

Negotiating the introduction of subjects whilst simultaneously changing the language of instruction in Grade 4: A case study of Natural and Social Sciences in a rural KwaZulu-Natal school.

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DECLARATION

I, Sifiso Siegfried Ngcobo, declare that this thesis is my own work and has not been submitted for any degree at any university.

Sifiso Siegfried Ngcobo

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This thesis is dedicated to Gogo Ngunezi's generation; especially Mile and Khulokuhle, my children, who are already in the field of learning - you should be inspired to even greater heights.

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ABSTRACT

This study explores the introduction of subjects whilst simultaneously changing the language of instruction. It focuses on the introduction of specialised concepts at Grade 4 level in a primary school where isiZulu Home Language learners switch to English as their Language of Learning and Teaching (LoLT). The study critically analyses the concepts, interactions and new academic words used by the teachers and learners, in the process of knowledge building, specifically in Natural Science (NS) and Social Sciences (SS) in Grade 4. Data was collected from Grade 4 teachers: one teaches NS and the other teaches SS. The researcher conducted lesson observations; interviewed the two teachers and also analysed the conceptual structure of Grade 4 NS and SS textbooks. For the purposes of this dissertation, the researcher also analysed the collected data in detail, looking for emergent themes, in order to obtain in-depth insight about the teachers' experiences of teaching Grade 4. The findings indicate that the NS and SS textbooks are working carefully and constructively between the concrete and abstract concepts and between high and low levels of complexity. However, discrepancies were, in most cases, displayed by the teachers who mostly did not focus on conceptual development; instead they wanted to ensure that learners learnt how to read well and have good pronunciation, thus paying particular attention to decoding the texts only. This study recommends that teachers in the Intermediate Phase require exposure to and explicit guidance in teaching methodologies that would enable cumulative knowledge building. Teacher in-service training or subject advisors' intervention programmes ought to empower teachers with approaches to teach specialised concepts explicitly in their learning areas. Teachers should enhance reading literacy development in order to improve the learners' English competency levels and teachers should also be aware of and equipped with an understanding of learners' background knowledge (which could be resulting in barriers to learning opportunities) as a lack of conceptual understanding results in learners' poor performance. Textbook authors ought to consider translating key concepts and new terminology from English to African languages in order to enhance learners' acquisition and effective conceptual understanding, especially in the scientific and mathematical subjects.

KEY CONCEPTS

Semantic Gravity, Semantic Density, Complex, Pseudo concept, Spontaneous and Scientific concepts, Technical Lexis, Grade 4 Natural Science and Grade 4 Social Science.

LIST OF ACRONYMS

Acronyms and Abbreviations

ANA	Annual National Assessments
BICS	Basic Interpersonal Communicative Skills
CALP	Cognitive Academic Language Proficiency
CAPS	Curriculum and Assessment Policy Statement
FAL	First Additional Language
FP	Foundation Phase
HL	Home Language
IP	Intermediate Phase
LCT	Legitimation Code Theory
LiEP	Language in Education Policy
KZN	KwaZulu-Natal, one of South Africa's nine provinces
LOLT	Language of Learning and Teaching (medium of instruction)
MMCC	Multi-dimensional Measure of Conceptual Complexity
NCS	National Curriculum Statement
NS	Natural Science
OBE	Outcomes Based Education
RNCS	Revised National Curriculum Statement
SD	Semantic Density
SG	Semantic Gravity
SA	South Africa
SS	Social Science
UKZN	University of KwaZulu-Natal

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1 Introduction

1.1 Introduction to the study

This study explores the transition to subjects whilst simultaneously changing the language of instruction at Grade 4 level. This chapter highlights the purpose and rationale of this study and how the research project was conducted. The research design and methodology, research questions, data collection method, theoretical framework, and the findings of the study are outlined.

1.2 Focus and the purpose of study

In the main, this research study focuses on the introduction of specialised concepts at Grade 4 level in a primary school where isiZulu Home Language learners switch to English as their Language of Learning and Teaching (LoLT). The study tries to critically analyse the concepts, interactions and new academic words used by the teachers and learners, in the process of knowledgebuilding as teachers present new concepts. Second to this main focus and as subsidiary aim, the study intends to examine how teachers use language to explain new concepts and content knowledge, that is how teachers work with concepts from IsiZulu to English and from English to isiZulu. I will be focusing specifically on Natural and Social Sciences in Grade 4. The National Curriculum Statement (NCS 2011) purports that “children come to school knowing their home language. They can speak it fluently, and already know several thousand words. Learning to read and write in Grade 1 builds on this foundation of oral language” (2011:8). In other words, the NCS states that children arrive at primary school with a very strong oral proficiency.

It is in line with this background that this research aims at analysing the situation when new concepts are presented, taught and learnt. In particular, the research examines how teachers and learners negotiate the language issues at Grade 4 level. The study is intended to focus on how language concepts in Grade 4 are structured and also looks at how teachers work with concepts from isiZulu into English and from English into isiZulu when presenting new content knowledge in Natural and Social Sciences. Language and conceptual development remains crucial for the successful teaching and learning in the Intermediate Phase (IP) in

Grade 4, in particular, and extends through to secondary schooling right through tertiary education. “Concepts are theoretical meanings that words and other linguistic items represent. Simply, a concept is a common thought or understanding which is related to a word or sign in a mind of a person and the forming of a concept is closely related to language acquisition” (Lambani and Mangena-Netshikweta, 2013: 222). Similarly, Gelman (2009) states that “concepts mean mental representations that organise experiences”. She further states that “even infants make use of concepts – when smiling at a human face, pointing to the family pet and saying ‘kitty’ or reaching eagerly for a spoonful of applesauce”. Furthermore, she argues that “the building blocks of ideas are concepts. They are also contained in larger knowledge structures” (Gelman, 2009: 2).

Comber argues that “learners, especially those who are at risk of failing at school do not get access to the languages of power - the special English secretly demanded by secondary schools” (Comber, 1994:657). Cope and Kalantzis extends this argument by stating that “those who have access to particular discourse also have access to realms of power” Cope and Kalantzis (1993: 197). The main purpose of this project is to critically analyse the concepts, interactions and new academic words used by the teachers and learners, in the process of knowledge building, in the school used for this research.

1.3 Rationale for the study

The act of teaching and learning, Hugo (2013) argues, “is a fundamental rhythm of human living: we transfer and build on what we have already specialised in through education rather than instinct. Understanding the processes that occur when a teacher and students actively engage with knowledge designed for systemic learning has been, and continues to be, a huge area of historical and current investigation” (Hugo 2013: 1).

One of the reasons for undertaking this study is that learners in the school display low levels of English competence both in the classroom / academic or cognitive development and their ordinary everyday interaction / Basic Interpersonal Communication Skills (BICS). It would seem that many learners in this school, particularly because they are second language learners, lack both BICS and Cognitive Academic Language Proficiency (CALP), which is essential for success in higher education. According to Cummins, (as cited by Wababa 2010), “if no link exists between the BICS and CALP of a learner, the conceptual

understanding abilities of that learner could be delayed. As Wababa points out, “this is especially true in conceptual areas such as Natural Sciences” (Wababa 2010: 26). It is clear that most learners who speak African languages could be in this situation.

It is therefore interesting to examine how new subjects are introduced in Grade 4 and the transition to English, both in terms of curriculum, that is textbooks and pedagogy, that is the way teachers teach. Contrary to the strong oral proficiency claims in the NCS documents, learners’ English language incompetency points to a disjuncture between curriculum policy and classroom practice. In this context (English First Additional Language), learners in Grade 4 to 7 cannot read effectively and as a result they are unable to write effectively, especially in the genres that are regarded by society as being powerful: the factual genres such as Social Sciences.

