science-related subjects and their representation in South African curricula. The following is a brief outline of the topic of Matter and Materials.

Matter and Materials

In the NCS and the senior phase of the CAPS, Matter and Materials is one of four components in the Natural Sciences content framework. The remaining three components are Energy and Change, Life and Living and Earth and Beyond. In the Intermediate phase (Grade 4-6) of the CAPS, Matter and Materials forms a part of the integrated subject, Science and Technology. No Matter and Materials content component is found in the Foundation phase of the CAPS. Similarly, in the National Curriculum Statement (NCS) Work schedule, Matter and Materials is organised as one of the above mentioned four components in the Senior phase as well as one of these four components in the Intermediate phase. No Matter and Materials content component is found in the Foundation phase of the NCS Work schedule, except for one investigation on the Properties of Materials in Grade three and another investigation on the Properties of Materials in Grade two. In the National Curriculum Statement (NCS), the same content knowledge for Matter and Materials span across Grade one to three in the Foundation phase, across Grade four to six in the Intermediate phase and across Grade seven to nine in the Senior phase. This means that the same content is covered for the topic Matter and Materials in each grade within the same phase.

Matter consists of the following subtopics:

1. *Pure substances* and *Mixtures*
2. *Elements* and *Compounds*

3. *Heterogeneous Mixtures* and *Homogeneous Mixtures*
4. *Metals, Semi- Metals* and *Non-metals*
5. *Organic* and *Inorganic Compounds* (Crossman, 2007).

Matter can simply be defined as comprising everything one can see, touch or smell. All Matter consists of atoms, which are defined as the smallest particles of Matter. *Molecules* are clusters of atoms. Matter is divided into *Pure Substances* and *Mixtures*. In a pure substance, the atoms are all the same. Pure substances can further be divided into *Elements* and *Compounds*. An element is a pure substance that is made of one type of atom only. A compound is also made up of one type of atom. The difference between an element and a compound however, is the fact that an element is the simplest form of pure substances -it cannot be broken down by chemical reactions whereas a compound can be broken down by chemical reactions, because it is made up of two or more elements that are bonded by chemical reactions (Barker, et. al. 2005). Elements are thus singular, whereas compounds are formed when two or more elements combine chemically (Clacherty et al; 2007).

A mixture consists of two or more substances. A mixture is a physical blend of substances mixed together in any proportions such as a mixture of sand and stone used in building materials. Substances in mixtures are not chemically bonded to one another, they keep their individual physical properties and they can be separated by physical means (Crossman, 2007:7.7). Mixtures can further be divided into Heterogeneous Mixtures and Homogenous Mixtures. These two concepts however, are only taught in the FET Phase (Further Education and Training Phase/Grade 10-12).

Matter can be classified according to its appearance and according to its behaviour into solids, liquids and gases. Solids are hard and they do not lose their shape, liquids flow and take the shape of the container they are in and gases flow into available space. Matter can also be classified into acids, bases and neutrals. An acid is a compound containing hydrogen and as a substance, it has a sour taste. A base is a compound that is usually a metal oxide or metal hydroxide and as a substance, it has a bitter taste. Neutral substances are those that are neither acids nor bases and as substances, they have a neutral taste. Matter can also be classified according to whether they are metals or non-metals (Clacherty et al; 2007). To classify Matter in this way, the Properties of Materials are considered.

Materials consist of the following subtopics:

1. *Properties of Materials*
2. *Uses of Materials*

A Material is Matter that has been classified according to specific characteristics. These characteristics determine the names of Materials and are referred to as Properties of Materials. Properties of Materials are thus the characteristics materials have. These properties determine what they are used for by people. In the topic of Matter and Materials, many of these characteristics are investigated and discussed.

A few things can be deduced from the brief summary of Matter and Materials above. The first is that the topic has a specialised language which needs to be learned and understood to enable understanding of the content matter. The second is that topics are arranged in a specific order- one topic builds upon knowledge of prior topics, enabling a broader, deeper understanding of the topic. Content thus has to be taught according to a specific order. For example, when teaching the two concepts *Properties of Materials* and *Uses of Materials*, the first concept needs to be taught before the second concept is taught. Understanding what a property of a particular material is and how that property/ characteristic defines the material in terms of its name and usage enables the understanding of what the material is used for and why it has specific usages. The first concept thus enables the understanding of the second concept and the latter concept provides a deeper, broader understanding of the first concept that was taught. Concepts and Content are thus best understood when it is taught in a specific order. The last observation is that Matter and Materials span from the Intermediate Phase of schooling to the FET Phase of schooling. Concepts thus build upon each other within a grade as well as across grades, this means that content in one grade automatically has to reinforce and build upon content in the following grade.

In this chapter I have introduced my research topic leading up to this dissertation by stating what my research topic is, how my research topic developed and work from other researchers that have influenced my initial thoughts and planning. I have also introduced the specific topic in Natural Sciences my research focuses on and have given a brief overview of this topic as well as its representation in three curriculum documents; the NCS, the NCS Work schedule and the CAPS. In chapter two, I discuss the theoretical framework that underpins my research topic, grounding it in the broader field of knowledge structures, progression in curricula and South African education. I also discuss the particular concepts I have developed in order to analyse my data. My literature review then follows in chapter three which provides an outline of the work of other researchers, local and international who have addressed similar issues in their research. In the literature review, I not only discuss their specific areas of research, but selectively I discuss what their findings are. Chapter four is a discussion on the methods I used during the process of data collecting and data analysis and chapter five is a discussion of my analysis. Chapter six comprises of my final discussion and conclusion. The following chapter outlines my theory and conceptual framework.

CHAPTER 2: ***Theory and Conceptual Framework***

Theory and Conceptual Framework

My research is located within Basil Bernstein's theory and understanding of recontextualisation. Bernstein (1996), who was specifically concerned with the social and pedagogical aspects of education, formulated a question about whether there were general principles that underlie the transformation of knowledge into pedagogic communication. He wanted to understand how knowledge is changed or transformed into teachable and thus evaluative knowledge. He argued that pedagogic communication can be viewed as a carrier or relay of knowledge and he was specifically concerned with understanding what the internal structure of this relay was. His research presented three levels in the pedagogic device: knowledge formation, knowledge recontextualisation and knowledge evaluation (Bernstein, 1996).

Each of these stages of knowledge contained rules which can be outlined in the following manner:

1. Knowledge Formation- Distributive Rules
2. Knowledge Recontextualisation- Recontextualisation Rules
3. Knowledge Evaluation- Evaluative Rules.

According to Bernstein (1996), these rules are in hierarchical order and are in a particular relationship with one another. The distributive rules distinguish between two classes of knowledge, mundane (everyday) and esoteric (or academic knowledge). The first can be learned via practical day to day experiences while the latter can only be learned best at a specific institution that specializes in teaching this knowledge. The distributive rules focus on what knowledge is distributed to whom and from the perspective of the environment of education, what knowledge becomes the school curriculum. It is at the level of the distributive rules where a clear distinction between everyday knowledge and academic knowledge is made. The recontextualisation rules focus specifically on pedagogic discourse which, according to Bernstein (1996), can briefly be defined as an instructional discourse (teaching skills) that is embedded in the regulative discourse (teaching moral order). Together, these form pedagogic discourse. Pedagogic discourse can thus be defined as a point at which a particular discourse is embedded within another, to form one discourse. The knowledge produced/formed at the stage of the distributive rules is carried down and is recontextualised into knowledge that can become pedagogy in institutions such as schools. The evaluation rules focus on evaluation which is key in pedagogic practice. At the level of the evaluation rules, pedagogic discourse is transformed into pedagogic practice. It is at this level where pedagogic discourse and knowledge is evaluated by both the teacher and the learner. The process of evaluation is geared toward whether the specified knowledge is transmitted and whether it is acquired.

Recontextualisation was key in my research, because I aimed at focusing on and comparing the NCS and the NCS Work schedule to the CAPS documents. These documents have been designed in the field of recontextualisation by those selected to compile the school curriculum using knowledge and information gathered from the field of production at the level of the distributive rules. We can briefly identify distributors in the field of production as institutions of Higher Education. Research and knowledge here is then used as the foundational source for pedagogic discourse and is represented in these documents, this is transformed into pedagogic practice in the classroom.

Another key concept in my research is the idea that knowledge or the internal structure of it, can either be vertical or horizontal. Muller (2006) explained that horizontal discourses are forms of sense making that are segmental and have no recontextualising principles. Horizontal discourses can be labeled as everyday knowledge, because of their development and structure. Vertical discourses, Muller argued, do have recontextualising principles and they can be labeled academic knowledge as a result of their development and structure. The sciences have been identified by Muller (2006) as vertical discourses that consist of vertical knowledge structures where concepts and content build upon each other in a continuum of progressiveness. The nature of progression in a school subject which is based on a vertical knowledge structure is the focus of this thesis.

Definition of Progression

Progression in the curriculum consists of sequence and conceptual demand. Sequence refers to units of knowledge that are represented in a particular order lending structure to a specific subject. Conceptual demand refers to various skills and abilities to be learned that can be plotted hierarchically from lowest to highest levels of complexity and cognitive demand. In vertical subjects, there are a number of crucial elements to consider. The first is, because there is more content in the progression chain, the sequence of how the various units of vertical knowledge is presented and taught is crucial. In these subjects, if some content is skipped or learners receive content that does not directly build upon previous content they have received, learners will not be able to recognise and link it to the previous knowledge learned (Muller, 2006). This new knowledge will thus not fit into the internal structure of the knowledge of the subject which enables learners to understand the subject as a whole, as well as prepare learners for the new knowledge about to be received. The second element is the coverage of content. This is crucial, because each unit of knowledge fits into another unit of knowledge by virtue of the verticality of the subject. For students to understand each unit of knowledge more completely, it needs to be directly linked to and built upon the previous unit of knowledge taught (Muller, 2006). If knowledge units are taught in this way it enhances the understanding of the next unit of knowledge to be taught. Lack of coverage thus influence units of knowledge already learned and allow for a limited understanding of subject knowledge and a limited understanding of the overall subject matter. There also needs to be a clear, continuous link between content and concepts in the construction of the curriculum (Muller, 2006).

Elsewhere, Muller (2009) explained that the more vertical the curriculum of a specific subject is, the more important the sequence with which knowledge is taught becomes. Elements that follow later in the curriculum depend upon earlier elements in the curriculum to be grasped and understood. His distinction between conceptual coherence in a curriculum -which refer to a curriculum where concepts form the core of the knowledge structure and each concept internally produces knowledge and understanding for the following concept needed to be taught -and contextual coherence, which refer to a curriculum where context forms the core of the knowledge structure and each segment is adequate to a specific context and is sufficient for a specific purpose; enable us to understand that curricula needs to be designed specifically according to the knowledge structure or subject for which it is being designed.

Muller (2006) noted the failure of curriculum developers of Curriculum 2005 with regards to this issue in the following manner: “What the Review Committee found was that the original designers of Curriculum 2005 had proceeded as if contextual coherence was the sole, or almost only, requirement to be met in the school curriculum. Arranging the curriculum in terms of a set of segmental activities rather than in a hierarchy of concepts to be grasped is by and large what a radical outcomes- based (OBE) curriculum format does. The consequence for the conceptual disciplines was, and is, a curriculum whose signaling of knowledge and sequence was and is wholly inadequate”(2009: 216).

There are three foundational conceptual issues that I would like to emphasize at this point. The first is that the NCS, the NCS Work schedule and the CAPS documents, which formed the core of my research, are based within the field of recontextualisation. This field and the principles attached to it is in a hierarchical relationship with the field of production (distributive rules) and the field of reproduction (evaluative rules). My focus, however, is specifically on the recontextualisation rules where curriculum is constructed. The specific rules that determine what is taught and how it is taught, occurs at the level of the evaluation rules, or pedagogy. My particular focus is thus what content is specified in curricula and the guidelines that are given in relation to such content. The field of recontextualisation, however, has an effect on, and is in turn affected by the two remaining fields previously mentioned. The second conceptual issue I would like to emphasize is the fact that knowledge structures or subjects differ. Curricula thus have to be designed in relation to the internal knowledge structure of a learning area or subject. Sequence becomes crucial when it comes to subjects with a vertical knowledge structure that are concepts and content rich. A lack of sequence in these subjects lead to negative consequences for the field of reproduction. For example, in a discipline like science, that can be described as concept-rich as a result of a long sequence of hierarchically related concepts, a lack of correct sequence could mean getting stuck at any rung of the hierarchy which in turn mean that conceptual learning stops (Hoadley and Muller, 2009).

The third and final conceptual issue that I want to emphasize is that there is a distinct difference between knowledge structures and curriculum structures. Knowledge structures refer to the internal structure of the knowledge of disciplines- the relationship between concepts and content at the level of the distributive rules. Concepts and content can either be horizontally developed or they can be vertically developed in disciplines. Curriculum structures refer to the structure of the curriculum- how concepts and content are positioned in relation to each other when knowledge is recontextualised for the purpose of learning in the curriculum. Curriculum structures can also either be horizontal or vertical. Thus, a key interest in the dissertation is the way in which curriculum structures and knowledge structures relate to each other.

Concepts developed to analyse data

In order to analyse the data I extracted from the three curriculum documents selected, I utilised and developed certain concepts from the theory and literature I examined. These concepts were then used to analyse the Matter and Materials content framework in each curricula. Along with these concepts, I also analysed each Matter and Materials statement in terms of whether the statement was generic, whether the statement was specific to science or whether the statement was relevant to other subjects in the curriculum. The concepts I utilised are:

1. ***Depth***: A defined body of subject knowledge that consists of small particularities and big concepts. Depth in a subject is visible when these particularities lead to bigger concepts or bigger concepts are followed by small particularities that explain the bigger concept (Schmidt et al; 2005).

2. ***Curriculum Focus***: A stipulation in curriculum statements that guide a reader to focus on skills, concepts or content.

3. ***Curriculum Ordering*****:** The sequence of subtopics within a topic that show progression of hierarchically related concepts in the curriculum (Hoadley & Muller, 2009).

4. ***Classification(++)(--)***: This refers to the nature of the boundary between science and other subjects in the school curriculum (Bernstein, 1975).

5. ***Classification (+)(-)***: This refers to the nature of the boundary between science knowledge and everyday knowledge (Bernstein, 1975).

6. ***Breadth****:* This refers to the total number of sub-topics or content that needs to be covered for one specific topic in a curriculum document.

I used the concepts listed above as categories to measure progression of knowledge in the NCS, the NCS Work schedule and the CAPS. The first three concepts; Depth, Curriculum Focus and Curriculum Ordering were used to measure progression of knowledge directly and the last three concepts; Classification (++)(--), Classification (+)(-) and Breadth were used to measure progression of knowledge indirectly. Depth is a direct indication of progression, because when small particularities and bigger concepts accompany each other in a grade of phase, there is greater potential in the curriculum to have bigger concepts and small particularities build upon each other to form a coherent knowledge structure.

Curriculum Focus indicates progression, because when the curriculum emphasizes concepts/content for a subject that is particularly concept/content rich; then that curriculum complements the vertical knowledge structure of the subject. A focus on content that progresses from lower to higher levels of cognitive demand however, is an indication of visible progression. With regards to Curriculum Ordering, the sequence of sub-topics is also an indication of progression/ a lack of progression. Sub-topics that are sequenced in a manner that positions hierarchically related concepts/content to follow after each other, indicates progression in the curriculum.

The two categories of Classification indirectly indicates progression in the Natural Science Curriculum, because when curriculum statements in a subject with a vertical knowledge structure and a specialised language, have a clear boundary between science knowledge and everyday knowledge as well as a clear boundary between a science subject and other subjects; then there is greater potential for progression, because the statements are science and subject focused. This type of content will clearly complement the verticality of the internal knowledge structure of the subject. Content that are not science and subject focused limits the verticality of the internal knowledge structure in that it represents 'other' content or information that are not specific to the subject. Lastly, Breadth is an indirect indicator of progression as a result of the fact that an overload of statements in a grade/phase primarily means that there is limited opportunity for a reader of the curriculum to emphasize individual statements in an in-depth manner as a result of the amount of statements that need to be covered. This hinders progression indirectly.

In Chapter four I return to these concepts in an explanation of the methods I used to analyse the data I extracted. The next chapter (Chapter three) positions my research in relation to other research studies that have been done in similar or complimentary fields of interest.

CHAPTER 3: Literature Review

Literature Review

The purpose of this literature review is twofold. The first purpose is that it positions my research in relation to similar research projects that have been done within South Africa and internationally. The second purpose is that it provides a broader view and understanding of the path that the science curriculum and thus science education in South Africa has taken since the implementation of C2005. By doing this I aim to engage the reader in understanding how the curriculum was and the impact of past curricula on students, how it has changed over time and the impact of changed curricula on students as well as where it is moving towards, in the hope that the current shift in curricula will have a positive effect on student learning and teaching.

Studies on Science Education in South Africa and in the USA

As a highly specialized school subject, science is perceived in many countries (as well as in South Africa) as key in stimulating national progress (Atkin & Black, 2003). **Science has a specific** focus and language attached to it. Science students need to learn and understand this language in order to successfully participate in and engage with the subject as well as understand its focus in order to fully comprehend it. Content knowledge, concepts and practical skills are crucial school science components through which science students learn to understand science as a discipline and learn how to apply it in day-to-day events and experiences in their lives.