The reading challenges experienced by learners at Grade 4 level emanate from the fact that teachers in the Foundation Phase spend most of the time teaching decoding skills, according to Hoadley (2010) and Zimmerman (2014). This focus on decoding text in the primary language essentially means that it is most likely that non-English learners have not yet mastered reading comprehension skills in their vernacular. As a result, these learners lack the necessary skills to transfer to literate reading in English. Clearly this state of affairs ought to change for the better. Very powerful measures have to be taken to improve the general literacy and reading levels of learners. Reading skills are necessary for academic attainment of learners throughout school (Naidoo et al 2014).

It is in light of this that Rose (2005) argues that “very few South African secondary students are likely to achieve their goals of further education and professional careers”. Similarly, Taylor and Vinjevold (1999) state that “learners' reading, listening, speaking, and writing skills are poorly established in both English and their home language, mainly due to very little focus on actually reading and writing”.

The second reason for undertaking this research is based on the various international benchmarking tests and Annual National Assessments (ANA) which were introduced by the Department of Basic Education to measure the South Africa's improvement in learning at school. Internationally, Fleisch (2008), Taylor (2008) and Spaul (2012) explain, South Africa has partaken in three large cross-national comparisons of primary school learner achievement, namely SACMEQ² (2000 AND 2007, Grade 6), TIMSS (2003, Grade 8), and PIRLS (2006, 2011, Grade 4 and 5). South Africa also has internal national standardised

testing programs, the most important of which are the Systemic Evaluations (2001 and 2007, Grade 3), the National School Effectiveness Study – NSES (2007- 2009, Grade 3-5), and most recently, the Annual National Assessments – ANA (2011, Grade 4-6). The report on ANA 2012 in KwaZulu-Natal (KZN) showed that Grade 4 children score, on average, 38% in first language literacy, and 34% in second language literacy. The average for Grade 9 children was 38% in first language literacy and 32% in second language literacy (Department of Basic Education, 2012). All of these datasets have been analysed by academic researchers, policy makers, and educational non-governmental organisations (NGOs). Unfortunately the picture that emerges time and again illuminates the ‘crisis’, especially in the primary stages of schooling in South Africa (Fleisch, 2008).

My own interest in doing this research is that, as a primary school teacher, I intended to critically examine the transition from Grade 3 to 4 in order to get a picture of what happens when new concepts are presented during lessons and how certain concepts are structured in Natural and Social Sciences. Firstly, I intended to explore the experiences of teachers as they negotiate new and difficult concepts. Secondly, I aimed to analyse the semantic profiles of these concepts, that is, look at the language shifts, during lesson presentation, from the known/every day, concrete and general to the unknown/abstract, specialised and specific or vice versa. My observation as the practicing educator is that although English is encouraged as a language of communication at school and the learners, in general, display positive attitudes towards using it as a mode of addressing teachers and school management, there is still a problem and this is revealed in the academic results. Learners perform poorly on the common test; learners also fail the ANA common papers.

1.4 Research design and methodology

Since this study is concerned with the experiences of people, the research style is a case study, qualitative approach, and an interpretive design. As argued by Cohen et al (2007), the essential effort of the interpretive paradigm is to understand human experience in all its subjective complexity. Care is taken to get inside the state of affairs and to understand from within by observing the teachers whilst teaching, interviewing them and conducting an extensive textbook analysis. Central in the study are the meanings and interpretations of the participants’ language practices: what Habermas (1984), in Cohen et al (2007), describes as a

‘double hermeneutic’, where people struggle to understand and work within a world that already has meanings and interpretations within it. Hermeneutics works by reaching out and grasping the meanings of people in interaction with each other or within a situation so that the subjective understandings come out.

To gain an in-depth understanding of the research problem, lesson observations, unstructured or in-depth interviews and textbook analysis were used to collect qualitative data. An audio-recorder ensured that both the observed information and the respondents’ views were not lost or omitted. The audio-recorded information was transcribed into a data set which was used for analysis purposes. Data analysis consisted of an emergent language of description, looking for themes. This allowed for a detailed qualitative discussion of these themes.

This emergent type of content analysis is combined with a more deductive analysis that uses the concepts outlined in the theoretical framework as an external language of description to analyse the data. For example, concepts from Vygotsky’s conceptual development (1934/1987), Maton’s LCT – semantics (2009) Brown’s Multi-dimensional Measure of Conceptual Complexity, 2005 (MMCC) and Naidoo’s Technical Lexis (2013) were used to analyse the contents of teachers’ responses to interview questions, to deductively analyse the concepts used by teachers during their observed lessons and examine the portrayal of concepts in the teaching texts, that is, trying to recognise these theoretical concepts in data.

1.5 Key research questions

- How text-books introduce and negotiate new and specialised concepts as well as shifting the language of instruction when introducing new subjects and explaining new and specialised concepts at Grade 4 level in the Natural and Social Science subjects.
- How language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science subjects.

1.6 Research context and sampling

This research study took place in my teaching context (Kwangobese Primary School - a pseudonym). The school is part of the greater uMgungundlovu district, in the Sweetwater Circuit, located on the outskirts of Pietermaritzburg, KZN. The respondents were two teachers (Mrs Magwaza and Mrs Vilakazi, pseudo names intended to protect their identity). One teaches Natural Science and the other teaches Social Sciences in the Intermediate phase and they both come from non-English speaking backgrounds. My choice of sampling is both *convenience* and *purposive*. I say it is convenience sampling because the respondents are within my teaching context (Cohen et al 2007). Since they teach in my school, I have easy access to them. It also is purposive in the sense that I chose my own school as respondents in exploring the efficacy and how the transition in Grade 4 is managed. Cohen et al (2007) described this sort of sampling as a handpicking of a sample based on what is being researched given the availability at hand.

1.7 Researcher's involvement in the study

In order to conduct this research project, the researcher identified his school context, focusing on two Grade 4 teachers, one for NS and the other for SS. The study was precipitated by the researcher's interests in understanding how teachers manage to work with learners whose medium of instruction (LoLT) in the Foundation Phase was isiZulu and in the Intermediate Phase is English as a First Additional Language (EFAL). In other words, the researcher wanted to examine how Grade 4 deals with how teachers and learners negotiate the language issues at grade 4 level: how teachers encourage conceptual development whilst simultaneously dealing with the introduction of subjects in the IP.

Although I am in a position of authority within the school, I do not teach the sampled grade. My role as the researcher was limited to that of an observer who did not participate nor contribute to the observed pedagogical activities. I used an audio-recorder in order to capture what was said by both the teachers and learners during the observed lessons. It is believed that what was captured was a true reflection of the lessons because during the time of the actual recordings both the teachers and the learners had become familiar with the presence of me as the researcher as I had visited the classes on a number of previous occasions and had

just sat there quietly, observing. With regards to the in-depth interviews, the respondents were made to understand their participation in the study was quite voluntary, they were free to withdraw at any stage and such a decision would never harm them in any way. They were also assured that upon completing the study, the research findings and recommendations would be made available to them.

1.8 Theoretical framework

The main theories that support this study are Vygotsky's conceptual development (1934/1987), Karl Maton's LCT (2009), Browns Conceptual Complexity Tool (MMCC 2005) and Devika Naidoo's work on Technical Lexis (2013). The study therefore used these theories as tools to analyse data collected using the lesson observation, the teachers' interviews and the analysis of the teaching texts. Michael Long's Interaction Hypothesis (1996) was also used for the purposes of analysing the pedagogical practices. These theories were used in relation to the key research questions that have been mentioned above.

1.9 Research findings

In the main, the study reveals that the teaching texts are in line with the theoretical frameworks that are employed in this study in the sense that both NS and SS textbook analysis reveals that both subjects are working carefully and constructively between the concrete and abstract concepts, between high and low Semantic Density (SD) and Semantic Gravity (SG) concepts and using different levels of complexity. However, discrepancies were, in most cases, displayed by the teachers who mostly did not focus on conceptual development; instead they wanted to ensure that learners learnt content as much as possible.