Research that was conducted by Laugksch & Spargo (1999) indicated that even though South African science students pass science subjects with good marks, they are unable to apply the knowledge they gain at school to contexts outside of school. "The implication of the above findings is that South Africa's current ability to produce the larger labour force skilled in science, engineering, and technology thought necessary in order to achieve the economic success urgently required for social upliftment is therefore seriously in doubt" (Laugksch, 2000). One particular reason for the above mentioned doubt is the justified concern over not only the state of science education in South Africa, but also the decline in South African students who show an interest in science by participating in it and the poor performance on international surveys by South African Mathematics and Science students (Le Grange, 2007). In their research study, Laugksch & Spargo (1999) examined the levels of scientific literacy of first year university/technicon students at five different universities/technicons across the

Western Cape. Scientific literacy can briefly be defined as what the general public should know about science (Laugksch & Spargo, 1999). Scientific literacy was examined according to different variables such as gender, population group and secondary/tertiary education. The examination was done in the form of a survey named the *Test of Basic Scientific Literacy*; this test was recommended by the American Association for the Advancement of Science (Laugksch & Spargo, 1999). The overall scientific literacy of the students who were tested was 36%. Students who did science subjects at school were more scientifically literate than those who did not do scientific subjects at school and there was no difference found in the scientific literacy of students who did one scientific subject at school and those who, for example, did two or three scientific subjects at school. The results of this study indicate two issues; one is that at this particular time in the history of science education in South Africa not many students chose to do science subjects at school level. The other is that the level of scientific literacy at this time was very low amongst first year university/technicon students, because the curriculum (Curriculum 2005) was found to have large amounts of content removed from certain subjects, replaced by generic skills. The design of the curriculum was of such a nature that teachers were expected to use their own content knowledge in the process of teaching learners in the classroom (Hoadley, 2011).

For the purposes of the above study however, being scientifically literate encapsulates more than just what the general public should know about science, particularly because the research referred to above involved school leavers who had matriculated and were furthering their education at institutions of higher learning. For these participants (and especially for those who did scientific subjects in Grade 12), being scientifically literate meant understanding the processes of science in such a manner as to apply it to their daily lives. It did not necessarily mean knowing and recalling content knowledge. What it did mean however, was understanding the nature of science as a discipline in order to apply it. Content does not provide this for students, but content that is taught in a particular order where concepts fit into each other and build upon each other to provide an understanding of the overall nature of a discipline, specifically in a vertical knowledge structure such as science, does. A lack of this in curricula would result in a state of non-scientific literacy amongst students such as was the case in the research study done by Laugksch & Spargo (1999).

Dempster and Hugo (2006) analysed the Natural Sciences component of the NCS in terms of the theory of evolution. They mention that as a result of political and religious agendas, this theory has been omitted from the South African science curriculum for many years. After it was implemented in the curriculum however, and as a result of their research, they found that content was either misrepresented or omitted in the curriculum. This had a negative impact on the verticality of the knowledge structure in terms of the theory of evolution and also in terms of natural sciences as a subject. The consequence of this was that units of knowledge within the curriculum did not fit into each other to create an adequate sequence and vertical progression within the evolution theory, which according to Dempster and Hugo (2006) is a crucial element in the understanding and comprehension of Natural Sciences in the Senior Phase and Life Sciences in the Further Education and Training Phase (FET), was hindered. In their research study, Dempster and Hugo (2006:108) “identified the foundational concepts of evolution that could convincingly be developed in South African schools.” Thereafter, they “... analysed the latest curriculum documents to identify where, when and how these principles... (2006:108)” were represented in the curriculum. They found that the NCS for Natural Sciences misrepresented core concepts such as *Natural Selection* within the theory of evolution and incorporates content that taught the theory of evolution without ever mentioning the name of the theory or concept, *Evolution*. Once again, the verticality of the knowledge structure was negatively influenced by the omission of, or the misrepresentation of crucial content and concepts that form an important part of the inherent logical structure of the subject of Natural Sciences.

Nazeem Edwards (2010) did a study on the “alignment between the South African Grade 12 Physical Sciences core curriculum and content and the exemplar papers of 2008 provided by the Department of Education, as well as the final examination papers of 2008 and 2009” (Edwards, 2010:571). In his report, Edwards stress that alignment between the curriculum and the final year examination is crucial for both school and learners; learners are equipped for their final year examination which determines entrance into institutions of Higher Education and schools are held accountable for exit examination results. Schools also have the potential of receiving monetary rewards for good achievements, particularly in science and mathematics. Thus, the degree to which assessments by the Department of Education and the core curriculum is aligned is crucial. In his study, the core knowledge and concepts of Physical Sciences in the NCS curriculum were outlined and collapsed into Physical Sciences knowledge areas for the purposes of effective and easy analysis. The knowledge areas in the various examination papers were outlined and the alignment of these was then tested through the use of Porter's alignment model (Edwards, 2010). The core knowledge and concepts of Physical Sciences as well as the various examination and exemplar papers were then analysed in terms of the Revised Bloom's

Taxonomy to determine whether the cognitive levels in all these documents were aligned. The results of the study showed that the physics component of the Physical Sciences core knowledge and concepts showed a balanced alignment whereas the chemistry component had instances of over, or under representation. Matter and Materials particularly, was identified as having 5% over representation in the final examination and students thus performed poorly in this area of the paper (Edwards, 2010). The core knowledge and concepts of the Physical Sciences curriculum in the NCS however, was found to be fairly consistent and balanced with the examination and exemplar papers.

Another alignment study was done in 2008 by Liu and Fulmer. This time the alignment between the New York State (NY) core curriculum and the NY Regents Test in Physics and Chemistry was done. Similar to the alignment study done by Edwards (2010), they used Porter's alignment model and analysed alignment between the Regents Test and the core curriculum as well as alignment in each of these in terms of cognitive demand. The results of the study showed that there was a high level of alignment between the Regents Test and the core curriculum for Physics and Chemistry. Liu and Fulmer (2008) mention that a core function of alignment studies is to evaluate and monitor the standards of the state or a specific country. These studies were conducted in the context of the No Child Left Behind Programme- one which focused specifically on standardization. The focus in these two studies was on the alignment of state standards and standardized tests.

In a study done by Schmidt et al. (2005) that compares the coherence and rigour of content standards in the United States with coherence and rigour of content standards in other countries through data gathered from the Third International Mathematics and Science Study; it is argued that coherence is one of the most crucial, defining elements of high-quality standards. In their report, they define coherence as alignment or the degree to which standards, textbooks, assessments, etcetera are in accordance with each other (Schmidt, 2005). From this perspective, the alignment studies done by Edwards (2010) in terms of alignment between the Physical Sciences exemplar/examination papers and the Physical sciences core curriculum and concepts of the NCS; by Dempster and Hugo (2006) in terms of the alignment between the theory of evolution in Natural Sciences and its representation in the NCS curriculum are similar to this current research (of which this is the report), because all of these studies are comparisons that trace the coherence and progression in the South African science curriculum over time. As a result of doing this, these studies also indicate the consequences of a science curriculum that is aligned or shows progression in content and a science curriculum that does not show progression in content. By indicating the consequences of alignment or a lack thereof, these studies are similar to the study done by Laugksch & Spargo (1999) in that coherence and progression in curricula is a crucial factor in the level of scientific literacy of students. As mentioned above, part of being scientifically literate is understanding the processes of science in such a manner as to be able to apply it to day-to-day living. It means understanding the nature of science as a discipline. Schmidt et al. (2005) indicate that coherence is critical to learning for understanding. "Understanding implies, at least at some level, that the structure of the discipline has become visible to the learner so that she or he can move beyond its particulars. We suggest that one way to facilitate such learning is by making the inherent logical structure of the discipline more visible both to teachers and students" (Schmidt et al; 2005:554). This dissertation provides an analysis of the inherent logical structure of Matter and Materials in three curriculum documents and is thus similar to the studies reported in this literature review thus far.

Another study that is relevant to the research reported on in this dissertation is a study done by Green and Naidoo (2006). Their study analyses "the contents of the Grade 10 Interim Physical Sciences curriculum document and the National Curriculum Statement for Physical Sciences to investigate changes in knowledge valued in the policies" (2006:71). These documents were then analysed and compared in terms of various categories such as instructional and regulative discourses, ideology, cognitive and socio-affective competences, complexity of competences and philosophical underpinnings. Green and Naidoo (2006) reported that there was a big shift in these documents from an emphasis on science content in the Interim Curriculum to "...the incorporation of other elements related to teaching and learning in the NCS" (2006:76). It was also found that the NCS endorses "...an image of science as human, corrigible, historically embedded and changing" (2006:77). It was also found that the NCS is a much more comprehensive and complex document to understand and apply than the Interim Curriculum (for Physical Sciences). Green and Naidoo (2006) argue that the particular reform process that resulted in the implementation of the NCS caused a shift in focus from viewing science as an academic discipline to a view that "...sees the study of science contributing to the achievement of economic utilitarian and social utilitarian goals as well" (2006:79). This study verifies what Hoadley (2011) indicated about Curriculum 2005- that it carried with it a strong political agenda. In this study, a comparison between the NCS, NCS Work schedule and the CAPS, we see a shift back toward greater content and science being viewed as an academic discipline once again in the new CAPS.

Studies on Science Education in South Africa- Umalusi

As the council for Quality Assurance in General and Further Education and training, Umalusi has conducted a wide range of research on South African curricula as well as examinations (the intended and examined curriculum) in an attempt to maintain effective educational standards in the country. In a comparative research study where syllabi and examinations in South Africa were compared with syllabi and examinations in Kenya, Ghana and Zambia; they note that "a world class curriculum is characterised by 'equity and inclusiveness, the encouragement of innovation and creativity, clarity and focus in content specification and assessment for learning'" (Victorian Curriculum and Assessment Authority, 2004:3; as quoted in Umalusi, 2007:5). They argue that it is very difficult to design a curriculum that achieves all of the objectives above. Curricula thus have to be revised consistently. Curriculum content was identified as always being contested and debated when designing curricula.

In order to do the particular comparative research study referred to above; Umalusi visited Kenya, Ghana and Zambia to conduct informal, unstructured interviews with various officials in curriculum institutes and examination councils. The same interviews were conducted in South Africa. They also selected four subjects (English, Mathematics, Biology and Science) from each country to determine the differences and similarities in syllabi and senior secondary systems for these subjects. One of the findings of this study, in terms of the South African Science syllabus, was that teachers were required to sequence content for effective teaching and there was a tight specification of the level of difficulty with which topics were to be dealt with. Another observation from the study was an argument from science evaluators that there was too much content specified in the South African curriculum (Umalusi, 2007).

In another study done by Umalusi (2009) in which they compare the old NATED 550 Curriculum and the National Curriculum Statement as well as the examinations associated with each; Umalusi (2009) found that for the subjects Physical Sciences, Life Sciences, Mathematics and English First Additional Language, the sequencing and progression in the NATED 550 were implicit, whereas these were explicit in the NCS through the learning outcomes and the assessment standards. Another observation from this study with respect to the Physical Sciences NCS curriculum was "that while the desired sequencing of content and skills are clear, the mechanics for achieving progression are not" (Umalusi, 2009:35). A second report by Umalusi (2009) on the same study suggested that the Physical Sciences curricula (NATED SG, NATED HG, NCS) show some evidence of progression and sequence. In the NCS, “[T]he general progression within each topic is from concrete to abstract concepts and representations; sequencing within each topic is with respect to continually increasing levels of conceptual demand. In the NCS, there is a certain amount of guidance given to progression within each year, in the Learning Programme Guidelines, where suggested work schedules are provided per grade” (Umalusi, 2009:111). It was found however, that the information with regards to sequencing stipulated above, contradicted the sequencing in another NCS Physical Sciences document. “This variance suggests that there is no clear intention with regard to the progression of topics in the NCS Curriculum Design” (2009:111). The concluding recommendations of this study with regards to the Physical Sciences NCS Curriculum was that “...a single and much more explicit document be written with the purpose of minimising ambiguity and spelling out with clarity the depth of content to be assessed” (Umalusi, 2009:113).

Studies on Science Education in South Africa- Some conclusions

A few conclusions can be drawn with regards to science education in South Africa as a result of the studies discussed above. These conclusions are relevant as it summarizes critical points gathered from literature and positions this document analysis within the realm of education in South Africa. These are:

1. Since the fall of *Apartheid*, a concerted effort has been made to change the face of science education in South Africa. There has been a continuous effort from various parties, including Umalusi, to highlight weaknesses and to make science education more effective, explicit, and content driven as well as easy to understand for teaching.
2. Scientific Literacy of students in South Africa has generally been low. One attempt to improve this, has been through designing and implementing a more effective curriculum. The South African National Curriculum Statement has been identified as one of the consequences for the low levels of Scientific Literacy amongst students in South Africa.
3. Flaws have been found in the design of the NCS Sciences Curriculum and crucial content have been identified as omitted in the General Education and Training Phase (Grades 7-9). The Further Education and Training Phase of the NCS Sciences curriculum have been found to be more explicit in terms of the sequence of content and skills than the NATED 550 Curriculum.

Even though progression is evident in the NCS, especially in the Learning Outcomes and the Assessment Standards, guidelines on how to achieve progression are not clear. The NCS have also been identified as having too much content in the Physical Sciences syllabus and there are too many documents that represent the NCS Curriculum. One simple document is needed.

4. A few alignment studies have been done between curricula and examinations in South Africa following a large amount of alignment studies that have been done in the USA on the alignment of examinations/state tests and curricula.
5. There is a greater focus on Physical Sciences in the FET phase than on Natural Sciences in the GET Phase, in terms of research. A possible reason for this is the fact that the FET phase leads up to the Grade 12 final examination and thus maintaining a standard between the exit examination and the FET phase is much more crucial than maintaining a standard between the GET phase and the exit examination. Also, it seems that once the weaknesses in the FET phase have been ironed out, then the GET phase can be aligned with the FET phase.
6. Across various studies, sequence and visible progression in science is argued to be crucial in its representation in curricula.

Recontextualisation

A key feature of my research is that it is located within Bernstein's idea of recontextualisation and the rules that apply to it. There are many studies (Morais et al; 1999; Sharma & Anderson, 2007; Rose, 2004) that have been done on curricula/curriculum reform through the use and understanding of Bernstein's pedagogic device. These studies focus particularly on the recontextualisation rules. A prominent idea in these studies is that curricula carries with it deep social meanings. This means that curricula is designed for social/political/economic purposes as well as academic purposes. In South Africa particularly, as have been mentioned before, curricula have always been loaded with meanings and purposes other than academic. This is one reason why content have been omitted from certain subjects in the past, why certain subjects have been collapsed into Learning Areas and why we have a greater number and variety of Learning Areas/ Subjects in current curricula than before. The meanings curricula embody can also be referred to as a curriculum emphasis. Roberts (1982) argues that “[A] curriculum emphasis is a coherent set of messages to the student [and teacher] about science (rather than within science). Such messages constitute objectives which go beyond learning the facts, principles, laws, and theories of the subject matter itself...” (1982:245). He further notes that a curriculum emphasis can both reflect what is stated as well as what is not stated. In this study, there is also a focus on the emphasis of the Natural Sciences content framework of the three different curricula examined.

It is to this extent that the science curriculum and science education has been under constant review in South Africa during the last few years**.** Some of the studies that have been done on the science curriculum are based in the field of recontextualisation. The studies on South African science education indicate that an effective science curriculum that is aligned with examinations, particularly the final Senior Secondary exit examination, is crucial. Studies also indicate that science curricula has a big impact on the scientific literacy of South African students, which in turn has an effect on results achieved in science courses at Institutions of Higher Education. The following chapter outlines the methods I used in this study.

CHAPTER 4: Method

In this chapter, I outline the methods I used to gather, analyse and simplify my data. I also discuss the concepts/codes I used to analyse Matter and Materials statements across three curriculum documents I focused on. The first step in my research was to locate the three curriculum documents that form the data for my research; the NCS, the NCS Work schedule and the CAPS. I located them and after analysing the structure and organisation of these documents individually, I extracted all the information which specified what to teach for Matter and Materials Grade R to Grade 9 from the NCS, the NCS Work schedule and the CAPS respectively. Below is a brief summary of the structure and organisation of these three curricula:

The curriculum documents

National Curriculum Statement (NCS) for Natural Sciences Grade R-9

The National Curriculum Statement (Grade R-9) for Natural Sciences consists of the following:

1. An introduction to Outcomes- based education,
2. Learning Area Statements,
3. Learning Programmes,
4. Time Allocations and
5. Assessment.

In this curriculum, outcomes-based education is defined as a system that strives to enable all learners to achieve their maximum ability by setting the outcomes to be achieved at the end of the learning process. A brief description of the type of teacher and learner that is envisaged by the curriculum is also given. The curriculum then specifies Learning Outcomes and Assessment Standards for each grade within each phase. A learning outcome refers to what learners are supposed to know and understand at the end of a specific period and assessment standards are ways in which learners demonstrate the achievement of a specific learning outcome. The document also considers Core Knowledge and Concepts for: Life and Living, Energy and Change, Matter and Materials and Earth and Beyond. These concepts are briefly summarised and then summarised from the perspective of each phase in a table. Then the NCS also considers Assessment principles used in outcomes-based education, Continuous

Assessment as well as managing assessment. From the NCS, I extracted the LO's and AS's, the Core Knowledge and Concepts for Matter and Materials Grade R-9 and the curriculum definition for the Learning Area, Natural Sciences for analysis.

NCS Work schedule for Natural Sciences Grade R-9

The Work schedule is a document that stipulates certain changes to the National Curriculum Statement that were introduced in 2010 by the Minister of Basic Education. Each Work schedule is accompanied by a Teacher guide. The Work schedule offers a selection of content that is accompanied by a weekly outline of the content and the assessment focus. The selection of content covers all the core knowledge and concepts within the four strands of Natural Sciences; Matter and Materials, Earth and Beyond, Life and Living and Energy and Change. Together, these work towards all the three Learning Outcomes in Natural Sciences and all the Assessment Standards. The Learning Outcomes and Assessment Standards of content is however, represented in the form of numbers and is not stipulated in the form of statements as in the NCS. These are given in a table along with the amount of time (in weeks) that should be spent on the content suggested. Some content is also accompanied by suggested activities; these activities are predominantly found in the Foundation and Intermediate phase. The teacher guides, which accompany Work schedules, have suggested lessons that build up to activities and tasks related to the Learning Outcomes and Assessment Standards. It elaborates on the content specified in the Work schedules and gives further details on concepts that need to be taught. There are also recommendations given on how to use the Work schedule and Teacher guide together. It was clear that the intention of the NCS Work schedule was to elaborate the science content to be taught. For this reason I extracted only the Matter and Materials content framework for analysis for the Work schedules for Grade R to Grade 9.

CAPS

The CAPS documents generally, provide a brief Overview and Background of the CAPS, outline the General Aims of the South African Curriculum; offer Time Allocations for all subjects within a phase, provide Skills and Assessments for each grade as well as Formal Assessments for each grade. The formal assessments for each grade provide content as well as practical and written examination guidelines with allocated percentages. Work schedules for Grade 7-9 also outline the various topics to be covered throughout the year giving a time allocation in weeks, topic, content to be covered, practical work and resources to be used. From this document, I extracted an outline of what has to be taught for Grades 7-9 and a definition for Natural Sciences from the perspective of the CAPS. The CAPS document for the Intermediate Phase is similar to the Senior Phase, but a few pages on Natural Science and Technology along with the reasons why they are integrated in the Intermediate phase are given as well as how these two subjects need to be integrated during the process of teaching. I extracted the definition and introduction of Natural Sciences and Technology as well as Work schedules for Grade 4-6 from this document. The Work schedule outline suggested hours that need to be spent on topics, content that need to be covered, skills aligned with content, suggested activities, suggested practical work and resources that need to be used during the teaching process. The CAPS document for the Foundation Phase is similar. Science content is found in the Beginning Knowledge section of the Life Skills curriculum. I extracted this section for analysis.

<ins>*The construction of a Data set*</ins>

After having selected the particular documents from the curricula mentioned above, I also selected the Learning Outcomes (LO'S) and Assessment Standards (AS's) for this subject and topic in the NCS as they are to be read in conjunction with the NCS content framework and they form a crucial intended part of the NCS Curriculum. I tabulated all the statements that are in the NCS, NCS Work Schedule and the CAPS for Matter and Materials in the subject, Natural Sciences. Summaries of each LO, AS and statements found in the above mentioned curricula were then made in order to devise a table suitable and clear enough for effective and manageable quantitative and qualitative analysis. I concluded this process with two tables; one that show the statements referred to above exactly as they appear in the content framework for Matter and Materials in the curricula mentioned, the other showing a summarised version of these statements for the purposes of more manageable data. Examples of these tables are shown below, full tables are provided in Addendum 1 and Addendum 2.

Table 1 shows a comparison of Matter and Materials statements in the NCS, the NCS Work schedule and the CAPS exactly as they appear in these documents. Learning Outcomes and Assessment standard statements are also included.

Table 1: Comparison of Subtopics in the topic Matter and Materials between curriculum documents

Learning Outcomes and Assessment Standards	*National Curriculum Statement*	*NCS Work schedule*	*CAPS*
Grade 9: LO 1: Scientific Investigation AS: 1. Learner plans a procedure to test predictions or hypotheses, with control of an interfering variable. 2. Learner contributes to systematic data collection, with regard to accuracy, reliability and the need to control a variable. 3. Learner seeks patterns and trends in the data collected	*Grade 9:* *Properties and uses of Materials:* 1. Substances in different states or phases have distinct properties. 2. A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. 3. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration,	*Grade 9: Term 1*: 1. The particle model of Matter, 2. Phase changes, Elements and compounds, 3. The periodic Table. 4. Acids and Bases. *Term 3:* 1. Properties of Materials. 2. Compressibility. Activity: Discuss method with which materials can be tested for different properties. Demonstrate the testing of some	*Grade 9: Term 1:* 1. Pure substances. 2. Elements and compounds. 3. Classify substances. 4. Names of elements, symbols, compounds using names of elements from which they are derived. 5. Properties of metals and properties of non-metals. 6. Introduction to the periodic table. 7. Chemical reactions (useful reactions, harmful reactions,

and generalises in terms of simple principles. LO2: Constructing Science Knowledge AS: 1. Learner, at the minimum, recalls principles, processes and models. 2. Learner applies multiple classifications to familiar and unfamiliar objects, events, organisms and materials.	distillation, evaporation, chromatography or magnetism). 4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy.	properties. Categorise materials according to different properties. Discuss how properties of materials are useful knowledge in industry.	acids and bases, anions and cations). 8. Balanced chemical equations. 9. Careers in chemistry, chemical engineering, manufacturing etc.

In Table 2 I show how I summarised the Matter and Materials statements across the three curriculum documents to simplify the process of analysis.

Table 2: Summarised statements: Comparison of subtopics in the topic Matter and Materials between curriculum documents

Learning Outcomes and Assessment Standards	*National Curriculum Statement*	*NCS Work schedule*	*CAPS*
 1. Learner tests predictions and hypotheses 2. Generic Statement/GS 3. GS 1. GS 2. GS 3. Learner hypothesizes possible relationships between variables 4. GS 1. Learner investigates of different explanations offered	*Grade 9:* 1. Phases of Matter 2. Pure substances and Mixtures 3. Properties of Matter 4. Separation of Gases from the Air 5. Properties of Gases 6. Chemical Reactions 7. Raw Materials 8. Environmental costs from the mining of Raw Materials 9. Land and Water usage for the growing of Raw Materials	*Grade 9:* 1. Particle model of Matter 2. Phase changes, Elements and compounds, 3. The periodic Table. 4. Acids and Bases. 1. Properties of Materials. 2. Compressibility	*Grade 9:* 1. Pure substances. 2. Elements and compounds. 3. Classify Substances. 4. Names of elements, symbols and compounds. 5. Properties of metals and non-metals. 6. Periodic table. 7. Chemical reactions 8. Chemical equations. 9. Careers in chemistry

by the Natural Sciences 2. GS			

<ins>*The method of analysis*</ins>

As mentioned in Chapter two, I utilised and developed six concepts from the theory and literature I examined. These concepts are: Depth, Curriculum Focus, Curriculum Ordering, Classification (++)(--), Classification (+)(-) and Breadth. As also mentioned before, I analysed each statement in terms of whether the statement was generic (GS), relevant to other subjects in the curriculum or science specific. For effective data analysis, I developed a scale for each concept. Below I will indicate what these categories are as well as provide statements from curricula as examples of how I coded the data using the categories in the analysis.

The two categories for Depth are ***Greater Depth (+)*** and ***Less Depth (-)***. Greater Depth is achieved in the curriculum when bigger concepts and particularities are visible in curriculum statements within a grade or within a phase. An example of greater depth is: *Definition of Matter; Phases of Matter; Particle Model of Matter; (NCS Work schedule, Natural Science, Grade 7).* The example shows greater depth, because all three statements build upon an understanding of Matter as a concept. The *Particle model of Matter* can be seen as a bigger concept of which the *Definition of Matter* and the *Phases of Matter* are small particularities enabling greater depth into understanding the bigger concept: *Particle model of Matter.* In turn, the *Particle Model of Matter* and *Phases of Matter* are small particularities of the bigger concept, *The Definition of Matter.* Less Depth is achieved in the curriculum when bigger concepts are not accompanied by particularities (or vice versa) in curriculum statements within a grade or within a phase. An example of less depth is: *Properties of Materials; Practical uses of Materials; Mixtures of paints and colours (NCS, Natural Science, Foundation phase Grade 1-3).* This example shows less depth, because *Mixtures of paints and colours* have no visible connection with *Properties of Materials* and *Practical uses of Materials.* The two statements, *Properties of Materials* and *Practical uses of Materials* do complement each other by being small particularities and bigger concepts of each other. However, with no definition of Materials and no visible connection being made between Materials and Matter; this chain of knowledge shows less depth in terms of the topic Matter and Materials in the Foundation Phase.

The three categories for Curriculum Focus are ***Content, Concepts*** and ***Skill***. Content is a defined body of knowledge that is specific to a particular subject and needs to be taught in the right order and at the right pace for it to enable the correct understanding of the concepts found in the relevant body of knowledge (Muller, 2006). An example of content is: *The Atom (NCS Work schedule, Natural Science, Grade 7).* A concept is a particular idea or ideas that are central to a defined body of knowledge and can best be understood with reference to the body of knowledge that the concept forms a part of (Muller, 2006). An example of a concept is: *Structure of Matter- Protons, Neutrons and Electrons (NCS Work schedule, Natural Science, Grade 7).* A skill is demonstrated when learners are "...able to do science or use the epistemic operations of science..." (Green & Naidoo, 2006:75). An example of a skill is: *Learner tests predictions and hypotheses (NCS, Natural Science LO1, AS1, Grade 9).* Curriculum focus considers which of these three knowledges are dominant- content, concepts or skills.

The two categories for Curriculum Ordering are ***Vertical Development (+)*** and ***Horizontal Development (-)***. Vertical Development is achieved when concepts visibly progress from a level of lower cognitive understanding to a level of higher cognitive understanding in a process of building upon each other to deepen understanding. An example of vertical development is: *Elements and compounds, Classify Substances, Names of elements, symbols and compounds, Properties of metals and non-metals, Periodic table (CAPS, Natural Science, Grade 9).* This particular example is vertical development, because the concepts follow each other in an order from lower to higher cognitive understanding. The concept *The Periodic Table* is preceded by the concepts *Elements and Compounds, Names of elements, symbols and compounds etcetera;* all these concepts are stepping stones to understanding the concept of *The Periodic Table* better, because all these concepts are found on the periodic table. These concepts thus build upon each other towards the last concept, *The Periodic Table*, to enable in-depth understanding. Horizontal Development is visible when concepts do not progress from a level of lower cognitive understanding to a level of higher cognitive understanding across curriculum statements. An example of horizontal development is *Melting, Evaporation, Condensation, Solidification, Sublimation, Diffusion (NCS Work schedule, Natural Science, Grade 8).* This particular example indicate horizontal development, because all the concepts are given, but there are no content indicated with the concepts in the framework that link the concepts and thus make them follow a particular order that enables an in- depth understanding of the individual concepts.

The concept of classification was used in two ways. One considered the boundaries between natural sciences and other subjects. The other considered the boundary between science knowledge and everyday knowledge. In relation to the boundary between subjects, two possibilities exist: ***Strong Classification (C++)*** and ***Weak Classification (C--)***. Strong classification refers to a state in curriculum documents when the boundary between natural sciences and other subjects are clear. (Bernstein, 1975). An example of strong classification is: *Phases of Matter (NCS Work schedule, Natural Science, Grade 6).* This example only refer to natural sciences in the General Education and Training Phase and to no other subject within this phase. Weak classification refers to a state in curriculum documents when the boundary between natural sciences and other subjects are not clear. (Bernstein, 1975). An example of weak classification is: *Raw materials, from which processed materials are made, must be mined, grown or imported from other countries (NCS, Natural Science, Grade 9).* This statement can relate to Natural Sciences, Geography and even to Economic Management Sciences (EMS), the boundary between natural sciences and other subjects are thus not clear.

In relation to the boundary between knowledges, two possibilities exist: ***Strong Classification (C+)*** and ***Weak Classification (C-)***. Strong Classification refers to a state in curriculum documents where the boundary between science knowledge and everyday knowledge is clear (Bernstein, 1975). An example of strong classification is: *Properties of Matter and Materials (CAPS, Natural Science, Grade 7).* The statement in this example show no suggestion of using everyday knowledge when teaching this statement. Weak Classification refers to a state in curriculum documents where the boundary between science knowledge and everyday knowledge is not clear (Bernstein, 1975). An example of weak classification is: *Name and describe different features of materials in immediate surroundings (NCS Work schedule, Natural Science, Grade 6).* The statement in this example refer to everyday knowledge by referring teachers and students to materials in their immediate surroundings.

The two categories for Breadth are ***High Breadth (+)*** and ***Low Breadth (-)***. High Breadth is when there are many sub-topics to be covered for one specific topic in a grade or phase. An example of high breadth is: *1. Substances in different states or phases have distinct properties.*
2. A pure substance cannot be separated into different substances, while a mixture can be separated,

usually by physical means.

3. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism).

4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy.

5. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them.

6. Extracting useful materials from raw materials depends on chemical reactions and methods of separation.

7. Raw materials, from which processed materials are made, must be mined, grown or imported from other countries

8. Raw materials that are mined are non- renewable and mining has environmental costs.

9. Growing raw materials involves choices about the use of arable land and water catchment areas.

10. A particle model of Matter can explain physical changes of substances such as melting, evaporation.

11. Many household substances are acidic or basic.

12. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours.

13. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates.

14. Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen.

15. Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed proportions.

16. Elements may react to form compounds, and compounds may be decomposed into their elements.

17. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound.

18. Oxygen has characteristic reactions with metals and non-metals, forming oxides.

19. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen.

20. The reaction of oxygen with food releases energy in the cells of living things (NCS, Natural Science, Grade 9).

The example above show high breadth, because there are twenty statements to cover in this one particular grade.

Low Breadth is when there are fewer sub-topics to be covered for one specific topic in a grade or phase. An example of low breadth is:

1.Pure substances.

2. Elements and Compounds 3. Classify substances.

4. Names of elements, symbols, compounds using names of elements from which they are derived.

5. Properties of metals and properties of non-metals. 6. Introduction to the periodic table.

7. Chemical reactions (useful reactions, harmful reactions, acids and bases, anions and cations).

8. Balanced chemical equations.

9. Careers in chemistry, chemical engineering, manufacturing etc. (CAPS, Natural Science, Grade 9).

The example above show low breadth, because there are only nine statements to cover in this particular grade. Table 3 is a summary of the six categories and their dimensions for measurement.

Table 3: Summary of categories and dimensions for measurement.

Depth: A defined body of subject knowledge that consists of small particularities and big concepts. Depth in a subject is visible when these particularities lead to bigger concepts or bigger concepts are followed by small particularities that explain the bigger concept (Schmidt et al; 2005).	Greater Depth(+): Is achieved in the curriculum when bigger concepts and particularities are visible in curriculum statements within a grade or within a phase.
	Less Depth (-): Is achieved in the curriculum when bigger concepts are not accompanied by particularities (or vice versa) in curriculum statements within a grade or within a phase.
Curriculum Focus: A stipulation in curriculum statements that guide a reader to focus on skills, concepts or content.	Content: A defined body of knowledge specific to a particular subject that needs to be taught in the right order and at the right pace for it to enable the correct understanding of the concepts found in the relevant body of knowledge (Muller, 2006). Concept: A particular idea or ideas central to a defined body of knowledge that is best understood with reference to the body of knowledge that the concept forms a part of (Muller, 2006).
	Skill: "...being able to do science or use the epistemic operations of science..." (Green & Naidoo, 2006:75).
Curriculum Ordering: The sequence of subtopics within a topic that show progression of hierarchically related concepts in the curriculum	Vertical development(+): Is achieved when concepts visibly progress from simple to complex across curriculum statements.

(Hoadley & Muller, 2009).	Horizontal development(-): Is visible when concepts do not progress from simple to complex across curriculum statements.
Classification(++)(--): This refers to the nature of the boundary between science and other subjects in the school curriculum (Bernstein, 1975).	Strong Classification (C++): Boundaries between natural sciences and other subjects are clear. (Bernstein, 1975). Weak Classification (C--): Boundaries between natural sciences and other subjects are not clear. (Bernstein, 1975).
Classification (+)(-): This refers to the nature of the boundary between science knowledge and everyday knowledge.	Strong Classification (C+): Boundaries between science and topics within everyday knowledge is clear (Bernstein, 1975). Weak Classification (C-): Boundaries between science and topics within everyday knowledge is not clear (Bernstein, 1975).
Breadth: Refers to the total number of sub-topics or content that needs to be covered for one specific topic in a curriculum document.	High Breadth (+): When there are many sub-topics to be covered for one specific topic in a grade or phase. Low Breadth(-): When there are fewer sub-topics to be covered for one specific topic in a grade or phase.

After developing these concepts and their various categories, I used them to analyse the data I extracted from the three curriculum documents. In the following chapter I discuss my analysis and findings during this particular process of my research.

CHAPTER 5: Analysis

5.1 The nature of Matter and Materials statements in Curricula

In order to analyse the three curricula documents previously mentioned, I devised codes based on literature concerned with the ordering and specification of knowledge in curricula. The first set of codes focused on the nature of the statements in the Natural Science content framework for Matter and Materials across curricula documents. The National Curriculum Statement (NCS) had a total number of 150 statements in the Matter and Materials content framework. Of these, 60 statements were Learning Outcomes and Assessment Standards and 90 statements were based on actual content prescribed for Matter and Materials Grade R to Grade 9. The National Curriculum Statement Work Schedule had 64 statements and the Curriculum and Assessment Policy Statement (CAPS) had 37 statements to be coded.