Teachers focused on content and neglected concepts by not explaining them in a developmental way, for instance there were very few occasions where teachers directly and explicitly explained these concepts in English or by giving isiZulu equivalent concepts. There were also very few instances where they deliberately used code-switching to explain technical and field specific terms. Their main focus was on how well learners read and

pronounced English words. The positive was that some degree of teaching and learning did happen.

1.10 Conclusion

Given the way in which concepts progress, the nature of the semantic profiles and the complexity of conceptual development, in Grade 4 textbooks particularly, in terms of Vygotsky's, Maton's, Naidoo's and Brown's framework, this study recommends that Intermediate Phase teachers explicitly teach concept development and adopt effective reading strategies that promote effective literacy and numeracy/mathematical skills. Teachers also need to have a thorough understanding of the curriculum dictates and stipulations.

Literature review

2.1. Introduction

Historically, it has been hard for South African students to learn through the use of English as a medium of instruction (Lambani and Mangena-Netshikweta, 2013) and for many children, not only in South Africa but around the world, reaching fluency in a second (dominant) language is vital for accessing higher education and the labour market (Taylor and Coetzee, 2013). This study focuses on how Grade 4 teachers negotiate the introduction of subjects, Natural and Social Science in particular, and how they deal with specialised concepts in a primary school where learners in the Foundation Phase are taught in isiZulu and then switch to English First Additional Language (EFAL) in the Intermediate Phase. Thus, in this chapter, literature that has informed my thinking about investigating the issues described above is reviewed.

2.2. The current state of Intermediate Phase education

A wide range of researchers (Nomlomo 2007, Mahlalela & Heugh 2002, Pretorius 2014, and Wababa 2010) concur that the language used as the medium of education in primary schools has a profound impact on the child's learning process. In South Africa, "many children start using their additional language, which is often English, as the Language of Learning and Teaching (LoLt) in Grade 4" (NCS 2011: 8). This means, the NCS policy document continues "they must reach a high level of competence in English by the end of Grade 3. In Grade 4 the majority of children are learning through the medium of their First Additional language, English, and should be getting more exposure to it. Greater emphasis is therefore on using the FAL for the purposes of thinking and reasoning. This enables learners to develop their cognitive academic skills, which they need to study subjects like Science in English. They also engage more with literary texts and begin to develop aesthetic and imaginative ability in their Additional Language" (NCS 2011). This transition from FP to IP poses serious tensions and gaps especially for learners at risk who happen to attend poorly resourced schools. This therefore points to serious implications e.g. how to empower learners from Grade 3 with the language skills they need as they reach Grade 4; and how to assist learners negotiate specialised and field specific concepts used in scientific subjects at Grade 4 level.

2.3. The nature of the shift from FP to IP

In most schooling systems around the world, Grade 4 represents a transition where the instructional focus changes from *learning to read* to *reading to learn* (Pretorius, 2014). In Grade 4, Pretorius (2014) argues, learners continue to build on and extend their literacy skills, but these skills become increasingly academic in nature. There is a growing reliance on literature practices for transmitting, acquiring and transforming knowledge. Content subjects and accompanying textbooks become increasingly important. The nature of the texts that learners read changes from narrative to more expository text types which are often conceptually dense and abstract and, unlike narrative text, tend to deal with topics that are unfamiliar to the readers' frames of reference (Pretorius, 2014). This transition or shift, therefore, highlights a number of crucial roles for teachers at Grade 4 level. The first focuses on promoting the quality of reading literacy in their classes. The second role focuses on the teachers' ability to enhance learners' conceptual development in order to be able to effectively manage the learners' shift from learning to read in the Foundation Phase to reading to learn in the Intermediate Phase.

The issue of learners shifting from learning to read in the FP to reading to learn in the IP is not peculiar to South Africa. Studies indicate that it is an issue that has interested practitioners and researchers for some time. One such study was conducted in 1982 by Mason and Osborn from the University of Illinois at Urbana-Champaign, in the US. In this study, a survey of classroom reading instruction practices in Grade 2 through to Grade 5 was conducted. The main purpose of this study was to investigate whether teachers believe there is an instructional shift and whether any direct evidence can be garnered to support an actual shift towards more comprehension instruction at about the fourth grade (Mason and Osborn, 1982). One of the critical questions this study posed was: "is there an actual change in the method of teaching between grades three and four, such as in the content or materials used for reading instruction?"

A commonly held belief about reading instruction in the elementary grade is that learners first must learn to read and that then they will utilise their reading skill to learn from written information and to acquire new ideas (Mason and Osborn 1982). This belief, they say, has been expressed in the phrase, '*learning to read and reading to learn*'. According to Mason and Osborn (1982), a corollary of the '*learning to reading and reading to learn*' belief is that most of the instructional time in Grade 1, 2, and 3 should be spent in teaching students how to

recognise words and read fluently, whereas in grade 4, 5, and 6 the instructional time ought to be spent reading diverse texts and learning how to understand, interpret, and evaluate new concepts.

Mason and Osborn (1982) assert that there are grade-to-grade changes in materials and in student competencies which could alter instruction at about the fourth grade. Amongst the examples that they give to support this assertion is that basal reader textbooks are carefully controlled by readability guidelines. Hence older children read stories that are longer; that contain a greater range of vocabulary; and that vary more in their structure and reading purpose. These changes, Mason and Osborn continue, may require a heavier emphasis on comprehension of information rather than on reading fluency. Another example they use is that before grade four, reading comprehension questions by teachers may be directed towards determining whether students have read the passage accurately whereas in later grades, questions may be aimed at analysing and evaluating test information. Also, as students become more proficient readers, teachers may encourage them to read novels and informational books in place of textbooks. Furthermore, as students become skilled at expressing themselves verbally, teachers may replace workbook tasks with text writing tasks.

One of the most notable studies, conducted prior to South Africa's new dispensation and cited by Hoadley (2010), was the Threshold Project (MacDonald, 1990): a three-year project that followed a 1985 pilot study examining the nature of the language and learning difficulties that black Standard 3 Sepedi learners (grade 5) experienced when they had to shift to English as their language of instruction. Essentially this study, Hoadley (2010) explains, revealed the difficulties learners experienced when they had to make a sudden and dramatic jump across languages and learn all their subjects in English. To make this jump at least 7000 English words are needed but the Threshold project revealed that learners only possessed around 700 English words.

It was not only the lack of vocabulary, but also the poor ability learners had to operate the linguistic structure of English that resulted in the learners being forced to rote learn because no real meaning could be made of the curriculum. Learners were likely to become alienated in this situation (Hoadley, 2010).

Another empirical study similar to this, conducted in South Africa, was research on in-service and pre-service training initiatives of teaching in South Africa done by of the Teaching Literacy Education Project (TLEP). This study, Zimmerman et al (2007) explain, "aimed at

finding out how teachers are trained to develop learner literacy in South Africa both in the learning to read Foundation Phase and the reading to learn Intermediate Phase”. They argue, citing Hannon (1999), “that literacy is the crucial key that unlocks understanding of the education curriculum” (Zimmerman et al 2007: 2).

Zimmerman et al (2007) highlight that teachers in certain South African schools feel that the current South African Language-in-Education Policy [LiEP] which specifies that all learners must learn to read in their vernacular from grades 1 to 3 is problematic. In effect it means that there is a massive and dramatic shift in the medium of instruction at Grade 4 level for all schools where English or Afrikaans has not been the medium of instruction in the Foundation Phase, a move that Zimmerman et al (2007) argue contributes to education failure amongst learners. They continue that most learners who have to make the transition to ‘reading to learn’ in Grade 4 “simply fall into the gap between learning in the mother tongue and learning through a second language of education, English. Most teachers do not know how to help their learners successfully bridge this gap” (Zimmerman et al 2007: 3). They point out that this daunting task “coincides with a change in the focus of learning from concrete, basic skill development to progressively more abstract thinking and learning tasks across a variety of learning areas” (Zimmerman et al, 2007: 4).