For my first analysis, statements were coded as either generic, relevant to other subjects in the curriculum or specific to the topic of Matter and Materials in Natural Sciences. A generic statement was defined as a statement that related to generic skills such as critical thinking or problem solving that could relate to any subject in the curriculum. Generic statements were predominantly found in the Learning Outcomes and Assessment Standards prescribed in the NCS curriculum. Some examples of statements coded as generic are:

1. "[L]earner uses materials selected by the group in order to communicate the group's plan;
2. [L]earner participates constructively in the activity with understanding of its purpose;
3. [L]earner explains and reflects on what action was intended, and whether it was possible to carry out the plan" (NCS, Natural Science, Grade 3, LO1, AS 1,2,3).

As can be seen from the three examples listed above, the focus of generic statements are skills learners need to develop during and after certain content knowledge had been taught. They are thus generic in that they can apply to any subject in the curriculum. Example one, two and three can easily be used for the purposes of testing skills in subjects such as Technology, History and even Economic Management Sciences respectively.

A statement relevant to other subjects in the curriculum was defined as a statement that was based on content knowledge (not skills) that could relate to any science in the curriculum as well as any other subject such as Natural sciences, the Social sciences, as well as any of the four topics in the Natural sciences content framework (Matter and Materials, Earth and Beyond, Life and Living, Energy and Change). An example of this type of statement is:

1. "[R]aw materials that are mined are non-renewable and mining has environmental costs" (NCS, Natural Science, Grade 8).

The example above could easily relate to the subject of Geography which focuses specifically on the natural environment, or the topic of pollution in the Natural Sciences topic, Energy and Change that deals with pollution in relation to non-renewable and renewable fuels and mining as a method of extracting fossil fuels from the earth. This statement even relates to Life Orientation where it could be dealt with through the topic of careers in environmental conservation, the social effects of mining on communities and the various dangers that relates to working in the mining industry.

Many of the statements that were coded relevant to other subjects in the curriculum were statements that could also relate to Technology. These statements teased out a practical aspect of Natural science and quite often referred to the technological advantages or disadvantages of science for people in different types of communities. An example of such a statement is:

1. "Materials produced in local industries (factories, clothing, utensils, building technologies)" (CAPS, Natural Science, Grade 7).

This example focuses on the actual production of materials in local industries. Properties of materials, understanding those properties as well as the function of materials in society was generally the focus of the topic materials in Matter and Materials. In the example above however, the focus was on how these materials are produced, where they are produced and different types of materials that move through the production process as well as materials used for building different types of structures. The focus on 'production of materials' and 'building materials' related more to Technology and seemed to fit into the field of Engineering which is a practical aspect of science.

A statement that was coded specific to the topic of Matter and Materials in Natural Science was defined as one that specifically and only related to the topic of Matter and materials in the Natural Sciences content framework, for example:

1. “[M]odels in science: atoms and molecules, [M]ovement of particles” (CAPS, Natural Science, Grade 8).

It was clear from this example that this statement belonged either to Physical Sciences or the topic of Matter and Materials in the Natural Sciences and could thus be coded as topic specific. The statement above would also find no relevance in any other subject in the curriculum.
The following table shows the results of the coding of all 251 curriculum statements in the analysis.

Table 4: Generic Statements/ Subject Related Statements/ Topic specific Statements

Curriculum document	NCS	NCS Work schedule	CAPS
Total percentage Generic statements	38%	0%	0%
Total percentage subject related statements	10%	6%	16%
Total percentage topic specific statements	52%	94%	84%
Total number of statements	150	64	37

As mentioned before and as can be seen in the table above, the NCS had a total number of 150 statements. Of these statements, 38% were coded as generic, 10% were coded as subject related and 52% were coded as topic specific. This was different to the NCS Work schedule that had a total number of 64 statements of which 6% were coded as subject related and 94% were coded as topic specific. None of the statements in the NCS Work schedule were coded as generic. The CAPS had a total number of 37 statements, 16% of these statements were coded as subject related and 84% were coded as topic specific. None of the statements in the CAPS were coded as generic.

Discussion

When analysing Table 3, it is easy to identify the vast changes that have occurred in the content framework for Matter and Materials. The first change of note is the reduction in the total number of statements from the NCS, to the NCS Work schedule and then later on to the CAPS. This change was predominantly brought about as a result of the Learning Outcomes and Assessment Standards, which were prescribed for teachers to cover and which had to be read in conjunction with the content framework, being eliminated from the NCS. This elimination led to a fewer number of statements in the NCS Work schedule as well as no generic statements in the NCS Work schedule, because all the generic statements in the NCS were predominantly Learning Outcomes and Assessment Standards. As a result, the NCS Work schedule has less statements or content to cover and is also a bit simpler to work through as a result of the above mentioned elimination. In the CAPS, the total number of statements were further reduced (by more than 50%), which could potentially make the content framework clearer (in relation to Natural Science) to work through for teachers especially, because there are no generic statements and more than 80% of the content framework focuses specifically on Matter and Materials.

Another clear shift is the fact that even though the CAPS has less statements than the NCS Work schedule, a higher percentage Matter and Materials statements were coded subject related and a lower percentage Matter and Materials statements were coded topic specific in the CAPS than in the NCS Work Schedule. As I analysed the table above to understand this shift, I observed that the 16% statements that were coded subject related in the CAPS focuses either on careers in chemistry or materials, as well as the advantages/disadvantages of indigenous knowledge and improvements made to scientific knowledge that are labeled indigenous, as well as the relationship science has with technology, as mentioned before. To illustrate this point, I have given three examples below that indicate these foci respectively:

1. "Careers in chemistry, chemical engineering, manufacturing etc." (CAPS, Natural Science, Grade 9).
2. "Indigenous knowledge: use of interactions between materials such as making beer" (CAPS, Natural Science, Grade 8).
3."Materials produced in local industries (factories, clothing, utensils, building technologies)" (CAPS, Natural Science, Grade 7).

As mentioned before, most of these statements teases out a practical aspect of science. Example one focuses on what students could do with the stream of science they are learning about at school level and how science apply to the day-to-day world around us. Example two focuses on traditional beer making practices and how this knowledge can be labeled scientific knowledge even though it is not commonly known as such, and example three's focus is on the production of materials in local industries, as discussed previously. These types of statements indicated that there seemed to have been a need to focus on the practicality of science in ways that stem from the emphasis on 'relevance' in Curriculum 2005. Although the specification of science has been strengthened, the relation to the domain of everyday life and the world of work has been retained.

For the intermediate phase of the CAPS, Natural Science and Technology were integrated. The underlying purpose of this, as set forth in the CAPS, is to ensure a smooth transition between the two subjects and allow teachers and learners alike, to recognise and understand the inter-connectedness of the two subjects as well as its relevance to daily life. The CAPS also stated that the integratedness of these two subjects is to enable an easier transition into learners managing Natural Sciences and Technology individually in the senior phase (CAPS, Natural Science, Intermediate Phase, 2011). The fact that a higher percentage statements were coded subject related as a result of their relevance to Technology in the CAPS than in the NCS Work schedule, was thus also predominantly due to the integration of Natural Sciences and Technology in the CAPS Intermediate Phase and the above mentioned reasons for this integration, as set forth in the CAPS. It is to this extent that the NCS Work schedule and the CAPS had a greater number of statements that were coded specific to the topic of Matter and Materials and the NCS had a greater number of statements that were coded generic, predominantly as a result of the Learning Outcomes and Assessment Standards, which could relate to any subject in the NCS.

5.2 Depth

Depth was defined as a body of subject knowledge that consists of small particularities and big concepts. It was visible in a subject when particularities either led to bigger concepts or bigger concepts were followed by small particularities that explained the bigger concept (Schmidt et al; 2005). For this analysis, a statement was coded as either having Greater depth(+) or Less depth(-). Greater depth was recognised as an achievement in the curriculum when bigger concepts and particularities were visible in Matter and Materials statements within the same grade for the NCS Work schedule and the CAPS or within the same phase for the NCS. Less depth was recognised in curricula documents when bigger concepts were not accompanied by particularities (or vice versa) within the same grade for the NCS Work schedule and the CAPS or within the same phase for the NCS. The reason why the NCS was coded according to a phase whereas the NCS Work schedule and the CAPS were coded according to a grade was, because of the way the Matter and Materials content framework for each were ordered in the three curricula documents. The NCS content framework spun over and through a phase whereas the content frameworks of the CAPS and the NCS Work schedule spun over and through a grade. An example of a grade where statements were coded as having Greater Depth in curricula documents are:

"1. Properties and uses of matter and materials.
2. Factors which determine the suitability of materials for specific uses.
3. Materials produced in local industries (factories, clothing, utensils, building technologies).
4. Environmental impact in the production and use of materials (damages caused in accessing materials, their use, waste production and pollution.
5. Properties of a mixture: physical methods of separation, hand sorting, magnetism, sieving and filtration, evaporation, distillation etc.
6. Separation methods: problems of recycling waste materials.
7. Careers in which knowledge of waste materials is important (building, engineering, electronics)" (CAPS, Natural Science, Grade 7).

The content framework for this grade shown in the example above was coded as having greater depth, because there are big concepts and small particularities visible in the content framework. Number one in this framework focuses on the properties and uses of Matter and Materials as individual concepts. In teaching this statement, it is assumed that a general understanding of what Matter and Materials are (and perhaps their relationship to each other), would be discussed together with what the properties and uses for each of these concepts are. Number one was identified as the bigger concepts in the framework. These two big concepts are then accompanied by number two to seven, all of which constitutes of small particularities that enable greater understanding of the bigger concepts. Number two to seven lean more toward being small particularities of the concept Materials than what they lean toward being small particularities of the concept Matter. No specific reason could be found for this other than the fact that the focus of the CAPS Grade seven content framework, was probably planned to be focused more on Materials, rather than Matter and that the focus of Matter in number one was thus planned to be more focused on its relationship to the concept 'Materials'. An example of a grade with statements that were coded as having Less Depth is:

“1. Solids, liquids, gases.
2. Properties (colour, smell, hardness, toughness, flexibility, strength in tension)” (CAPS, Natural Science, Grade 5).

As can be seen, there are only two statements in this grade for Matter and Materials. The first one focuses on the three phases of Matter; solids, liquids and gases. This statement forms a part of small particularities that would enable better understanding of the concept 'Matter', yet Matter as a concept is not visible in this grade. This indicates less depth. The second statement is 'Properties.' Once again, this is a small particularity of the bigger concept 'Materials', yet there are no statements indicating that this bigger concept needs to be taught in Grade 5. In addition to this, there are no explanations as to what should be taught about the concept 'Properties.' Examples of different types of properties are given, but that is the extent of what is indicated regarding the concept. The statements in this grade were thus coded as having less depth. Another example that was coded as having less depth is:

“1. Properties of materials (natural and man-made).
2. Properties of solids, liquids and gases.
3. Air is a real substance (gas), wind is moving air.
4. Energy transfer” (CAPS, Natural Science, Grade 4).

Once again, the first statement in this grade forms a part of the small particularities of the bigger concept Materials, yet there is no indication in this grade that the concept of Materials needs to be discussed on its own. The second statement was also coded as small particularities of the bigger concept Matter, yet there is no indication that Matter needs to be discussed in this grade. The third statement was coded as a small particularity of the second statement, which is also a small particularity of the bigger concept of Matter. The last statement was also coded as a small particularity of statement number two, however, the last statement is not very well specified as to what particularly about 'Energy Transfer' needs to be taught for this Grade. It was assumed that this statement refers to energy transfer between particles of Matter in different phases, but this was just an assumption. It could also be assumed that this statement refers to the definition of energy transfer and the relationship this has to the concept of Matter, but seeing that Matter as a concept is not found in this grade, this assumption could be wrong. This statement was thus not very clearly specified. This grade was coded as having less depth.

The following table show the quantitative data gathered from analysing the 251 statements across the three curriculum documents:

Table 5. Depth across the three curriculum documents

Grade	LO/AS	NCS	NCS Work schedule	CAPS
9	-	+	+	+
8	-	+	+	+
7	-	+	+	+
6	-	+	+	-
5	-	+	+	-
4	-	+	+	-
3	-	+	N/A	N/A
2	-	+	N/A	N/A
1	-	+	N/A	N/A

As can be seen from the table, all the grades in all three curriculum documents were coded as having greater depth except for Grades four, five and six of the CAPS. There is no Matter and Materials content found in the Foundation Phases of the NCS Work schedules and the CAPS, no coding was thus done for these phases. All the Learning Outcomes and Assessment Standards of the NCS were coded as having less depth.

Discussion

The one example mentioned above for the code of less depth is found in Grade four, five and six of the CAPS. The entire Intermediate Phase of the CAPS was coded as having less depth. This pattern seemed 'out of place', especially when viewing it in relation to the NCS Work schedule and the NCS, which were coded as having greater depth throughout the entire content frameworks of Matter and Materials. A possible reason for the code of less depth in the Intermediate Phase of the CAPS could be that the integration of Natural Sciences and Technology in this phase led to less content being included for

Matter and Materials to accommodate the two subjects that have been manipulated into one. Even if this might be the reason though, this reason could still not justify the fact that small particularities were stipulated throughout the Intermediate Phase, yet the bigger concepts of these smaller particularities were only visible and stipulated in the Senior Phase of the CAPS. This indicates a clear lack of Depth in the Intermediate Phase of the CAPS.

Another area where less depth was found was in the Learning Outcomes and Assessment Standards of the NCS. The lack of depth was visible within grades, within phases and across the Grade R to Grade 9 phase. The prescribed skills, set forth in these LO's and AS's that needed to be covered, did not link into each other to form an overall purpose and thus have an underlying foundation as to learners developing them. Each statement seemed to have an individual purpose, but no collective one and it seemed that they had little connection to each other. To illustrate this dis-connectedness further, I will draw on the LO's and AS's for Grade 6 in the NCS. They are:

<u>LO1:Scientific Investigation:</u>

<u>AS:</u>

1. Learner helps to clarify focus questions for investigations and describes the kind of information which would be needed to answer the question.
2. Learner conducts simple tests or surveys and records observations or responses.
3. Learner relates observations and responses to the focus question.

<u>LO2: Constructing Science Knowledge:</u>

<u>AS:</u>

1. Learner, at the minimum, describes the features which distinguish one category of things from another.
2. Learner categorises objects and organisms by two variables.
3. Learner, at the minimum, interprets information by using alternative forms of the same information.

<u>LO3: Science, Society and the Environment</u>

<u>AS:</u>

1. Learner describes similarities in problems and solutions in own and other societies in the present, the past and the possible future.

2. Learner suggests ways to improve technological products or processes and to minimize negative effects on the environment.
3. Learner suggests how technological products and services can be made accessible to those presently excluded (NCS, Natural Science, Grade 6, LO1 AS1,2,3; LO2 AS1,2,3; LO3 AS1,2,3).

When analysing Learning Outcome 3 with its accompanying Assessment Standards, the lack of depth is visible. The first Assessment Standard deals with learners describing problems and solutions in their own and other societies in different stages of history. The second one deals with suggestions to improve technological products and processes as well as suggesting ways to minimize the negative effects of these products and processes on the environment. The skill of describing one phenomena and then later on suggesting ways to improve a different phenomena does not seem to have any link to each other. The third and last Assessment Standard for this Learning Outcome focuses on learners suggesting ways to make technological products and services more accessible to people who are currently excluded from them. This skill is similar to the skill being tested in the first Assessment Standard, thus, once again, showing no depth.

The focus of the first Assessment Standard is any problem and solution in a particular society whereas the remaining two Assessment Standards focus specifically on technological products, processes and services. Assuming that the problems and solutions mentioned in the first Assessment Standard also refer to technological processes, products and services; then some link is created between the focus of the Assessment Standards prescribed for this grade and Learning Outcome three. However, nothing in the NCS, Natural Sciences content framework prescribed for Grade six focuses specifically on technological products, processes or skills. *This shows a lack of visible connection between the content, the Learning Outcomes and Assessment Standards for this grade, as well as a lack of depth in terms of the Assessment Standards for this grade and its accompanying Natural Sciences content*. As for the level of depth in the Matter and Materials content frameworks in the three curricula documents coded, the NCS is the only curriculum that show a lack of depth as a result of the Learning Outcomes and the Assessment Standards. A lack of depth was also coded in the Intermediate Phase of the CAPS and this could be, as mentioned before, as a result of the integration of the subjects Natural Sciences and Technology.

5.3. Curriculum Focus

Curriculum Focus was defined as a stipulation in the curriculum that guided a reader to focus on either skills, content or concepts. A skill was further defined as a stipulation in the curriculum that focused on learners "...being able to do science or use the epistemic operations of science..." (Green & Naidoo, 2006:75). An example of a skill is:

1. "Learner carries out instructions and procedures involving a small number of steps" (NCS, Learning Outcomes and Assessment Standards, Natural Science, Grade 5).

It is quite clear that the statement in the example above does not have any concepts or content that a learner would be required to come to know and understand; it was thus rather coded as a skill a learner would be required to develop in relation to other statements in the curriculum that stipulated Matter and Materials content or concepts.
For this coding, content was recognised as a defined body of knowledge that is specific to a particular subject and needs to be taught in the right order and at the right pace for it to enable the correct understanding of the various concepts within the given, defined body of knowledge (Muller, 2006). An example of a statement that was coded as content is:

2. "The Atom" (NCS Work schedule, Natural Science, Grade 7).