2.4. South Africa’s poor performance in literacy and numeracy assessments

The various national and international large-scale literacy assessments undertaken in South Africa in the recent past continue to highlight major concerns about the quality of reading literacy teaching in primary schools, irrespective of the language of testing (Zimmerman, 2014 and Pretorius, 2014). The concerns include the fact that South African learners at the PIRLS surveys of 2006 and 2011, as well as the TIMSS surveys of 1995, 1990, 2003 and 2011 consistently demonstrated that South Africa’s performance is amongst the lowest of all participating countries with a score of 302 (where a benchmark of 400 is the cut-off point for low achievers). This reveals a distinct lack of learners’ development of thinking and reasoning abilities for reading comprehension that is needed to make a successful transition to reading to learn in the Intermediate Phase of South African primary school years (Zimmerman, 2014).

Internationally, Fleisch (2008), Taylor (2008) and Spaul (2012) explain, South Africa has participated in three major cross-national comparisons of primary school student achievement: 1) SACMEQ² (2000 AND 2007, Grade 6); 2) TIMSS (2003, Grade 8); and 3) PIRLS (2006, 20011, Grade 4 and 5). South Africa has also undertaken extensive national standardised testing programs like the Systemic Evaluations (2001 and 2007, Grade 3), National School Effectiveness Study – NSES (2007- 2009, Grade 3-5), and the Annual National Assessments – ANA (2011, Grade 4-6). The data obtained from the outcome of these tests has been analysed by academic researchers, policy makers, and educational NGO's. The results that emerge each time highlight the extent of the problem that exists in South African education - especially in the primary stages of schooling in South Africa (Fleisch, 2008). Test after test reveal that South African primary school learners are not reaching the required levels of adequacy in literacy or numeracy (Spaul, 2012). This is shown very clearly at Grade 6 level, where learners have not mastered basic reading and numeracy skills (van der Berg et al 2011). Many of the learners are functionally illiterate and functionally innumerate. They have not got the basic reading and numeracy skills necessary to function meaningfully in society (van der Berg et al, 2011).

Graven and Metzuyanin (2014) call on all mathematics educational researchers to begin to research the role of learning dispositions promoted and or developed within mathematics classrooms in relation to this 'crisis' in the hope that the outcomes of the research can be used to work towards better support for learners as they develop mathematical proficiency. They consider this in terms of Kilpatrick, Swafford and Findell's (2001) conceptualisation of five "interrelated strands of mathematical proficiency namely: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and proactive disposition". They argue that all strands are equally important as mathematics proficiency is not something you get right by just focusing on one or two aspects (Graven and Metzuyanin, 2014: 40).

It is crucial to find ways of developing more effective learning dispositions across curriculum areas, particularly mathematics and science which suffer from the popular perception that they are difficult, remote from the understanding of most people and only for the specialist (UNESCO, 1993). Another contributing factor (UNESCO, 1993) is that many, perhaps most, primary teachers have received from their own education a legacy of failure or at least dissatisfaction in relation to science and/or mathematics. Wababa (2010) concurs with this argument and asserts that in South Africa, during Apartheid times, African language teachers

did not receive adequate training in either their home language or English, leaving them unable to deal with the demands of teaching science.

With regards to literacy, Zimmerman (2014) makes a point that literacy levels in South Africa remain a serious challenge to increasing the quality of education and contributing to the country's future growth. This challenge exists, she says, "in spite of numerous governmental initiatives to improve the quality of teaching and learning, since the PIRLS 2006" (Zimmerman 2014: 1). She further argues that "the roots of learners' low levels of literacy achievement lie in the ineffective teaching of reading in schools and learners' consequent inability to learn independently from reading across the curriculum" (Zimmerman 2014: 1). To emphasise this view, Pretorius (2014) argues that the poor performance of grade 4 learners in pre-PIRLS clearly indicates that learners are not well prepared for the literacy challenges of the Intermediate Phase.

The reading challenges experienced by learners at Grade 4 level emanate from the fact that teachers in the Foundation Phase spend most of the time teaching decoding skills, according to Hoadley (2010) and Zimmerman (2014). This focus on decoding text in the primary language essentially means that non-English learners have most likely not yet mastered reading comprehension skills in their vernacular. As a result, these learners lack the necessary skills to transfer to literate reading in English. Clearly this state of affairs ought to change for the better. Extreme measures have to be taken to improve the literacy and reading levels of learners. Reading skills are indispensable to the academic success of learners in school (Naidoo et al 2014). It is, Cook-Gumperz (1986) argues, "an unquestioned part of present-day social knowledge that literacy is both the purpose and product of schooling. Furthermore, it is equally well accepted that, for individuals, social groups and even for whole societies, literacy plays a massive role in the improvement of life" (Cook-Gumperz, 1986: 16).

Pretorius (2014) succinctly outlines other factors that impact on formal schooled literacy in South Africa: the low socio-economic backgrounds of learners mean that many of the adults that form part of their households have low literacy levels. Children from such homes are seldom exposed to books or regular literacy practices at home and they never have stories read to them in their pre-school years and so they have no idea of how to link meaning to the printed word before they start school. It is because of this background that schools need to play a compensatory role by providing an environment that is stimulating – a place where learners can be surrounded by print (Pretorius 2014: 55). She further argues "for the

development of strong language and literacy skills in the Foundation Phase, and says, it is critical for supporting the transition to Grade 4, even in homogeneous, well-resourced schooling systems where the LoLT is the home language” (Pretorius 2014: 56).

2.5. Recent educational initiatives to improve the situation

Under the ANC led government, South African educational system has undergone radical changes, with both infrastructure, legal and organisational frameworks and the curriculum being transformed. In March 1997, in a move that constituted a radical break from apartheid educational rulings, the former Minister of Education, Sibusiso Bhengu, announced the launch of Curriculum 2005: a progressive, learner centred model of education based on outcomes-based principles (Jansen & Taylor 2003).

The introduction and implementation of C2005 (OBE) was not without opposition and challenges (Jansen 1999). Academics and various organisations of professionals vehemently criticised OBE for reasons that included the following: its inaccessible language and complex architecture; the failure to properly prepare teachers and the large scale divergences in resources and capacity between the few privileged schools that could afford to do OBE properly and the large amount of disadvantaged schools that struggled with implantation (Jansen & Taylor 2003).

The Department of Education appointed the Policy Review Committee, the outcome of which was a slow and careful phasing out of Curriculum 2005 and a phasing in the Revised National Curriculum Statement (RNCS) (Zimmerman and van Staten 2008). The RNCS was phased in during 2002 for Grades R to 9. This new system removed some of the onerous language style and established a simpler and more manageable curriculum framework (Jansen & Taylor 2003). The developmental outcomes for learners from Grade R to 9, outlined in the RNCS Grades R – 9, project a vision of learners who are able to reflect on and explore a variety of strategies to learn more effectively (including reading and viewing), while also being able to contribute as responsible citizens in the life of local, national and international communities (Howie et al 2008).

From 2012 the two National Curriculum Statements, for grade R – 9 and the National Curriculum Statement Grade 10-12 respectively were combined in a single document and

became known as National Curriculum Statement Grade R – 12 (DBE, 2011). Lastly, Curriculum and Assessment Policy Statements (CAPS) replaced the Revised National Curriculum Statement. CAPS is a more structured learning programme than previous curriculum frameworks and affords more time for languages and mathematics (or literacy and numeracy). Admitting that the old curriculum had major problems, Minister of Basic Education, Angie Motshekga, had this to say: “We have and will continue to make changes” (City Press, 2010).

Zimmerman (2014) argues that the legacy of apartheid education policies is a factor that has contributed to low literacy levels but the deepening crisis in the education system can also be linked to the introduction of the progressivist OBE in curriculum 2005 (C2005); the subsequent Revised National Curriculum Statement (RNCS) and the National Curriculum Statement (NCS). Some of the most important government initiatives to improve education are outlined below (DoE, 2006a; DoE, 2006b; DoE, 2007a; DoE, 2007b; DoE, 2008a,). In spite of these numerous governmental initiatives, literacy levels in the country remain a serious challenge to increasing the quality of education and contributing to the country’s growth (Zimmerman, 2011; Bharuthram, 2012; Naidoo et al, 2014; Pretorius, 2014 and Zimmerman 2014). In another bid to improve South African learners’ poor performance in regional and international tests, the ANA tests were introduced by the Minister of Education in 2008 when she launched the Foundations for Learning Campaign which aimed at improving the average learner performance in literacy and numeracy to 60% by 2014 (Pausigere and Graven, 2013).

The government in South Africa continues to undertake radical initiatives as part of its attempt to develop reading and writing skills and to improve the quality of teaching and learning. The most significant one is reflected in the Grade 4 Natural Science CAPS document which dictates that the “ability to read well is central to successful learning across the curriculum... Writing allows learners to construct and communicate thoughts and ideas coherently. Frequent reading and writing practice across a variety of tasks and subjects enables learners to communicate functionally and creatively. Learners are required to read and write particular genres of texts (including instructions, reports and explanations) during Natural Science and Technology lessons. Learners need regular opportunities to read and write a range of genres in order to improve their reading and writing skills. The ability to read and write well is also critical when learners are assessed, both informally and formally” (DoE, 2011: 12). It is therefore important that educators at primary level, particularly in the

FP, afford the learners with the reading skills necessary for producing the genres deemed powerful by the society.

2.6. Shift in the language of instruction (LoLT)

Language of instruction, Gebre (2014) argues, is one of the primary determinants of effective classroom communication. In North American and European contexts, languages are considered “second” or “foreign” depending on whether or not learners are exposed to them in the outer community (Benson 2005). Globally, many countries with multiple languages have required a single language to dominate their education sectors (Gebre, 2014 citing UNESCO, 1953, 2003) and continue to say that this phenomenon is particularly prevalent in Africa. South Africa’s current language in education policy, and many other previously colonised countries e.g. Tanzania, Ethiopia and India, to name a few, encourages the use of Mother-Tongue Instruction in the first three years of primary school followed by a switch to English or Afrikaans in Grade four.

Gebre (2014) further argues that the effect of MTI is ambiguous. On the one hand, a number of studies argue that MTI is superior to second language instruction in facilitating effective classroom communication, thereby increasing access and quality of education. On the other hand, the use of a local language as medium of instruction can lead to lower proficiency in national and/ or international languages, which are often a medium of instruction in post primary education and have higher labour market returns.

Cummins, as cited by Brock-Utne, et al (2010), has often argued for bilingual education and the importance of mother tongue instruction in the context of areas such as the southwestern United States where many children speak Spanish as a home language but where linguistic policies dictate unilingual English education. He notes that “children perform better in schools when the school effectively teaches the mother tongue and, where appropriate, develops literacy in that language” (Brock-Utne et al, 2010). They make a strong point that children should not be forced to learn in the language they do not understand well (Brock-Utne et al, 2010).

Botes and Mji (2010) make the point that “language and education are interconnected because all teaching is given through the medium of language”. Language, they continue, “is both a prerequisite for thought and a carrier of thought and therefore influences the extent to which a child’s intelligence is actualised” (Botes and Mji, 2010: 123). In most schooling systems around the world, Grade 4 marks a transition year. The challenge is that this transition from *learning to read to reading to learn* does not automatically or easily take place with all children (Pretorius, 2014) especially in South Africa, where the majority of children do not speak English as their first language. The dilemma facing the education system is how to most effectively equip these children with a second language – English. This transition, therefore, “presents a difficult policy question: when and how should the teaching of English be introduced in schools, and when and how should a transition to English as the LoLT in non-language subjects occur?” (Taylor & Coetzee, 2013: 2).

Wababa (2010) notes that “learners, especially African home-language (IsiXhosa) speakers, in the IP had to jump from their home language to English at exactly the same time they shifted to more conceptual learning subjects before they have developed sufficient language skills to be able to cope with English as their new language of learning and teaching (LoLT) across the curriculum. This massive switch is one of the major reasons for the high failure rate and a large number of drop-outs in the conceptual learning areas of Science and Mathematics” (Wababa, 2010). However, a wide range of studies (Fleisch, 2008; Taylor, 2008; Spaul, 2011; Taylor & Coetzee, 2013; and Graven & Metzuyanin 2014) highlight several factors as impacting on learner performance, including: social disadvantage; teachers’ subject knowledge; teaching time; teacher absenteeism; lack of resources; poorly managed schools; and poverty effects including malnutrition and HIV/AIDS.

Pretorius (2014) reiterates this point by arguing that “the transition from FP to IP is especially challenging when children come from high-poverty homes and attend low-income, poorly resourced schools. The transition is also challenging within multilingual education contexts where learners are expected to be biliterate, and reading to learn is done in a language that is not the learners’ home language”. Pretorius further argues that “in South Africa where children are taught in an African language in the Foundation Phase, Grade 4 is particularly challenging because this is when English becomes the LoLT. Not only do learners need to develop adequate oral communication skills in the LoLT, they also need to cope with the increasing conceptual challenges of the Intermediate Phase” Pretorius, 2014: 53).

Wababa describes language as working with two basic functions – outward communication towards others; and internal work on how you think and represent thoughts. Language is vital for all of us to comprehend and deal with reality. It’s our most important tool of communication. One of its most basic functions is that of naming, and within naming is an “implicit conceptual mechanism” (Wababa 2010:23). According to Lambani and Mangena-Netshikweta (2013) “language is the vehicle that carries information”. They argue that “for learning to take place the learner has to understand or become aware of the concepts together with the language through which these concepts are expressed” Lambani and Mangena-Netshikweta (2013: 222).

The above sad situation can be explained in terms of Cummins (1980) Basic Interpersonal Communication Skills (BICS) and Cognitive / Academic Language Proficiency (CALP). Bharuthram (2012), drawing on Cummins (2000), explains that CALP involves the use of context reduced language that comes with written language and use of specialised terms in schools. According to Cummins (2000), as cited by Bharuthram (2012) “academic literacies are context reduced. For successful meaning making, writers and readers are required to share a significant amount of background knowledge. Therefore, CALP, which is context reduced, is needed for the production and interpretation of academic text. On the other hand, BICS is more context-embedded in the sense that meaning making can often be found within the interactional context. This implies that even if a learner has acquired a high level of proficiency in a language, the student is unlikely to succeed if the proficiency is mainly BICS proficiency; therefore, students need CALP to succeed academically” (Bharuthram, 2012: 209).

2.7. The shift in subjects’/ learning programmes’ structure in the IP

The Revised National Curriculum Statement (RNCS) which was phased in in 2002 spreads across three educational phases. The first phase, the Foundation Phase, includes a reception year, Grade R, and Grades 1 to 3, which mark the beginning of more formalised education activities. There are three learning areas in the Foundation Phase, namely: Literacy, Numeracy and Life Skills. The second phase is the Intermediate Phase, and includes Grades 4 to 6. The last phase, the Senior Phase, incorporates Grade 7 to 9 with Grade 8 being the first grade of high school. In the Intermediate and Senior Phases, RNCS stipulates that learners must have eight learning areas/subjects namely: Languages; Mathematics; Life Orientation;

Arts and Culture; Natural Science; Economic and Management Sciences; Social Science and Technology (DoE, 2002).

In November 2010, the Minister of Basic Education, Angie Motshekga, reminded the people of South Africa that “curriculum implementation is a process...we cannot assume that policy can be implemented overnight in a flawless manner” and she went on to say “the National Curriculum Statement is repackaged so that it is more accessible to teachers. Every subject in each grade will have a single, comprehensive and concise CAPS that will provide details on what teachers ought to teach and assess on grade-by-grade and subject-by-subject basis” (DBE, 2010). Part of this curriculum review involved the reduction of the number of subjects in the IP from eight to six, namely: Home Language, First Additional Language; Mathematics; Science and Technology; Human and Social Sciences and Life Skills.