In order to better understand the idea 'content' and 'concept' however, it is important to explain the two, along with their examples, in relation to each other. Thus, a concept was defined as a particular idea or ideas that are central to a defined body of knowledge and can best be understood with reference to the body of knowledge that the concept forms a part of (Muller, 2006). An example of a statement that was coded as a concept is:

3. "*Structure of Matter- Protons, Neutrons and Electrons" (NCS Work schedule, Natural Science, Grade 7).*

Example number one indicates a statement that was coded as content and refers to a defined body of knowledge. 'The Atom' is represented in the curriculum to have a broad body of knowledge filled with various concepts such as protons, neutrons and electrons along with each of their functions. These concepts are central to the defined body of knowledge labeled, 'The Atom.' The second example is thus rightfully coded as concepts, because it consists of different yet interlinked concepts that form a part of the broader body of knowledge labeled 'The Atom' and can best be understood within the spectrum of this body of knowledge.

As a statement in the curriculum however, 'The Atom' can be regarded as both content (a defined body of knowledge) as well as a concept -an idea within a defined body of knowledge that can best be understood with reference to that body of knowledge. It thus has a broad body of knowledge yet contributes to that body of knowledge by being a concept within it as well. Example two however, could only be labeled 'concepts' as it is found in the broader body of knowledge of' 'The Atom', yet does not have a broad body of knowledge on its own. It is in this way and to this extent that concepts and content fitted into each other in curricula documents and for this reason, and the examples highlighted above, concepts and content were analysed as one code in opposition to skills. The quantitative data for this analysis is:

Table 6. Curriculum Focus: Content/Concept/Skill

Curriculum document	NCS	NCS Work schedule	CAPS
Content/Concept	60%	100%	100%
Skill	40%	0%	0%
Total number of statements	150	64	37

As can be seen from the table, all the statements in the NCS Work schedule and the CAPS were coded as content/concepts and both curricula had no statements that were coded as skills. The NCS however, had 40% statements that were coded as skills and 60% statements that were coded as content/concepts.

Discussion

The difference in this analysis between the NCS, the NCS Work schedule and the CAPS, is the Learning Outcomes (LO's) and the Assessment Standards (AS's). As a result of these, there were 40% statements coded as skills in the NCS. The remaining statements in the content framework of the NCS were all coded as content/concepts.

The Revised National Curriculum Statement define Learning Outcomes as the operations learners "...must be able to do on a certain range of scientific knowledge" (RNCS 2002:6). The Learning Outcomes focus on a learners' ability to use scientific knowledge and not just acquire it. It was thus intended that the three Learning Outcomes for the learning area Natural Sciences are used to "...assess progress in a learners' ability to plan and carry out investigations involving knowledge, and the ability to interpret and apply that knowledge in classroom situations as well as in situations affecting the learner as a member of a changing society" (RNCS, 2002:6). The three Learning Outcomes for Natural Sciences are:

1. <u>Scientific Investigations:</u> The learner will be able to act confidently on curiosity about natural phenomena, and to investigate relationships and solve problems in scientific, technological and environmental contexts.
2. <u>Constructing Scientific Investigations:</u> The learner will know and be able to interpret and apply scientific, technological and environmental knowledge.
3. <u>Science, Society and the Environment:</u> The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment (RNCS, 2002:6).

In addition to this, the Assessment Standards are ways in which learners can demonstrate their achievement of the Natural Sciences Learning Outcomes. The curriculum stated that "the progress of learners can be seen in their increasing ability to perform at higher levels. These ways of demonstrating the Assessment Standards are policy and learners are to be assessed against these standards" (RNCS, 2002:15). The main purpose of the Learning Outcomes and Assessment Standards in the NCS Curriculum was thus to provide a platform against which learners could demonstrate skills of how to use the knowledge acquired through the Natural Sciences content framework. Another purpose was its usage as a measuring guide for progress in the NCS. The intention was that if used appropriately in a classroom, the progress of learners in terms of content knowledge and skills could be assessed through the application of the Learning Outcomes and Assessment Standards to the content framework provided in the NCS. It is to this extent that the code of skills were found only in the NCS as a result of the Learning Outcomes and Assessment Standards, whereas the NCS Work schedule and the CAPS had no statements coded as skills, only statements coded as content/concepts. Thus we see a significant shift from a skills to a concept/content based curriculum away from generic statements to a more strongly classified curriculum.

5.4 Curriculum Ordering

The next part of the analysis focused on Curriculum Ordering. Curriculum Ordering was defined as the sequence of subtopics within a topic that showed progression of hierarchically related concepts in the curriculum (Hoadley & Muller, 2009). Vertical development(+) was further defined as a state in curricula documents where concepts visibly progressed from lower cognitive understanding to higher cognitive understanding across curriculum documents. Horizontal development(-) was defined as being visible in curricula documents when concepts did not progress from lower to higher cognitive understanding. An example of a grade that was coded as having Vertical development is:

1. The particle model of Matter,
2. Phase changes, Elements and compounds,
3. The periodic Table,
4. Acids and Bases,
5. Properties of Materials,
6. Compressibility (NCS Work schedule, Natural Science, Grade 9).

The example above show statements with regards to Matter and Materials that move from lower to higher cognitive understanding. Number two, 'Phase changes of Matter' and 'Elements and compounds', is more complex to understand than the first statement which is the 'Particle model of matter'. Number one thus enables a better, clearer understanding of number two. On the 'Periodic table', which is statement number three, there are elements and compounds (number two) and the idea of elements and compounds is simpler to understand than the idea of the periodic table. The fourth statement, 'Acids and bases' can also be discussed and understood better once the periodic table has been dealt with as acids and bases can either be found on the periodic table or they can be created by mixing the elements on the above mentioned table. Statement number five is a simpler statement to understand than statement number six, because 'Compressibility'(statement six) is one property of a specific type of material, and 'Properties of materials' (statement five) are discussed in statement number five. 'Properties of Materials' thus enable a better, clearer understanding of 'Compressibility.'

Two instances were coded as having horizontal development (-). The first instance is:

1. Properties of Materials (3 classes).
2. Three phases of Matter.
3. Boiling point.
4. Melting Point.
5. Define: Appearance, Flexibility, Hardness, Solubility, Heat Conduction, Heat Insulation, Magnetism.
6. Describe different properties of materials.
7. Properties of Materials in three classes (metals, polymers and ceramics).
8. Heating and Cooling can change materials.
9. Define; thermal heating, properties of solids(holds its own shape, has mass and fixed volume), liquids(takes shape of container, has mass and fixed volume) and gases(no fixed shape, has mass but no fixed volume) respectively.
10. Heating, Cooling, Contraction, Melting, Evaporation, Condensation, Temporary and Permanent changes.
11. Differences between Mixtures (any two substances mixed together) and Solutions(mixture of a soluble substance in a liquid).
12. Define: Soluble, Insoluble, Decant, Filter and Distill, Solutions.
13. Define; Solute, Solvent, Solution, Soluble, Temperature (NCS Work schedule, Natural Science, Grade 5).

The second instance is:

1. Revise Materials and their properties.
2. Changes in Mixtures.
3. Matter and Materials (difference between them).
4. Rusting.
5. Magnetism.
6. Electrical Conduction.
7. Insulation.
8. Solubility and Composite Materials.
9. Properties of metals, ceramics and plastics.
10. Phases of Matter.

11. Absorbed energy.

12. Released energy.

13. Evaporation.

14. Particle model of Matter (spaces, movement energy and forces between particles).

15. Features that distinguish a solid, liquid and gas from one another.

16. Define temporary phase change and permanent phase change, melting and solidification.

17. Define: Substance, Condensation, Evaporation, Separation, Solidification, Distillation and Crystallisation.

18. Separation of Solutions.

19. Define: Boiling point, Melting Point, Thermometer.

20. Units of Measuring temperature (NCS Work schedule, Natural Science, Grade 6).

The first observation from both instances, which were coded as having horizontal development (-), is the fact that both grades have an overwhelming amount of statements. Apart from this, most of the statements do not follow each other in an order from lower cognitive understanding to higher cognitive understanding. In the first example, Grade five, statements three and four focus on 'Boiling point' and 'Melting point' which links to statement two (Phases of Matter), yet the link is indirect and not directly from a state of simpler understanding to a more complex understanding. This means that even though 'Melting Point' and 'Boiling Point' link to 'Phases of Matter', teaching the phases of matter and then melting point and boiling point immediately after that would be a jumping crucial features of 'Phases of matter' that are not made clear or suggested in the order of the content framework for this grade. An example of omitted features of Phases of Matter would be the Particle model of Matter. Here, it is the duty of the teacher to make the connections between these statements. Another jump occurs between statement number one and statements number five, six and seven. Number one focus on 'Properties of Materials', number five on different definitions of certain properties of materials, number six focus on describing certain properties of materials and statement number seven is similar to statement number one. These statements all link to each other, yet there are three statements that deal with the phases of matter in between them. These statements are thus not directly ordered in a manner from a lower to a higher cognitive understanding, especially because number one and number seven are the same statement and there is no indication that number seven is revision of number one. It is thus ordered from lower to higher to lower cognitive understanding again. Statement number eleven deals with 'Mixtures and solutions', this is a statement of higher cognitive understanding that has no statement with lower cognitive understanding leading to a better, clearer understanding of mixtures and solutions preceding it. This statement is followed by two statements focusing on definitions that could enable a clearer understanding of the idea of 'Mixtures and Solutions.'

Similar to some statements in Grade five, Grade six have many one word statements such as Rusting, Magnetism etc. that are not directly linked to the statement before them in terms of understanding. Individually they make sense in terms of Matter and Materials, but they are not linked to the broader knowledge base of which they form a part in the content framework. Grade six also have a few statements that indicate the idea of defining certain concepts that are found in the knowledge base of Matter and Materials. These statements are problematic in the sense that some teachers may just focus on defining the concepts (especially, because that is what the statements indicate they must do), without linking them to the statement before or after the statement that indicate to define a statement. It is thus left to teachers to make the connection. This grade was thus also coded as having horizontal development. The quantitative data gathered from analysing the 251 statements across the three curriculum documents is:

Table 7. Curriculum Ordering across the three curriculum documents.

Grade	LO/AS	NCS	NCS Work schedule	CAPS
9	-	+	+	+
8	-	+	+	+
7	-	+	+	+
6	-	+	-	+
5	-	+	-	+
4	-	+	+	+
3	+	+	N/A	N/A
2	+	+	N/A	N/A
1	+	+	N/A	N/A

As can be observed from the table above, the Learning Outcomes and Assessment Standards in the NCS were coded to have Horizontal development (except for the Foundation Phase of the NCS).

Grade five and six of the NCS Work schedule were also coded to have Horizontal Development. The CAPS and the NCS content framework were both coded to have Vertical Development.

Discussion

It becomes clear, from the coding of Curriculum Ordering, that the content frameworks of the NCS, the CAPS and the NCS Work schedule (except for two grades in this framework), is vertically developed in terms of its knowledge base and structure. One of the reasons for this, from my perspective, is the fact that Matter and Materials in Natural Sciences forms a part of the broader, very specified and very rigid vertical knowledge structure of the subject Physical Sciences. From the level of the University, to the FET level, Physical Sciences is well demarcated from other subjects and sciences, it is well specified and it also projects a language that is specific to the subject. This filters through to the GET Phase for Matter and Materials in terms of the structure of the knowledge in the subject, because the statements were very ordered in terms of Vertical Development, except for the two grades in the NCS Work schedule. In the NCS, the code for Horizontal Development stems from the Learning Outcomes and the Assessment Standards. Grade four to Grade nine was coded to have Horizontal Development whereas Grade one to Grade three was coded to have Vertical Development. Similar to the lack of depth found in the LO's and AS's, there was also no particular hierarchical order found in them, an order that shows progression and one level of skill leading into another deeper level of skill. A hierarchical order moving from lower cognitive understanding to higher cognitive understanding was found; however, in the Natural Sciences Learning Outcomes and Assessment Standards for Grade one to Grade three. It is to this extent that most of the Matter and Materials content frameworks are vertically developed and the reason for the evident horizontal development in the NCS is due to the Learning Outcomes and Assessment Standards.

5.5 Curriculum Classification
5.5.1 Classification between subjects

The first code of Classification was defined as the nature of the boundary between science subjects (specifically the topic of Matter and Materials in science) and other subjects (Bernstein, 1975). It is important to mention that 'science' in this definition (as it referred specifically to the topic of Matter and Materials) referred only to the two scientific subjects Natural Sciences and Physical sciences, because the topic of Matter and Materials can only be found in the content frameworks of these two subjects. The code of classification was further broken down into strong classification (C++) and weak classification (C--). Strong classification referred to a state where the boundary between science and other subjects was clear and weak classification referred to a state where the boundary between science and other subjects was not clear. Two examples of statements that were coded as strong classification are:

1. "A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means" (NCS, Natural Science, Grade 9).
2. "Elements and Compounds" (CAPS, Natural Science, Grade 8).

Example number one relates to Matter and Materials in Physical Sciences and Natural Sciences only. This statement does not refer to any other subject in the curriculum. For this reason, it was coded as strongly classified, because the boundary between science and other subjects were clear. Similarly, example two was coded as strong classification, because elements and compounds only refers to the topic of Matter and Materials in science and it refers to no other subject in the curriculum. Two examples of weak classification are:

1. "Indigenous knowledge: use of interactions between materials such as making beer" (CAPS, Natural Science, Grade 8).
2. "Units of Measuring temperature" (NCS Work schedule, Natural Science, Grade 6).

Example number one was coded as weak classification, because the boundary between the scientific topic Matter and Materials in Physical Sciences and Natural Sciences, and other subjects were weak. The first example can relate to the Social Sciences subject History, in that it refers to indigenous knowledge. History focuses on people in the past and in the present, how these two sets of people lived, the tools they used and also on how these tools have changed over time. The focus on the use of the interactions between materials in making beer can thus also be a statement in the History content framework. Similarly, this same statement can also refer to Technology in terms of how technological processes for making beer have changed over time, from indigenous knowledge to modern-day knowledge and usages. For this reason example number one was coded as weakly classified as it can refer to subjects other than the Natural and the Physical Sciences. The second example, "Units of measuring temperature", can refer to the subject Geography as this subject specifically deals with climatology, temperature, the instruments and units used as well as how to measure the various aspects of the climate such as temperature. This statement can thus definitely form a part of Geography as well as Matter and Materials in Natural Sciences and was thus weakly classified.

The table below show the quantitative data gathered from this analysis:

Table 8. Classification: Nature of boundary between science and other subjects

Curriculum document	NCS	NCS Work schedule	CAPS
Strong Classification (++)	54%	97%	78%
Weak Classification (--)	46%	3%	22%
Total number of statements	150	64	37

As can be observed from the table above, the NCS had 54% statements that were coded as strong classification and 46% statements that were coded as weak classification out of a total number of 150 statements. The NCS Work schedule had a total number of 64 statements, of these 97% were coded as strong classification and 3% were coded as weak classification. In the CAPS, the total number of Matter and Materials statements that had to be coded were 37, of which 78% were coded as strong classification and 22% were coded as weak classification.

Discussion

It is clear from this data that the National Curriculum Statement (NCS) is much more weakly classified than the NCS Work schedule and the CAPS. The NCS Work schedule however, is the most strongly classified curriculum in terms of the boundary between science and other subjects. This means that the nature of the boundaries between the statements for the topic Matter and Materials in Natural Sciences and other subjects is often not clear in the NCS. Thus, 46% of Matter and Materials statements can be used for other subjects or are related to other subjects in the NCS curriculum. This percentage is deeply influenced by the Learning Outcomes and Assessment Standard statements for Matter and Materials in the NCS, most of which can refer to almost any subject in the NCS curriculum. The NCS Work schedule had the highest percentage statements that were coded as strong classification with a higher number of statements for Matter and Materials than the CAPS. The CAPS on the other hand had less statements than the NCS Work schedule, but a lower percentage statements were coded as strong classification. The CAPS is thus less dense than the NCS Work schedule, but as a result of the integrated subject Science and Technology and reasons mentioned previously, the CAPS had a higher percentage statements that were coded as weak classification than the percentage statements coded as weak classification in the NCS Work schedule. Thus, in terms of the nature of the boundary between the topic of Matter and Materials and other subjects, a greater number of statements in the NCS Work schedule had boundaries that were clear, the CAPS had a slightly lesser number of statements that were coded as strong classification with less statements in the Natural Sciences content framework that were in the NCS Work schedule. The NCS had the most statements that were coded as weak classification. The statements that were coded as weak classification in the NCS were predominantly found amongst the Learning Outcomes and the Assessment Standards.

5.5.2 Classification between science knowledge and everyday knowledge

The second part of this analysis also focused on classification, but classification in terms of the nature of the boundary between science knowledge and everyday knowledge. In this definition, science knowledge referred to knowledge about science learners could only learn at school through the means of a national curriculum and its accompanying documentation such as textbooks and assessments. Everyday knowledge referred to knowledge learners could gain through the day-to-day interactions and activities with family or members of the community at home or places they visit in their own time as opposed to during school time. This code of classification was further broken down into strong classification(+) and weak classification(-). Strong classification referred to a strong boundary in Matter and Materials statements between science knowledge and everyday knowledge whereas weak classification referred to a weak boundary in Matter and Materials statements between science knowledge and everyday knowledge. Two examples of statements that were coded as strong classification are:

1. “Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates” (NCS, Natural Science, Grade 9).
2. “The Atom” (NCS Work schedule, Natural Science, Grade 7).

Both examples show a focus on science knowledge and not everyday knowledge. Also, the scientific knowledge proposed by the two statements individually can only be offered by an institution such as a school. Two examples of statements that were coded as weak classification in terms of the boundary between science knowledge and everyday knowledge are:

1. “Learner, at the minimum, uses own most fluent language to name and describe objects, materials and organisms” (NCS, Natural Science, Learning Outcomes and Assessment Standards, Grade 4).
2. “Learner identifies difficulties some people may have in using technological devices” (NCS, Natural Science, Learning Outcomes and Assessment Standards, Grade 4).