Also significant is that Minister Motshekga reiterated that “while there have been some amendments to the NCS, the aims and values of the curriculum remain the same. The curriculum is based on the acquisition of knowledge, skills and values. It aims to develop the full potential of each learner as a citizen of a democratic South Africa. The curriculum seeks to create a lifelong learner who is confident and independent, literate, numerate and multi-skilled and compassionate, has respect for the environment and the ability to participate in society as a critical and active citizen” (DBE, 2010).

In light of the above explanation, it is recognised that language and conceptual development remains crucial for the successful teaching and learning in the IP right through to tertiary education. As already stated, this current study focuses on how Grade 4 teachers and learners negotiate the introduction of subjects and deal with specialised concepts where learners in the Foundation Phase are taught in isiZulu and then switch to English First Additional Language (FAL) in the Intermediate Phase. Concepts are theoretical meanings that words and other linguistic items represent. Simply, a concept is a common thought or understating which is related to a word or sign in a mind of a person and the forming of a concept is closely related to language acquisition (Lambani and Mangena-Netshikweta, 2013: 222).

Gelman (2009) concurs and says concepts mean mental representations that organise experiences. As mentioned earlier, she shows how even infants make use of concepts. Furthermore, she argues that “concepts are generally understood to be the building blocks of ideas. They are also embedded in larger knowledge structures” (Gelman, 2009: 2).

To gain a full understanding of the research area, it was necessary to read about children's early conceptualisation even though this does not directly relate to this research project and its key questions. Children's conceptual learning entails learning from others: much of their knowledge is derived not from their direct experience with the environment but rather from the input of others (Gelman, 2009). However, she cautions that this "notion that children learn from those around them does not mean that children simply passively take in what they are exposed to". Furthermore, she argues that "both child biases and environmental input are critical, and that it is important not to characterise concept acquisition processes as exclusively either learned or innate. A wide array of concepts requires social input beyond the information children can acquire directly from their senses" (Gelman, 2009: 2).

Gelman goes on to argue that "children make use of several distinct kinds of informational sources when constructing concepts, in addition to their own observations and actions. These include: perceptual cues (which things look most alike); others' actions on the world (how others group objects in the environment, or how they use objects functionally); explicit assertions, and implicit cues from language" (Gelman, 2009:2).

In particular, Gelman focuses on "cues transmitted via language (both explicit assertions and implicit cues) as language is early acquired, as one of the most powerful means of expressing and imparting cultural beliefs, knowledge, and values in humans" (Gelman, 2009:3). She reviews several ways in which language serves as a vital mechanism in conveying conceptual material to children through what she calls testimony, lexicalisation, and covert and implicit categories.

With regards to testimony, Gelman says, "language enables one to express assertions that provide new information, either explicit 'the earth is round' or implicit 'objects can be divided into animate 'he'/'she' and inanimate 'it'" (Gelman, 2009:3). She argues that what other people assert can be key for learning conceptual ideas. More importantly, for this study, she points to Vygotsky (1934/1962) and his distinction between spontaneous and scientific concepts. The crucial point for both Gelman and Vygotsky is that scientific concepts actually need more information than that given just by local experiences. Gelman provides a hypothetical example of how testimony works with a girl learning who hears from her teacher that plants come in male and female genders. This completely takes her by surprise, but she takes it seriously and starts to think about how plants come in different types and that reproduction of plants is strange, interesting and complex.

The second category Gelman uses to focus on the types of information carried to children through language is lexicalisation. Lexicalisation is when a word is attached to a concept in such a way as to make it clear, like when a child learns that the object used to drink out of is a ‘cup’. This is sharper than ‘all the things used to drink out of’. Lexicalised concepts normally have cultural importance, are common within a community, and are fairly steady. Lexicalised concepts have a distinctive role to play, especially for children, as it makes the thing and concept stand out in a way where other things that have similar properties can also be named.

Lexicalisation exerts especially powerful effects with atypical instances (like a penguin is a bird, or a tomato a fruit) that do not much look like their category. Lexicalisation enables some stability and ability to work across contexts and localities, as its meaning is extendable to all instances that have the defining characteristics.

Henning and Ragpot (2014) shed more light on conceptual development and the role of language in the forming of foundational Mathematics concepts in the context of early childhood development in South African. They look at the beginning stages of children’s learning through symbolic means – when they start using language increasingly around the age of three years. One of the vexing questions of cognitive developmental research is how pre-school children’s concepts of number develop once they begin to use language. They outline two types of ‘core knowledge’ of number that exist in pre-linguistic children (and animals). The first system is generally described as the *approximate number system* (ANS), which allows for the (non-exact) distinction between different quantities and is seen as the primary foundation on which symbolic knowledge of number will develop. Innately, humans and other animals are able to distinguish between ‘more’ and ‘fewer’ in a set.

The other system which they say “files individual objects up to three neurologically, is known as the *object tracking system* (OTS). It allows for the recognition of one, two, or three objects”. They say “both behavioural research and neuroscience research have confirmed that infants are able to make a distinction between quantities of many and few (in the ANS) and between one, two, and three (in the OTS) and both research approaches explain that the term ‘magnitude’, instead of ‘number’ would be the appropriate term to use when studying number concept development”. They argue that “this term includes notions of number, space, time rate and probability, all of which are interrelated, not only conceptually but also neurologically, in analogue magnitude”.

“Children across all languages mimic oral counting words in succession soon after they have mastered speech and they recite the ‘counting list’ from verbal memory, not knowing what each numeral beyond three means yet. Children begin to understand the concept of the next number at around the age of three years and thereafter learn the principle of ‘one more’ (Henning and Ragpot, 2014:4). They continue to say “at this point, verbal knowing intersects with conceptual knowing. Gradually, and depending on interaction and on language development and instruction, children learn cardinal values of small numbers beyond three. By the time children go to school around the age of six - seven years, they normally have a good grasp of the cardinal value of small sets and are able to count them out to the ‘total’. They adhere to the cardinal principle” (Henning and Ragpot, 2014:5). They further observe that “language is also likely to be the only connecting feature between OTS and ANS with which to further Mathematical concepts” (Henning and Ragpot, 2014:5).

Over and above that they argue that “if language serves to ‘productively combine’ or ‘assemble’ information from core systems (or one core system) of number in order to form new concepts, there may be implications for dual language learners: children who live in linguistic code-switching environments. In such environments they have to develop conceptual mapping routes for different languages” (Henning and Ragpot, 2014:5)

It is therefore clear that language remains cardinal in conceptual development in the IP especially in the Science and Mathematics curriculum. The majority of L2 learners perform poorly in content subjects such as Mathematics and Science and most studies link this poor performance to socio-economic problems, poor teacher training, teacher absenteeism, lack of teaching and learning resources and poor reading skills (Fleisch, 2008; Spaul, 2011; and Pretorius, 2014). However, few argue the fact that “the inability of these learners to pass Science and Mathematics is due to lack of fluency in the language of instruction” (Wababa, 2010:33). Hence the call for the use of learners’ home language alongside English in the teaching, learning and assessment of learners. He argues that such use would benefit the learners in the conceptual and cognitive challenges that they have to face in their everyday educational experience. Developing the child fully, using her mother tongue would assist her to have more conceptual understanding of the content subjects (Wababa, 2010).

2.8. Effective strategies to deal with the challenges in the IP

I now turn to strategies to effectively deal with transition from the FP to IP which includes language shift and conceptual development (in NS and SS) and the subject structure in the IP in a Second Language Learning context such as the one in which this current study took place. Grade 4 represents a key milestone in how children develop their reading (Zimmerman et al, 2011). Once learners come to Grade 4 (IP) they must start learning the registers needed to understand and produce the language and discourse of their academic content subjects, which Cummins (2000) refers to as CALP (Pretorius 2014). Learners need to become competent in accessing and making meaning from written language with its vast range of vocabulary. To this end, Pretorius (2014) advocates ‘oral reading fluency’ which she sees as the bridge between decoding in the FP and reading for comprehension in the IP. Ready access to print or electronic information and the ability to understand such information fast and accurately are critical factors in the early development of academic literacy. Academic literacy, thus, has its roots in *reading to learn* when learners transition from Grade 3 to 4 (Pretorius, 2014: 53).