The first example is an assessment standard for Matter and Materials and was coded as weak classification. As an assessment standard, this statement primarily refers to a skill that needs to be tested against the content knowledge of Matter and Materials. This statement does not only refer to science knowledge in Matter and Materials however, it also refers to everyday knowledge in that learners need to use their own most fluent language (which is assumed to be the mother tongue of learners), and use this language they learned to speak and understand at home amongst family and community members to name and describe objects, materials and organisms. This is a skill that can be learned and even tested in the personal environment of learners. This statement thus shows a boundary between science knowledge and everyday knowledge that is not clear. The second example, also a skill that needs to be tested against the content knowledge of Matter and Materials, expects learners to identify difficulties some people have when they use technological devices. As this statement does not specify a certain group of people that can be found in a resource book/ specific time and place learned about at school, it is assumed that these people could be identified from the natural surroundings of learners. This statement thus suggests that learners can identify people they know who have difficulties with technological devices, such as their parents who may have difficulties with cellular phones etc. This statement was thus also coded as having a weak boundary between science knowledge and everyday knowledge. The quantitative data for this analysis for the second code of Classification is:

Table 9. Classification: Nature of boundary between science knowledge and everyday knowledge

Curriculum document	NCS	NCS Work schedule	CAPS
Strong classification (+)	96%	98%	78%
Weak classification (-)	4%	2%	22%
Total number of statements	150	64	37

Discussion

As can be observed from the table above, 96% of the statements in the NCS were coded as strong classification and 4% were coded as weak classification out of a total number of 150 statements. In the CAPS, 78% of the statements were coded as strong classification and 22% of the statements were coded as weak classification out of a total number of 37 statements. In the NCS Work schedule, there were 2% of the statements that were coded as weak classification and 98% of the statements were coded as strong classification. Thus, the boundary between science knowledge and everyday knowledge were generally very clear in the NCS, the NCS Work schedule and the CAPS.

5.6 Breadth

Breadth was referred to as the total number of sub-topics or content that need to be covered for one specific topic in curricula documents. High Breadth(+) was recognized as a state in curricula documents where there were many sub-topics to be covered for one specific topic in curriculum documents. Low Breadth(-) was recognised as a state where there were fewer number of sub-topics to be covered for one specific topic in curriculum documents. An example of a grade that was coded as having High Breadth is:

"1.Substances in different states or phases have distinct properties.
2. A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means.
3. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism).
4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy.
5. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them.
6. Extracting useful materials from raw materials depends on chemical reactions and methods of separation.
7. Raw materials, from which processed materials are made, must be mined, grown or imported from other countries.

8. Raw materials that are mined are non-renewable and mining has environmental costs.
9. Growing raw materials involves choices about the use of arable land and water catchment areas.
10. A particle model of Matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction.
11. Many household substances are acidic or basic.
12. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours.
13. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates.
14. Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen.
15. Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed proportions.
16. Elements may react to form compounds, and compounds may be decomposed into their elements.
17. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound.
18. Oxygen has characteristic reactions with metals and non-metals, forming oxides.
19. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen.
20. The reaction of oxygen with food releases energy in the cells of living things" (NCS, Natural Science, Grade 9).

An example of a grade that was coded as having Low Breadth is:

"1. Pure substances.
2. Elements and compounds.
3. Classify substances.
4. Names of elements, symbols, compounds using names of elements from which they are derived.
5. Properties of metals and properties of non-metals.
6. Introduction to the periodic table.
7. Chemical reactions (useful reactions, harmful reactions, acids and bases, anions and cations).
8. Balanced chemical equations. 9. Careers in chemistry, chemical engineering, manufacturing etc." (CAPS, Natural Science, Grade 9).

The two examples listed above both represent Grade 9, one belonging to the NCS and the other to the CAPS. As Breadth refers to the total number of sub-topics within one topic, it is visible from these examples that the first (with 20 Matter and Materials statements to be covered) indicates a state of High Breadth in the NCS Curriculum and that the second (with 8 Matter and Materials statements to be covered) represents a state of Low Breadth in the CAPS curriculum.

The quantitative data gathered from the coding of all 251 statements in this analysis is:

Table 10: Breadth across the three curriculum documents.

Grade	LO/AS	NCS	NCS Work schedule	CAPS
9	-	+	-	-
8	-	+	-	-
7	-	+	-	-
6	-	-	+	-
5	-	-	+	-
4	-	-	+	-
3	-	-	N/A	N/A
2	-	-	N/A	N/A
1	-	-	N/A	N/A

The pattern that can be seen from this analysis is that in the Learning Outcomes and Assessment Standards of the NCS, there is low breadth throughout the Matter and Materials statements. In the content framework of the NCS, there is a pattern from high to low breadth; in the NCS Work schedule there is a pattern from low to high breadth and the CAPS show a pattern of low breadth throughout the Matter and Materials statements. It is also evident from the analysis that the CAPS is the only document that has all its statements coded as having Low Breadth. This means that for Grades 6-9, the Matter and Materials content framework in the CAPS has a total number of statements ranging between eight and thirteen in various grades. All the Learning Outcomes and Assessment Standards were also coded as having Low Breadth, because the total number of LO's and AS's in a grade are generally between three and nine. The Senior Phase of the NCS was coded as having High Breadth whereas the Intermediate and Foundation Phase of the same curriculum was coded as having Low Breadth. The Senior Phase of the NCS Work schedule was coded as having Low Breadth and the Intermediate Phase of the NCS Work schedule was coded as having High Breadth. No Matter and Materials statements are found in the Foundation Phases of the NCS Work schedule and the CAPS. Thus, no coding for Breadth was done in these phases.

Discussion

Two things are important to mention at this time, with regards to this coding. The one is that it was obvious from this coding that the South African curriculum has gone through different phases, and with each phase there have been significant changes. The shift between High breadth and Low breadth in the NCS and NCS Work schedule is evidence of these changes. Another important note to make is the fact that this coding is also evidence of the amount of work in the Intermediate Phase of the NCS Work schedule. The high amount of work in this phase led to the reduction of subjects in the Intermediate Phase of the CAPS as well as the integration of the subjects Natural Sciences and Technology in this phase. Thus, the new Curriculum and Assessment Policy Statement (CAPS) show Low Breadth- less amount of statements in a grade and statements that are more specific to the topic of Matter and Materials- as opposed to the NCS and the NCS Work schedule where some grades were coded as having High Breadth.

Summary

The table and extracts below provide a brief summary of the general findings of my analyses:

CODE	**LO/AS**	**NCS**	**NCS WORK SCHEDULE**	**CAPS**
Depth	Less	Greater	Greater	Less
Curriculum Focus	Skill	Skill	Content/Concept	Content/Concept
Curriculum Ordering	Horizontal(-)	Vertical (+)	Horizontal (-)	Vertical (+)
Classification- the nature of the boundary between science and other subjects (++)(--)	C--	-C-	C++	C++
Classification – the nature of the boundary between science knowledge and everyday knowledge(+)(-)	C+	C+	C+	C+
Breadth	Low	High to Low	Low to High	Low

Depth: The content frameworks of the NCS and the NCS Work schedule were both coded as having Greater Depth. The Learning Outcomes and the Assessment Standards of the NCS were all coded as having Less Depth. The Intermediate Phase of the CAPS was also coded as having Less Depth. This particular code stems from the integration of the two subjects, Natural Sciences and Technology- it seems that less Matter and Materials statements are incorporated into the CAPS Intermediate Phase, because room was needed to merge the Natural Sciences and Technology statements.

Curriculum Focus: The Matter and Materials statements in the content frameworks of the NCS, the NCS Work schedule and the CAPS document are all content or concepts. The Learning Outcomes and Assessment Standards of the NCS are all statements that focus on skills.

Curriculum Ordering: The Matter and Materials content frameworks of the NCS, the NCS Work schedule and the CAPS are Vertically developed. Matter and Materials, as a result of having Physical Sciences as its parent knowledge, is very well specified and has a rigid structure. This ensured its vertical development throughout the shifts and changes in the various curricula. The Learning Outcomes and the Assessment Standards are horizontally developed, Grade five and six of the NCS Work schedule was also coded as being horizontally developed.

Classification (++)(--): The NCS was coded as being weakly classified in terms of the boundary between Natural Sciences and other subjects, specifically as a result of the Learning Outcomes and the Assessment Standards which can relate to almost any subject in the NCS curriculum. Both the NCS Work schedule and the CAPS are strongly classified in terms of the boundary between Natural Sciences and other subjects. Of the two however, the CAPS had the most statements that were coded as weak classification, predominantly as a result of the integration of the subjects Natural Sciences and Technology in the Intermediate Phase.

Classification (+)(-): The Matter and Materials statements in all three curricula documents are strongly classified in terms of the boundary between science knowledge and everyday knowledge. One of the reasons for this is the fact that the parent knowledge of these statements, Physical Sciences, is very well specified and has a rigid structure.

Breadth: The entire Learning Outcomes and Assessment Standards of the NCS has Low Breadth whereas the Senior Phase of the actual content framework in the NCS has High Breadth. Only the Intermediate Phase of the NCS Work schedule has High Breadth and the entire CAPS were coded as having Low Breadth.

In the chapter hereafter, I provide a discussion on my research and conclude this dissertation.

CHAPTER 6: ***Discussion and Conclusion***

Progression

As mentioned before, progression in the curriculum consists of sequence and conceptual demand. Sequence refers to units of knowledge that are represented in a particular order lending structure to a specific subject. Conceptual demand refers to various skills and abilities to be learned that can be plotted hierarchically from lowest to highest levels of complexity and cognitive demand.
As a result of being derived from a vertical knowledge structure, Natural Sciences has specific content in the progression chain and the sequence of how the various units of vertical knowledge is presented and taught is crucial. New knowledge needs to fit into the internal structure of the knowledge of the subject and into the previous knowledge taught, because it will then enable learners to understand the subject as a whole, as well as prepare learners for the new knowledge later in the chain of progression. For vertical subjects such as Natural Sciences, coverage of content is also crucial. The reason for this is, because each unit of knowledge fits into another unit of knowledge by virtue of the verticality of the subject. For students to understand each unit of knowledge more completely, it needs to be directly linked to and built upon the previous unit of knowledge taught (Muller, 2006). If knowledge units are taught in this way it enhances the understanding of the next unit of knowledge to be taught. Lack of coverage thus influence units of knowledge already learned and allow for a limited understanding of subject knowledge and a limited understanding of the overall subject matter. There also needs to be a clear, continuous link between content, concepts and skills (if any are stipulated) in the construction of the curriculum with regards to vertical subjects (Muller, 2006).

The codes in my analyses that indicate progression directly are *Depth, Curriculum Focus* and *Curriculum Ordering.* Breadth and the two codes of Classification also indicate progression, but they do this indirectly. I will thus focus on the first three codes.

Depth: Cognitive Demand, which is one of the aspects of progression, can also be identified through the code of Depth in my analysis. In the assessed curriculum cognitive demand may be analysed in relation to various taxonomies. It is more complex to determine in the intended curriculum, which this study focuses on. When small particularities and big concepts are visible in one grade, that grade is labeled with the code of Greater Depth. Less Depth is visible in a grade when small particularities are not accompanied by big concepts or big concepts are not accompanied by small particularities. Greater Depth in a grade can thus be identified as cognitive demand in a grade, because particularities suggest an elaboration and deeper understanding of a more limited number of topics. Thus, when big concepts are accompanied by small particularities in a grade, there is an indication of lower and higher levels of complexity within the same grade.

The NCS content framework indicated Greater Depth, but Less Depth was indicated in the Learning Outcomes and Assessment Standards. This means that in the Learning Outcomes and Assessment Standards, there was no indication of progression in terms of small particularities and big concepts or different levels of cognitive demand. This indication, once again, hinders progression in the NCS. The NCS Work schedule indicated Greater Depth, progression was thus visible in this curriculum. The CAPS however, showed limited progression in that Greater Depth was indicated in the Senior Phase of the CAPS and Less Depth was indicated in the Intermediate Phase. As mentioned before, this code was influenced by the fact that Natural Sciences and Technology were manipulated into one subject for the Intermediate Phase of the CAPS. The consequence of this act is limited progression in the CAPS, a clear lack of lower and higher levels of cognitive demand as a result of the absence of either big concepts or small particularities in Matter and Materials statements.

It is to this extent that my analysis indicates that the National Curriculum Statement is the one curriculum document that shows limited progression in the Matter and Materials statements for Grade R-9 for the subject of Natural Sciences. The limitation in progression is predominantly as a result of the Learning Outcomes and the Assessment Standards. In the ways mentioned above and in my analysis, they influence the content framework in such a significant manner reducing vertical development and jeopardizing a structure relevant to the scientific subject, Natural Sciences. The actual statements that deal with content are vertically developed, but the High Breadth in the NCS content framework influence the verticality of these statements negatively. As mentioned before content coverage is crucial in vertical subjects, because each unit of knowledge fits into another unit of knowledge by virtue of the verticality of the subject. For students to understand each unit of knowledge more completely, it needs to be directly linked to and built upon the previous unit of knowledge taught (Muller, 2006). Thus, as a result of High Breadth in the NCS, it seems that there could be limited time for teachers to teach each unit of knowledge thoroughly and then get through all the units of knowledge suggested in the curriculum to ensure coverage of content- Natural Sciences is thus negatively influenced by the fact that there are too many statements in the Matter and Materials content framework.

My analysis also indicate that the NCS Work schedule attempted to deal with problems of progression in the NCS, especially with the marginalization of the Learning Outcomes and the Assessment Standards. The Matter and Materials content framework in this curriculum is focused on content/concepts, it has predominantly Low Breadth and it is vertically developed, except for two grades in the Intermediate Phase. These two grades and their horizontal development, does influence the content framework negatively.

The CAPS seem to be the strongest curriculum in terms of vertical development, for the Matter and Materials statements of Natural Sciences. It is vertically developed, it indicates an overall Low Breadth and it is content/concept driven instead of skills driven. These three aspects make it the curriculum that has been best designed to meet the needs of a vertical subject, of all the three curriculum documents analysis is based on. The one flaw in the design of the CAPS however, is the fact that the Intermediate Phase has Low Depth- there is either a lack of small particularities, a lack of big concepts or both in this phase. The over-arching reason for this is the subject Technology and Natural Sciences being merged into one subject for this curriculum. One of the main purposes for doing this, as explained in the 2009 Review of the NCS, is the fact that in the NCS and the NCS Work schedule, there are too many subjects in the Intermediate Phase- students literally move from having three learning areas in the Foundation Phase to eight in the Intermediate Phase. **Of these eight, two learning areas are further divided into two subjects or parts. The learning area Languages, is divided into English Home Language and First Additional Language, and the learning area Social Sciences is divided into Geography and History. Essentially, this makes it ten subjects in eight learning areas for the Intermediate Phase of the NCS and the NCS Work schedule. It was acknowledged that the jump in number of learning areas from the Foundation to the Intermediate Phase is too big, learning areas were thus reduced. A consequence of this is the merged Natural Sciences and Technology subject.** Low Depth is thus indicated in the Intermediate Phase predominantly, because certain Matter and Materials statements are left out of the content framework to make space for Technology. This is a design flaw that impacts the verticality of the subject Natural Sciences negatively. As a result of this particular design flaw, the NCS Work schedule becomes the curriculum that is the strongest in terms of vertical development and depth, because the NCS Work schedule only has two Grades (Grade 5 and Grade 6) that are horizontally developed whereas the impact of the integration of Natural Sciences and

Technology run throughout the Intermediate Phase of the CAPS.

Curriculum Focus: The foci of both the NCS Work schedule and the CAPS are content and concepts. The focus of the NCS however, is content/concepts and skills. As mentioned above, cognitive demand refers to various skills and abilities to be learned that can be plotted hierarchically from lowest to highest levels of complexity and cognitive demand. When cognitive demand in curriculum statements move from lower to higher levels, we can argue that there is visible progression in the statements. When they do not move from lower to higher levels of cognitive demand, we can argue that there is no visible indication of progression in the curriculum. According to this, there is no indication of progression in the NCS. Even though there is an indication of skills and content/concepts, the fact that the Learning Outcomes and the Assessment Standards do not move in a hierarchical order from lowest to higher cognitive demand, as shown in my analysis, show that there is a lack of progression in the NCS. There is also no indicated links between the prescribed skills for grades and the prescribed content for grades. The lack of these connections between the skills and the content in the curriculum also indicate that the curriculum itself show a lack of progression, specifically because progression in terms of the content knowledge is supposed to be indicated by the Assessment Standards. There is a greater indication of progression in the NCS Work schedule and the CAPS. In these curricula, there is only a focus on content/concepts. The main indication of progression in these curricula however, is the fact that the sequence of Matter and Materials statements are mostly vertically developed in the NCS Work schedule (Grade 5 and Grade 6 are horizontally developed) and 100% vertically developed in the CAPS.