Pretorius (2014) argues that for an education system to deliver academic results and produce learners who can maintain a livelihood in the knowledge economy of the 21st century, it needs to produce learners who are fully literate and that irrespective of the language in which early schooling is done, all children need to be explicitly taught to read, and what happens in the classroom has critical consequences for how well children learn to read” (Pretorius, 2014:). Zimmerman et al (2011) concur that the development of reading literacy needs to be viewed as a whole-school responsibility involving teamwork and a co-ordinated approach between teachers and other role-players in a school. She asserts that in effective schools, teachers are committed to the idea that all learners can learn to read and write and thus work to produce this outcome. Zimmerman and Smit (2014) affirm this by arguing that “highly effective Grade 4 teachers distinguish themselves by their abilities to simultaneously instruct learners who are either learning to read, reading to learn, trying to use higher-order thinking skills to gain more information from content-area texts or using higher level comprehension abilities” (Zimmerman and Smit 2014: 2).

The following strategies assist learners to read more speedily and efficiently (Zimmerman et al, 2011; Pretorius, 2014; Zimmerman and Smit, 2014 and Naidoo et al, 2014): activating learners’ prior knowledge; generating questions while reading; visualising text; inferring;

predicting; retelling; deciding what is important; evaluating; synthesising; summarising and graphic and semantic organisers. Zimmerman and Smit (2014) also state that “learners who can understand the plot, character, setting, point of view and theme of texts are better able to understand what they read” (Zimmerman and Smit 2014: 2). Another important point they make concerns vocabulary development. They argue that “comprehension does improve when teachers help learners to understand important vocabulary and concepts they will encounter in their reading, or demonstrate strategies they can use to figure out unknown words as they read. For comprehension development, learners need more opportunities to engage in both written and verbal question answering which requires the deliberation and answering of higher order questions while avoiding closed questions” (Zimmerman and Smit, 2014: 3).

Besides the above reading strategies to improve reading literacy development in the classroom, Pretorius (2014) highlights other enabling or inhibiting factors in the home environment that have an impact on reading literacy development, such as “socio-economic factors, parental literacy levels, the amount and kind of literacy practices in the home, the amount and kind of extended discourse that parents engage in with their children, storybook reading in the home, the support given to children after school for homework activities, and the values that parents assign to literacy practices. She further argues that children who are exposed to storybook reading in the preschool years tend to have larger vocabularies, greater background knowledge, and better language and conceptual development than their peers who have not been exposed to books or storybook reading, and they also learn to read and write more easily and quickly” (Pretorius, 2014: 55).

Pretorius (2014) argues that “reading is more than simply a language issue; even when the LoLT is the home language, reading does not just happen; it needs to be explicitly taught and nurtured” (Pretorius, 2014: 72). Similarly, Rose (2006) argues that reading is seen as the primary mode of learning in formal education. It should be the core focus of teaching and to this end Rose designed a literacy instruction course – the Learning to Read: Reading to Learn (LRRL) programme.

LRRL is “a literacy teaching program designed to enable all learners to read and write at levels appropriate to their age, grade and area of study. It was developed with teachers of primary, secondary and tertiary students of all backgrounds, across Australia and internationally, to support reading and writing across the curriculum” (Culican, 2004: 12).

Rose (2006) states that “using LRRL teaching strategies means that weak readers quickly learn to read and write at grade-appropriate levels, and advanced students show substantial linguistic development. The programme draws on principles of scaffolding learning (Wells, 1999), functional linguistics (Halliday, 1993) and genre approaches to writing (Martin, 1993, 1999, 2001) with the result being that it is accessible, practical and meets the needs of teachers and students” (Rose 2006: 3).

This is how Rose (2006) outlines “the steps involved in the LRRL program: for beginner readers the programme is based on recognising, understanding and spelling words, and reading and writing stories. In the middle school years it extends to techniques for teaching reading and writing of both fictional and factual texts. Teachers support students to read a high-level text, firstly by preparing them to understand the text as it is read aloud, and then giving them meaning cues to recognise and comprehend words within each sentence. As students are actively recognising words for themselves, these reading skills transfer to other contexts over time. Once students can read and understand a text, they prepare to write by spelling words and writing sentences from it, or by taking notes from it. With guidance by the teacher, students then jointly practice writing a new text that follows a similar structure to the original. The final step is then to research, plan and write their own texts, using the language resources they have learnt from the preparatory activities” (Rose 2006: 5).

The need to develop strong language and literacy skills as the foundations of primary schooling is critical for supporting the transition to Grade 4, even in homogeneous, well-resourced schooling systems where the LoLT is the home language (Pretorius, 2014). In school contexts where learners are taught in a language (English) which is not their home language, Pretorius (2014) argues for a strong language and literacy foundation in the home language and in the FAL and warns that if learners start falling behind in Grade 4, it is very difficult to catch up later. If learners come into this transition phase with poorly developed reading skills, the challenges are even greater (Pretorius, 2014). Howie (2012) proposes a strategy to successfully negotiate this transition: all teachers have to be reading teachers and need to be trained to recognise reading difficulties and have the skills to further develop learners’ literacy and comprehension.

Language is critical for cognitive development as it provides the concepts for thinking and therefore a means for expressing ideas and asking questions (Vygotsky, 1989). Comber (1994, p. 657) argues that learners, especially those who are at risk of failing at school (such

as those from disadvantaged backgrounds), do not get access to the languages of power - the 'secret' English demanded by secondary and tertiary schools. Cope and Kalantzis (1990) assert this point by arguing that those who have access to a particular discourse also have access to realms of power. Botes and Mji (2010) suggest that many of learners' problems in Mathematics originate from an inadequate knowledge of the basic vocabulary. The mastery of a specialised subject such as Science is in large part the mastery of its specialised language (Botes and Mji, 2010).

Second language learners often perform poorly academically, particularly in the case of content subjects such as Natural Science, because the language of assessment, both orally and in writing, is solely English (Wababa, 2010). It is in the light of this view point that proponents of Mother tongue education argue for the use of First Language as the language of instruction until a level of academic proficiency has been attained in that language, rather than using a Second Language from the early stages of school (Wababa, 2010; Taylor and Coetzee, 2013; Naidoo, 2014 and Pretorius 2014). Proponents of the bilingual transitional model maintain that a child must first develop cognitively to a sufficient level in the medium of their First Language in order to gain the skills necessary for second language acquisition. Taylor and Coetzee (2013) argue that there is a great interdependence between literacy skills across languages. They also hold that academic proficiency in a language takes considerable time to master – at least five years. Therefore, as the argument goes, once academic mastery in the First Language has been attained, a child will possess the necessary literacy skills to transition to a second language (Taylor and Coetzee, 2013).

Kaschula (2013) also emphasises that “we need to teach our children in the language that they understand best, thereby creating better conceptual understanding, while at the same time properly teaching English as an additional as part of additive bilingualism or even multilingualism”. He uses the example of the Eastern Cape Education Department's Cofimvaba Project where they use Alexander's (2000) model and says “children are taught and examined using isiXhosa in Mathematics, alongside English, and English is taught as a subject”. He further states that “the result is that in these schools the pass rate for the Mathematics national benchmark test has gone up from around 30% to 70% in the past two years” (Mail and Guardian, 2013).

Both the constitution of the country and the language policy in education take it as their point of departure that the 11 official languages used in the country are deemed to be assets rather

than problems (Alexander, 2003; Pliiddemann et al, 1998 and Wababa, 2010). Furthermore, the Language in Education Policy (LiEP) gives a clear directive regarding additive bilingualism, stressing the need to encourage the home language of learners as the foundation for learning additional languages. To concur with this assertion, Heugh (2000) affirms that the current LiEP is based on non-discriminatory language use and the internationally accepted principle of mother tongue education in the context of a bilingual or multilingual framework. The LiEP aims, amongst others, to: ‘pursue the language policy most supportive of general conceptual growth amongst learners, and hence to establish additive multilingualism as an approach to language in education’ (DoE 1997:4).