Curriculum Ordering: The sequence of subtopics in the Matter and Materials content framework of the NCS has vertical and horizontal development. The content framework is vertically developed, but the Learning Outcomes and Assessment Standards- which are a crucial part of the NCS- are horizontally developed. As a result of the importance and emphasis of these Learning Outcomes and Assessment Standards for the NCS, I argue that the National Curriculum Statement is horizontally developed in terms of the topic of Matter and Materials. The Learning Outcomes and Assessment Standards are developed horizontally: there is no continuous link between the skills and the content/concepts prescribed for the specified grades; the skills prescribed in the NCS also do not build upon each other or fit into each other to form a coherent internal structure. As mentioned in the analysis, individually the skills make sense, but collectively they appear as random skills scattered across the content framework. The skills in the NCS are thus horizontally developed and as a result of this, they influence the content framework for Matter and Materials negatively. *This shows a lack of visible connection between the content, the Learning Outcomes and Assessment Standards in this curriculum.* The NCS Work schedule is predominantly vertically developed (two grades are developed horizontally), but the CAPS is 100% vertically developed in that all the statements in each grade (from Grade 4-9) show progression in terms of the sequence of the Matter and Materials subtopics. The CAPS is thus well structured for the topic of Matter and Materials in terms of verticality. However, the Low Depth in the Intermediate Phase as a result of the integration of Natural Sciences and Technology, does hinder progression in this Phase. The content framework for the NCS is well structured, but the influence of the Learning Outcomes and the Assessment Standards make it the least structured, of all three curricula, for the topic of Matter and Materials in the subject Natural Sciences. The NCS Work schedule is best structured for Matter and Materials in terms of Depth and is better structured than both the NCS and the CAPS in terms of Vertical Development as a hindrance in terms of verticality only appear in Grade 5 and Grade 6.

Conclusion

At the turn of 2012, the South African education system will engage in a new 'moment' that carries with it the hope for improvement where teachers, learners and the Department of Education are concerned. With OBE completely behind us and generic skills in the NCS abandoned, it seems that at least some improvement and greater enhancement of learning and knowing is actually possible. Ideas such as OBE and the focus on generic skills (what learners should be able to do) has had an immense impact on the education system. This research has added to the many others showing that the impact of these ideas were predominantly negative (Review Report, 2009). Over the past few years since the fall of *Apartheid,* it is safe to say that teachers' opportunities to teach in the classroom had been limited, learners' opportunities and ability to learn in the classroom were also limited and in some instances, as a result of curricula, teaching occurred, yet learning stopped. Reviews of curriculum documents have thus been essential in the move to where we are now.

As indicated in this dissertation, the CAPS is a big improvement from the NCS. The predominant reasons for this improvement are; the elimination of the Learning Outcomes and Assessment Standards, less subjects in the Intermediate Phase, curriculum statements that are shorter than those found in the

NCS as well as less statements within a grade as opposed to having many statements in a grade- such as was the case with the NCS. The collapse of Natural Sciences and Technology into one subject was identified as a design flaw in the CAPS, however, time and more reviews will determine whether this change was good or bad for the Intermediate Phase and it will also determine what the impact of this change is. All that stands to be seen now is whether the implementation of the CAPS is done in a more effective manner than what the implementation of the NCS was. More effective implementation of the CAPS will lead to the curriculum itself having a greater effect in the classroom. In terms of the Matter and Materials component however, there is indeed a greater visibility of sequence and progression in the CAPS than what there was in the NCS. As mentioned before, the CAPS seem to be the strongest curriculum in terms of vertical development for the Matter and Materials statements of Natural Sciences. Knowledge that is crucial to connect the internal knowledge structure in Matter and Materials are found in the CAPS and the manner in which these units of knowledge are represented is in a much more coherent manner than in the NCS. The verticality of the knowledge structure is thus maintained and this potentially improves learning. It also seems that science in the CAPS reflects the reform's intention to make science education more effective, more explicit and more content driven. Progression in this curriculum is, however, compromised somewhat by a move to integration in the intermediate phase, so that in the final analysis, the thesis finds the NCS Work schedule to be best structured for the topic of Matter and Materials in Natural Sciences.

ADDENDUM 1

COMPARISON OF MATTER AND MATERIALS STATEMENTS (AS THEY APPEAR IN CURRICULUM DOCUMENTS) BETWEEN THE NCS, THE NCS WORK SCHEDULE AND THE CAPS:

Learning Outcomes and Assessment Standards	*National Curriculum Statement*	*NCS Work schedule*	*CAPS*
Grade 9: LO 1: Scientific Investigation AS: 1. Learner plans a procedure to test predictions or hypotheses, with control of an interfering variable. 2. Learner contributes to systematic data collection, with regard to accuracy, reliability and the need to control a variable. 3. Learner seeks patterns and trends in the data collected and generalises in terms of simple principles. LO2: Constructing Science Knowledge AS: 1. Learner, at the minimum, recalls principles, processes and models. 2. Learner applies multiple classifications to familiar and unfamiliar objects, events, organisms and materials. 3. Learner interprets information by translating line graphs into text descriptions	*Grade 9:* *Properties and uses of Materials:* 1. Substances in different states or phases have distinct properties. 2. A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. 3. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism). 4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy. 5. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them. 6. Extracting useful materials from raw materials depends on chemical reactions and methods of separation. 7. Raw materials, from which processed	*Grade 9: Term 1*: 1. The particle model of Matter, 2. Phase changes, Elements and compounds, 3. The periodic Table. 4. Acids and Bases. *Term 3:* 1. Properties of Materials. 2. Compressibility. **Activity:** **Discuss method with which materials can be tested for different properties. Demonstrate the testing of some properties. Categorise materials according to different properties. Discuss how properties of materials are useful knowledge in industry.**	*Grade 9: Term 1:* 1. Pure substances. 2. Elements and compounds. 3. Classify substances. 4. Names of elements, symbols, compounds using names of elements from which they are derived. 5. Properties of metals and properties of non-metals. 6. Introduction to the periodic table. 7. Chemical reactions (useful reactions, harmful reactions, acids and bases, anions and cations). 8. Balanced chemical equations. 9. Careers in chemistry, chemical engineering, manufacturing etc. **Activity: (Practical Work)** **Investigate the properties of metals. Construct a table to show results. Report on conclusions. Investigate the properties of some non-metals. Construct a table to show results. Investigate reactions**

and vice versa, by extrapolating from patterns in tables and graphs to predict how one variable will change, and by identifying relationship between variables from tables and graphs of data, and by hypothesising possible relationships between variables. 4. Learner applies principles and links relevant concepts to generate solutions to somewhat unfamiliar problems. <u>LO3: Science, Society and the Environment AS:</u> 1. Learner recognises differences in explanations offered by the natural sciences and other systems of explanation 2. Learner responds appropriately to knowledge about the use of resources and the environmental impacts.	materials are made, must be mined, grown or imported from other countries. 8. Raw materials that are mined are non-renewable and mining has environmental costs. 9. Growing raw materials involves choices about the use of arable land and water catchment areas. <u>*Structure, Reactions and Changes of Materials:*</u> 10. A particle model of Matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction. 11. Many household substances are acidic or basic. 12. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours. 13. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates. 14. Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen. 15. Elements are made of just one kind of atom, whereas compounds are		**between weak acids and bases.**

	made of two or more kinds of atoms in fixed proportions. 16. Elements may react to form compounds, and compounds may be decomposed into their elements. 17. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound. 18. Oxygen has characteristic reactions with metals and non-metals, forming oxides. 19. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen. 20. The reaction of oxygen with food releases energy in the cells of living things.		
<u>LO1: Scientific Investigation:</u> <u>AS:</u> 1. Learner identifies factors to be considered in investigations and plans ways to collect data on them, across a range of values. 2. Learner collects and records information as accurately as equipment permits and investigation purposes require. 3. Learner considers the	*<u>Grade 8:</u>* *<u>Properties and uses of Materials</u>:* 1. Substances in different states or phases have distinct properties. 2. A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. 3. Differences in properties can be used to separate mixtures of different substances (by	*<u>Grade 8: Term 2</u>*: 1. The particle model of Matter. 2. Melting. 3. Evaporation. 4. Condensation. 5. Solidification. 6. Sublimation 7. Diffusion. (These concepts should be explained in terms of the phases of Matter).	*<u>Grade 8: Term 3:</u>* 1. Models in science: atoms and molecules. 2. Movement of particles. 3. Effect of increased energy; physical changes; three phases of Matter. 4. Elements and Compounds. 5. Common household compounds (acids and bases). 6. Chemical reactions between elements.

extent to which the conclusions reached are reasonable answers to the focus question of the investigation. <u>LO2: Constructing Science Knowledge:</u> <u>AS:</u> 1. Learner, at the minimum, recalls procedures, processes and complex facts. 2. Learner applies classification systems to familiar and unfamiliar objects, events, organisms and materials. 3. Learner interprets information by translating tabulated data into graphs, by reading data off graphs, and by making predictions from patterns. 4. Learner applies conceptual knowledge to somewhat unfamiliar situations by referring to appropriate concepts and processes. <u>LO3: Science, Society and the Environment</u> <u>AS:</u> 1. Learner identifies ways in which people build confidence in their knowledge. 2. Learner identifies information required to make a judgement about resource use.	methods such as filtration, distillation, evaporation, chromatography or magnetism). 4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy. 5. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them. 6. Extracting useful materials from raw materials depends on chemical reactions and methods of separation. 7. Raw materials, from which processed materials are made, must be mined, grown or imported from other countries. 8. Raw materials that are mined are non-renewable and mining has environmental costs. 9. Growing raw materials involves choices about the use of arable land and water catchment areas. <u>*Structure, Reactions and Changes of Materials:*</u> 10. A particle model of Matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction.	<u>**Activity:**</u> **Design an investigation to determine the effect of heating on ice.**	7. Indigenous knowledge: use of interactions between materials such as making beer. 8. Solubility: factors that influence solubility of common compounds such as concentration and temperature. 9. Separation of mixtures: evaporation, distillation. <u>**Activity: (Practical Work)**</u> **Observe potassium permanganate dissolving in water, or food colouring in water. Observe the three phases of matter for instance water, by heating ice.** **Observe or demonstrate a variety of chemical reactions, for instance, heating of sodium hydrogen carbonate, decomposing a copper sulphate solution, or electroplating a metal object.** **Investigate the factors that affect solubility. Identify variables.** **Crystallisation of table salt from a saturated salt solution. Explain this phenomenon.** **Examine shape of salt crystals by means of a hand lens.**

	11. Many household substances are acidic or basic. 12. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours. 13. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates. 14. Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen. 15. Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed proportions. 16. Elements may react to form compounds, and compounds may be decomposed into their elements. 17. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound. 18. Oxygen has characteristic reactions with metals and non-metals, forming oxides. 19. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the		

	reactions between iron, water and oxygen. 20. The reaction of oxygen with food releases energy in the cells of living things.		
<u>LO1: Scientific Investigation:</u> <u>AS:</u> 1. Learner plans simple tests and comparisons, and considers how to make them fair. 2. Learner organises and uses equipment or sources to gather and record information. Learner generalises in terms of relevant aspect and describes how the data supports the generalisation. <u>LO2: Constructing Science Knowledge:</u> <u>AS:</u> 1. Learner, at the minimum, recalls definitions and complex facts. 2. Learner compares features of different categories of objects, organisms and events. 3. Learner interprets information by identifying key ideas in text, finding patterns in recorded data, and making inferences from information in various forms such as pictures, diagrams and text. 4. Learner applies conceptual knowledge by linking a taught concept to a variation of	<u>Grade 7:</u> *<u>Properties and uses of Materials</u>:* 1. Substances in different states or phases have distinct properties. 2. A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. 3. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism). 4. Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy. 5. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them. 6. Extracting useful materials from raw materials depends on chemical reactions and methods of separation. 7. Raw materials, from which processed materials are made, must be mined, grown	*<u>Grade 7: Term 1</u>*: 1. Explain the concept of Matter. *<u>Term 2:</u>* 1. Revise concepts: Melting, Dissolving, Evaporation and Crystallisation, Solution and Phases of Matter. 2. The particle Model of Matter . 3. The Atom. 4. Structure of Matter in terms of particles called atoms composed of protons, neutrons and electrons. 5. Describe and compare the properties of Matter (solids, liquids and gases). **<u>Activity:</u>** **Use materials such as marshmallows, styrofoam or balls available to make a model of an atom.** **Use household substances to demonstrate the properties of matter that can be observed in everyday life.** **Categorise elements on the periodic table into metals and non metals.** **Design an investigation to determine which**	*<u>Grade 7: Term 1</u>*: 1. Properties and uses of matter and materials. 2. Factors which determine the suitability of materials for specific uses. 3. Materials produced in local industries (factories, clothing, utensils, building technologies). 4. Environmental impact in the production and use of materials (damages caused in accessing materials, their use, waste production and pollution. 5. Properties of a mixture: physical methods of separation, hand sorting, magnetism, sieving and filtration, evaporation, distillation etc. 6. Separation methods: problems of recycling waste materials. 7. Careers in which knowledge of waste materials is important (building, engineering, electronics). **<u>Activity: (Practical Work)</u>** **Design simple tests to examine and compare**

a familiar situation. <u>LO3: Science, Society and the Environment AS:</u> 1. Learner compares differing interpretations of events. 2. Learner analyses information about sustainable and unsustainable use of resources.	or imported from other countries. 8. Raw materials that are mined are non-renewable and mining has environmental costs. 9. Growing raw materials involves choices about the use of arable land and water catchment areas. *<u>Structure, Reactions and Changes of Materials:</u>* 10. A particle model of Matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction. 11. Many household substances are acidic or basic. 12. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours. 13. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates. 14. Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen. 15. Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed	**materials filters best. Design an investigation to separate a mixture which involves using at least three kinds of separation methods. Compare the different indigeneous knowledge systems or methods that were and or are still used to filter.**	**properties of selected materials to determine strength, flexibility, mass, boiling and melting points. Test how well separation techniques work. Record observations and report on which methods work for which mixtures. Investigate the purification of dirty water using some of the methods for separating mixtures. Evaluate the efficiency of these methods.**

	proportions. 16. Elements may react to form compounds, and compounds may be decomposed into their elements. 17. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound. 18. Oxygen has characteristic reactions with metals and non-metals, forming oxides. 19. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen. 20. The reaction of oxygen with food releases energy in the cells of living things.		
LO1: Scientific Investigation: AS: 1. Learner helps to clarify focus questions for investigations and describes the kind of information which would be needed to answer the question. 2. Learner conducts simple tests or surveys and records observations or responses. 3. Learner relates observations and responses to the focus	*Grade 6:* *Properties and uses of Materials:* 1. Pure substances have melting temperatures and boiling temperatures which are characteristic of each substance, and help us to identify the substance. 2. Materials are evaluated and classified by their properties (such as hardness, flexibility, thermal conductivity or insulation, whether they can be magnetised,	*Grade 6: Term 2:* 1. Revise Materials and their properties. 2. Changes in Mixtures. 3. Matter and Materials (difference between them). 4. Rusting. 5. Magnetism. 6. Electrical Conduction. 7. Insulation. 8. Solubility and Composite Materials. 9. Properties of metals, ceramics and plastics. 10. Phases of Matter. 11. Absorbed energy.	*Grade 6: Term 2*: 1. Difference between melting and dissolving. 2. Temporary and permanent changes. 3. Soluble and insoluble substances. 4. Dissolve, Even Mixture, Solvent, solute, solution. Saturated solutions. 5. Rate of dissolving in relation to temperature. 6. Rate of dissolving in relation to the grain size. 7. Conservation of matter: Functions of water in the ecosystems

question. LO2: Constructing Science Knowledge: AS: 1. Learner, at the minimum, describes the features which distinguish one category of things from another. 2. Learner categorises objects and organisms by two variables. 3. Learner, at the minimum, interprets information by using alternative forms of the same information. LO3: Science, Society and the Environment AS: 1. Learner describes similarities in problems and solutions in own and other societies in the present, the past and the possible future. 2. Learner suggests ways to improve technological products or processes and to minimise negative effects on the environment. 3. Learner suggests how technological products and services can be made accessible to those presently excluded..	solubility and rusting). 3. Major classes of materials are metals, ceramics (including glasses) and polymers (including plastics and fibers). 4. Composite materials combine the properties of two or more materials. *Structure, Reactions and changes of Materials:* 5. Some changes to materials are temporary but other changes are permanent. 6. Substances change when they receive or lose energy as heat. 7. These changes include contraction and expansion, melting, evaporation, condensation and solidification. 8. The dissolving of a substance in a solvent depends on variables which affect the rate of dissolving.	12. Released energy. 13. Evaporation. 14. Particle model of Matter (spaces, movement energy and forces between particles). 15. Features that distinguish a solid, liquid and gas from one another. **Activity:** **Describe how different phases of Matter are and were used to solve problems in history (steam engine for transport, wind mills for pumping water).** 16. Define temporary phase change and permanent phase change, melting and solidification. 17. Define: Substance, Condensation, Evaporation, Separation, Solidification, Distillation and Crystallisation. **Activity** **Investigation on the crystallisation of a substance.** 18. Separation of Solutions. 19. Define: Boiling point, Melting Point, Thermometer. 20. Units of Measuring temperature. **Activity** **Investigations on**	of plants and animal life. Wetlands as habitats for animals. **Activity: (Activities and Practical Work)** **Observe processes of melting and dissolving, be able to explain the difference between the two. Be able to explain the concepts of temporary and permanent changes, be able to identify temporary and permanent change. Learners must make solutions such as flour in water and oil in water. Learners must be able to explain the concept "saturated solution."** **Design fair test and carry out the test with the help of teacher. Learners must be able to identify the factors that will influence the rate of dissolving. Use any solute and solvent and carry out the experiment using different grain sizes. Learners must be able to explain the concept "conservation of matter."** **Research the functions of water in the ecosystem.** **Research: Learners must be able to explain the concept "wetland", explain the importance of wetlands as habitats for animals/sponges to**

		boiling and melting points. **<u>Scientific Investigations:</u>** **Properties of Materials** **Permanent or temporary phase changes** **Crystallisation** **Boiling points of different liquids** **<u>Learners should:</u>** **Design investigations, conduct investigations, collect data, write reports, evaluate data and communicates findings.**	**regulate the flow of water/resources for humans. Learners must name and know the location of at least one wetland in South Africa, explain the importance of that specific wetland and explain the impact of the loss of wetland on biodiversity.**
<u>LO1: Scientific Investigation:</u> <u>AS:</u> 1. Learner lists, with support, what is known about familiar situations and materials, and suggests questions for investigation. 2. Learner carries out instructions and procedures involving a small number of steps. 3. Learner reports on the group's procedure and the results obtained. <u>LO2: Constructing Science Knowledge:</u> <u>AS:</u> 1. Learner, at the minimum, uses own most fluent language to name and describe features and properties of objects, materials and organisms. 2. Learner creates own	<u>Grade 5:</u> <u>*Properties and uses of Materials:*</u> 1. Pure substances have melting temperatures and boiling temperatures which are characteristic of each substance, and help us to identify the substance. 2. Materials are evaluated and classified by their properties (such as hardness, flexibility, thermal conductivity or insulation, whether they can be magnetised, solubility and rusting). 3. Major classes of materials are metals, ceramics (including glasses) and polymers (including plastics and fibers). 4. Composite materials combine the properties of two or more	<u>*Grade 5: Term 2*</u>: 1. Properties of Materials (3 classes). 2. Three phases of Matter. 3. Boiling point. 4. Melting Point. 5. Define: Appearance, Flexibility, Hardness, Solubility, Heat Conduction, Heat Insulation, Magnetism. **<u>Activity:</u>** **Name and describe different features of materials in immediate surroundings.** 6. Describe different properties of materials. 7. Properties of Materials in three classes (metals, polymers and ceramics). 8. Heating and Cooling can change materials. 9. Define; thermal	<u>*Grade 5: Term 1*</u>: 1. Solids, liquids, gases. 2. Properties (colour, smell, hardness, toughness, flexibility, strength in tension). **<u>Activity: (Activities and Practical Work)</u>** **Learners must be able to explain the concepts "fair test" and "factors" that will have an effect on the outcome of a test. Learners must identify factors and fair tests using given examples. Design fair test and carry out the test. (examples may include testing three types of glue for the strongest glue, three kinds of wood for hardness).**

categories of objects and organisms, and explains own rule for categorising. <u>LO3: Science, Society and the Environment: AS:</u> 1. Learner identifies ways in which products and technologies have been adapted from other times and cultures. 2. Learner identifies the positive and negative effects of scientific developments or technological products on the quality of people's lives and/or the environment. 3. Learner describes the impact that lack of access to technological products and services has on people.	materials. *<u>Structure, Reactions and changes of Materials:</u>* 5. Some changes to materials are temporary but other changes are permanent. 6. Substances change when they receive or lose energy as heat. 7. These changes include contraction and expansion, melting, evaporation, condensation and solidification. 8. The dissolving of a substance in a solvent depends on variables which affect the rate of dissolving.	heating, properties of solids(holds its own shape, has mass and fixed volume), liquids(takes shape of container, has mass and fixed volume) and gases(no fixed shape, has mass but no fixed volume) respectively. 10. Heating, Cooling, Contraction, Melting, Evaporation, Condensation, Temporary and Permanent changes. 11. Differences between Mixtures (any two substances mixed together) and Solutions(mixture of a soluble substance in a liquid). 12. Define: Soluble, Insoluble, Decant, Filter and Distill, Solutions. 13. Define; Solute, Solvent, Solution, Soluble, Temperature. **<u>Activity:</u>** **Investigate whether heat speeds up dissolving. Learner conducts investigation and collects data, evaluates data and communicates findings. Investigate how much solute and solvent do we need to make a saturated solution. Learner conducts investigation, evaluates data and communicates findings.**	
<u>LO1: Scientific</u>	<u>Grade 4:</u>	*<u>Grade 4: Term 2:</u>*	*<u>Grade 4: Term 2:</u>*

Investigation: AS: Learner contributes ideas of familiar situations, needs or materials, and identifies interesting aspects which could lead to investigations. 2. Learner explores the possibilities in available materials, finding out how they can be used. 3. Learner talks about observations and suggests possible connections to other situations. LO2: Constructing Science Knowledge: AS: 1. Learner, at the minimum, uses own most fluent language to name and describe objects, materials and organisms. 2. Learner sorts objects and organisms by a visible property. LO3: Science, Society and the Environment: AS: 1. Learner describes how local indigenous cultures have used scientific principles and technological products for specific purposes. 2. Learner identifies features of technological devices around him or her, and tells about their purpose and usefulness. 3. Learner identifies difficulties some people	*Properties and uses of Materials:* 1. Pure substances have melting temperatures and boiling temperatures which are characteristic of each substance, and help us to identify the substance. 2. Materials are evaluated and classified by their properties (such as hardness, flexibility, thermal conductivity or insulation, whether they can be magnetised, solubility and rusting). 3. Major classes of materials are metals, ceramics (including glasses) and polymers (including plastics and fibers). 4. Composite materials combine the properties of two or more materials. *Structure, Reactions and changes of Materials:* 5. Some changes to materials are temporary but other changes are permanent. 6. Substances change when they receive or lose energy as heat. 7. These changes include contraction and expansion, melting, evaporation, condensation and solidification. 8. The dissolving of a substance in a solvent depends on variables which affect the rate of dissolving.	1. Materials and their properties. 2. Pure substances and mixtures. 3. Classification of materials. 4. Properties of Materials. 5. Making things with materials that have useful properties. 6. Phases of Matter. 7. Define: Solid, Liquid, Gas, Energy Lost, Energy gained. Dissolving familiar substances (soluble and insoluble). 8. Define: Dissolve, Solution and Substance. 9. Three phases of water- melting ice and boiling water. 10. Define: Solid, Liquid, Gas, Melting point, Boiling point, Substance, Explore, Melting, Boiling, Freezing, Evaporation and Condensing. 11. Properties of Materials. 12. Define: Matter, Materials, Classify, Categorise, Sort, Properties (flexibility, hardness, solubility) and Classes of Materials (ceramics, polymers, metals). **Activity:** **Investigate which substances are soluble and which are insoluble in water: Learner explores the**	1. Properties of materials (natural and man-made). 2. Properties of solids, liquids and gases. 3. Air is a real substance (gas), wind is moving air. 4. Energy transfer. **Activity: (Activities and Practical Work)** **Learners must combine materials to make new products, compare properties, use the materials to make or shape it for a purpose.** **Learners must experience and compare materials used in daily life.** **Explore properties they can feel, see, hear and taste. Use words like hard, soft, springy, sticky, wet, dry, runny, stiff, shiny etc.** T**wo Practical Activities:** **Examples can include mixing sand, water and cement to make concrete, mixing flour and water to make play dough.** **Heat a substance to let it melt and allow it solidify again (butter, candle wax etc).** **Observe the difference between the solid and liquid forms of a substance.** **Learners must be able to describe the**

may have in using technological devices.		**possibilities in available materials, finding out how they can be used: Learner talks about the observations and suggests possible connections to other situations.** **Investigate what happens to water as we heat it to boiling point: What happens to ice as we heat it? Learner explores the possibilities in available materials, finding out how they can be used: Learner talks about observations and suggests possible connections to other situations.** **Learner sorts objects and organisms by their visible property.**	**properties of the different phases.**
LO1: Scientific Investigation: AS: Learner uses materials selected by the group in order to communicate the group's plan. 2. Learner participates constructively in the activity with understanding of its purpose. 3. Learner explains and reflects on what action was intended, and whether it was possible to carry out the plan.	Grade 3: *Properties and uses of Materials:* 1. Materials have different properties such as texture, colour, strength and heaviness, and can be classified by these properties. 2. We make things with materials which have the properties we want. *Structure, Reactions and Changes of Materials:* 3. Substances can be mixed and sometimes changes can be seen, such as the dissolving of a solid or new colours when food	*Grade 3: Term 2:* **Activity:** **Conduct an investigation of how the properties of materials impact on use. Do an investigation to see if different materials can for example bend, fold, sink, float, fly etc.**	

	colourings/paints are mixed.		
<u>LO 1: Scientific Investigation:</u> <u>AS:</u> 1. Learner plans an investigation as part of group. 2. Learner participates in planned activity independently or as part of a group. 3. Learner shows and explains what was intended and how it was done.	<u>Grade 2:</u> *<u>Properties and uses of Materials:</u>* 1. Materials have different properties such as texture, colour, strength and heaviness, and can be classified by these properties. 2. We make things with materials which have the properties we want. *<u>Structure, Reactions and Changes of Materials:</u>* 3. Substances can be mixed and sometimes changes can be seen, such as the dissolving of a solid or new colours when food colourings/paints are mixed.	*<u>Grade 2: Term 2:</u>* **<u>Activity:</u>** **Investigate properties of Materials such as texture, strength, weight. Choose two different materials and investigate the properties of each. Do the materials float, sink, bend, break etc? Evaluate.**	
<u>LO1: Scientific Investigation:</u> <u>AS:</u> 1. Learner plans an investigation independently. 2. Learner independently participates in planned activity. 3. Learner thinks about what has been done and says what has been found.	<u>Grade 1:</u> *<u>Properties and uses of Materials:</u>* 1. Materials have different properties such as texture, colour, strength and heaviness, and can be classified by these properties. 2. We make things with materials which have the properties we want. *<u>Structure, Reactions and Changes of Materials:</u>* 3. Substances can be mixed and sometimes changes can be seen, such as the dissolving of a solid or new colours when food colourings/paints are mixed.		

ADDENDUM 2

COMPARISON OF SUMMARISED MATTER AND MATERIALS STATEMENTS BETWEEN THE NCS, THE NCS WORK SCHEDULE AND THE CAPS:

Learning Outcomes and Assessment Standards	*National Curriculum Statement*	*NCS Work schedule*	*CAPS*
1. Learner tests predictions and hypotheses 2. GS 3. GS 1. GS 2. GS 3. Learner hypothesises possible relationships between variables 4. GS 1. Learner investigates of different explanations offered by the Natural Sciences 2. GS	<u>*Grade 9:*</u> 1. Phases of Matter 2. Pure substances and Mixtures 3. Properties of Matter 4. Separation of Gases from the Air 5. Properties of Gases 6. Chemical Reactions 7. Raw Materials 8. Environmental costs from the mining of Raw Materials 9. Land and Water usage for the growing of Raw Materials 10. Particle model of Matter 11. Acids and Bases 12. Acids and Bases 13. Acidic reactions 14. Chemical reactions 15. Elements and Compounds 16. Elements and Compounds 17. Elements and Compounds 18. Characteristic reactions of Oxygen with metals and non-metals 19. Reactions between iron, oxygen and water.	<u>*Grade 9:*</u> 1. Particle model of Matter 2. Phase changes, Elements and compounds, 3. The periodic Table. 4. Acids and Bases. 1. Properties of Materials. 2. Compressibility	<u>*Grade 9:*</u> 1. Pure substances. 2. Elements and compounds. 3. Classify Substances. 4. Names of elements, symbols and compounds. 5. Properties of metals and non-metals. 6. Periodic table. 7. Chemical reactions 8. Chemical equations. 9. Careers in chemistry
1. GS 2. GS	<u>*Grade 8:*</u> 1. Phases of Matter 2. Pure substances and	<u>*Grade 8:*</u> 1. Particle model of Matter.	<u>*Grade 8:*</u> 1. Models in science 2. Movement of

3. GS 1. GS 2. GS 3. GS 4. GS 1. GS 2. GS	Mixtures 3. Properties of Matter 4. Separation of Gases from the Air 5. Properties of Gases 6. Chemical Reactions 7. Raw Materials 8. Environmental costs from the mining of Raw Materials 9. Land and Water usage for the growing of Raw Materials 10. Particle model of Matter 11. Acids and Bases 12. Acids and Bases 13. Acidic reactions 14. Chemical reactions 15. Elements and Compounds 16. Elements and Compounds 17. Elements and Compounds 18. Characteristic reactions of oxygen with metals and non-metals 19. Reactions between iron, oxygen and water.	2. Melting 3. Evaporation. 4. Condensation. 5. Solidification 6. Sublimation 7. Diffusion	particles. 3. Phases of Matter. 4. Elements and Compounds. 5. Acids and bases 6. Chemical reactions 7. Indigeneous knowledge 8. Solubility 9. Separation of Mixtures, evaporation, distillation
 1. GS 2. GS 1. GS 2. GS 3. GS 4. GS 1. GS 2. GS	Grade 7: 1. Phases of Matter 2. Pure substances and Mixtures 3. Properties of Matter 4. Separation of Gases from the Air 5. Properties of Gases 6. Chemical Reactions 7. Raw Materials 8. Environmental costs from the mining of Raw Materials 9. Land and Water usage for the growing of Raw	*Grade 7:* 1. Definition of Matter 1. Phases of Matter 2. Particle Model of Matter 3. The Atom 4. Structure of Matter (protons, neutrons, electrons) 5. Properties of Matter	*Grade 7:* 1. Properties of Matter and Materials 2. Uses of Materials 3. Production of Materials in local industries 4. Environmental impact of material production 5. Properties of Mixtures 6. Recycling of Materials 7. Careers in materials

	Materials 10. Particle model of Matter 11. Acids and Bases 12. Acids and Bases 13. Acidic reactions 14. Chemical reactions 15. Elements and Compounds 16. Elements and Compounds 17. Elements and Compounds 18. Characteristic reactions of Oxygen with metals and non-metals 19. Reactions between iron, oxygen and water.		
 1. GS 2. GS 3. GS 1. GS 2. GS 3. GS 1. GS 2. GS 3. GS	*Grade 6:* 1. Pure substances 2. Properties of Materials 3. Properties of Materials 4. Composite materials 5. Changes in Materials 6. Effect of heat on substances 7. Changes in substances 8. Changes in substances	*Grade 6:* 1. Properties of Materials 2. Changes in Mixtures 3. Differences between Matter and Materials 4. Rusting 5. Magnetism 6. Electrical Conduction 7. Insulation 8. Solubility and Composite Materials 9. Properties of metals, ceramics and plastics. 10. Phases of Matter. 11. Absorbed energy 12. Released energy 13. Evaporation 14. Particle model of Matter 15. Phases of Matter 16. Definitions of temporary and permanent phase changes; melting and	*Grade 6:* 1. Melting and dissolving. 2. Temporary and permanent changes. 3. Soluble and insoluble substances. 4. Dissolve, Even Mixture, Solvent, solute, solution. Saturated solutions. 6. Rate of Dissolving 7. Conservation of matter

		solidification 17. Definitions: Substance, Condensation, Evaporation, Separation, Solidification, Distillation and Crystallisation. 18 Separation of Solutions 19. Define: Boiling point, Melting Point, Thermometer 20. Units of Measuring temperature	
1. GS 2. GS 3. GS 1. Learner uses own most fluent language to describe properties of Materials and Objects 2. GS 1. GS 2. Learner identifies positive and negative effects of scientific development 3. GS	Grade 5: 1. Pure substances 2. Properties of Materials 3. Materials that are metals and ceramics 4. Composite materials 5. Changes in Materials 6. Effect of heat on substances 7. Changes in substances. 8. Changes in substances	*Grade 5: Term 2*: 1. Properties of Materials 2. Phases of Matter. 3. Boiling point 4. Melting Point 5. Define: Appearance, Flexibility, Hardness, Solubility, Heat Conduction, Heat Insulation, Magnetism 6. Properties of materials. 7. Properties of Materials 8. Changes in Materials 9. Define: thermal heating, properties of solids, liquids and gases. 10. Phase Changes of Matter 11. Mixtures and Solutions 12. Define: Soluble, Insoluble, Decant, Filter and Distill, Solutions. 13. Define; Solute, Solvent, Solution, Soluble, Temperature	*Grade 5: Term 1*: 1. Phases of Matter 2. Properties of Matter
 1. GS	Grade 4: 1. Pure substances	*Grade 4:* 1. Properties of	*Grade 4:* 1. Properties of

2. GS 3. GS 1. GS 2. GS 1. Learner describes how local indigeneous cultures have used scientific principles 2. GS 3. GS	2. Properties of Materials 3. Materials that are metals and ceramics 4. Composite materials 5. Changes in Materials 6. Effect of heat on substances 7. Changes in substances. 8. Changes in substances	Materials 2. Pure substances and mixtures. 3. Classification of materials. 4. Properties of Materials. 5. Practical uses of Materials 6. Phases of Matter. 7. Define: Solid, Liquid, Gas, Energy Lost, Energy gained. Dissolving familiar substances (soluble and insoluble). 8. Define: Dissolve, Solution and Substance. 9. Phases of Water 10.Define: Solid, Liquid, Gas, Melting point, Boiling point, Substance, Explore, Melting, Boiling, Freezing, Evaporation and Condensing. 11. Properties of Materials. 12. Define: Matter, Materials, Classify, Categorise, Sort, properties and Classes of Materials	materials 2. Properties of solids, liquids and gases. 3. Air as a real substance 4. Energy transfer.
1. GS 2. GS 3. GS	<u>Grade 3:</u> 1. Properties of Materials 2. Practical uses of Materials 3. Mixtures of paints and colours		
1. GS 2. GS 3. GS	<u>Grade 2:</u> 1. Properties of Materials 2. Practical uses of Materials		

	3. Mixtures of paints and colours		
1. GS 2. GS 3. GS	<u>Grade 1:</u> 1. Properties of Materials 2. Practical uses of Materials 3. Mixtures of paints and colours		

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