2 Research Design and Methodology

3.1. Methods of research: Introduction

This chapter describes the approaches, paradigms and research tools employed to explain how the introduction of subjects whilst simultaneously changing the language of instruction in Grade 4 is negotiated. The research project intended to gain insight into the teachers' experiences and perceptions of the language shift and language interaction, the introduction of new concepts, how the transition in Grade 4 from isiZulu to English is managed and the introduction of subjects. Since this study is concerned with the experiences of the people, a case study, qualitative approach, and an interpretive design is appropriate. To gain an in-depth understanding of the situation, lesson observations, unstructured or in-depth interviews and textbook analysis were used to collect qualitative data which in turn was analysed by looking for emergent themes and the findings were then discussed. The manner in which the validity and reliability of the study was ensured and the limitations and ethical considerations of the study are also outlined in this chapter.

3.2. Research style/design

3.2.1. Qualitative design

Qualitative data analysis, Cohen and Manion state, “involves organising, accounting for and explaining the data; in short, making sense of data in terms of the participants' definition of the situation, noting patterns, themes, categories and regularities” (Cohen and Manion, 2007: 461). Christiansen et al (2010) state that qualitative data are textual or verbal and are collected when depth is required. Qualitative research is a form of interpretive inquiry in which researchers make an interpretation of what they see, hear, and understand (Creswell, 2009). As I intended to collect in-depth, rich data that would provide me with an understanding of language concepts and how concepts are used when teaching Grade 4 Natural and Social Sciences, the qualitative research design is appropriate.

The proposed study undertakes to study the situation in its natural state, through the eyes of participants, without the intervention of, or manipulation by, the researcher (Cohen et al, 2007). I set out to describe; summarise; interpret; discover patterns; generate themes;

discover commonalities, differences and similarities (Cohen and Manion, 2007) as well as to examine the application of the issues raised by the theoretical framework. “Qualitative data often focus on smaller numbers of people than quantitative data, yet the data tend to be detailed and rich” (Cohen and Manion, 2007:461) thus I focussed on two Intermediate Phase educators teaching Natural and Social Science and interpreted their experiences of working with learners. In-depth interviews where I asked open-ended questions were used. This enabled my participants to share their experiences of how they deal with the transition at Grade 4 level.

3.2.2. Research paradigm

In line with this qualitative design, the interpretivist approach is appropriate as it attempts to understand human and social reality. As argued by Cohen, Manion and Morrison (2007), the central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience. They assert that meaning and interpretation is paramount. Efforts were made to get inside the situation and to understand from within by observing the teachers whilst teaching, interviewing them and conducting an extensive text book analysis.

This approach views people as intentional, meaning making human beings who are creative and active (Blumer, 1996 cited by Cohen and Manion, 2007). It holds a view that the social world should be studied in its natural state, without the intervention of, or manipulation by, the researcher. Furthermore, researchers need to examine situations through the eyes of participants rather than the researcher (Cohen and Manion, 2007).

Central in the study are meanings and interpretations of the participants’ language practices. Habermas (1984) in Cohen et al (2007) describes this as a ‘double hermeneutic’, where people strive to interpret and operate in an already interpreted world. Hermeneutics involves recapturing the meanings of interactions of others; recovering and reconstructing the intentions of the other actors in a situation. Such an enterprise involves the analysis of meaning in a social context (Cohen et al, 2007, citing Held, 1980).

3.2.3. The research approach

The research style is a case study, defined by Cohen et al (2007) as a specific instance that is frequently designed to illustrate a more general principle. “A case study, they say, is the study of an instance in action; the single instance is of a bounded system, for example a child, a clique, a class, a school or a community. Case studies provide a unique example of real

people in real situations, enabling readers to understand ideas more clearly than simply by presenting them with abstract theories or principles. They enable readers to understand how ideas and abstract principles can fit together. Furthermore, case studies opt for analytic rather than statistical generalisation; that is, they develop a theory which can help researchers to understand other similar cases, phenomena or situation” (Cohen et al, 2007: 253).

One of the strengths of case studies, they say, is that “they can establish cause and effect; they observe effects in real contexts, recognising that context is a powerful determinant of both causes and effects.” In addition, “context is unique and dynamic, hence case studies investigate and report the complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance” (Cohen et al, 2007: 253). In this study the researched instance in action is Grade 4, the first class in the IP where transition occurs in both the LoLT and from learning to read to reading to learn.

This study aims to explore the situation when new concepts are presented, taught and learnt and in particular, how teachers and learners negotiate the transition issues at Grade 4 level. The study is intended to focus on how language concepts in Grade 4 are structured and also to look at how teachers work with concepts from isiZulu to English and from English to isiZulu when presenting new content knowledge in Natural and Social Sciences.

This case study is combined with a more deductive analytical approach that uses the concepts of Vygotsky’s conceptual development, Maton’s LCT - semantics and Brown’s MMCC to analyse the data sets. As mentioned before, the study follows an interpretive design hence theory is emergent and ‘grounded’. Theory will arise from analysing the data collected from teacher interviews, lesson observation and textbook analysis. According to Cohen et al (2007), in qualitative data analysis there is often a mixing of interpretive work and analysis, with both often happening together at the same time (Cohen et al, 2007: 495). I intend to work directly with the teachers, examining their experiences and understanding of effecting the transition in Grade 4. Thus theory will be a set of meanings which produce insight, understanding and experiences of how teachers negotiate the introduction of subjects whilst simultaneously changing the language of instruction at Grade 4 level.

3.3. Data collection

To collect rich, in-depth data for this research the participants were interviewed, their lessons were observed and textbooks were analysed.

3.3.1. Lesson observations

One of the data production techniques used was observations. I observed teachers' lessons and their interaction with learners: planned, unplanned, verbal and non-verbal. Observations offered me, as Cohen et al (2007: 397) put it, “an opportunity to gather ‘live’ data from naturally occurring social situations”. In this way, I looked directly at what takes place *in situ* rather than relying on second-hand accounts. Kumar (1999) says observation is “a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place” (Kumar, 1999: 140). I recorded the verbal interaction to do analyses of the transcripts at a later stage.

Observation means that the researcher goes into a school or classroom and examines what is actually taking place there (Sarantakos, 1998; Kumar, 1999; Gay et al 2006 and Christiansen et al, 2010). An advantage of observation is that it is a powerful method for gaining insight into situations (Christiansen et al, 2010). Similarly, Cohen et al (2007) argue that “observations enable the researcher to gather data on the physical setting for example, the physical environment and its organisation and the human setting for example, the organisation of people: the characteristics and make-up of the group or individuals being observed, for instance gender and class” (Cohen et al, 2007:397:). In this way, the researcher can see what is actually happening in the classroom and does not have to rely on the opinions of others. In this instance, observing the participants’ lessons enabled me to see how teachers actually negotiate the introduction of subjects whilst simultaneously changing the language of instruction at Grade 4 level.

“Observations in qualitative research draw the researcher into the phenomenological complexity of participants’ worlds; here situations unfold, and connections, causes and correlations can be observed as they occur over time. The qualitative researcher aims to see intentionality, to seek nature of events, to see intentionality and to seek trends and patterns over time” (Cohen et al, 2007: 397). Furthermore, traditionally observation has been characterised as non-interventionist, where the researcher does not seek to manipulate the situation or subjects (Cohen et al (2007).

In this study the classroom observations were undertaken by me as the researcher. During this process I took no part in the teaching and learning process, but remained an outside observer. A distinction between unstructured and structured observation is drawn by Sarantakos (1998), Kumar (1999) and Christiansen et al (2010). To assert this distinction, Cohen et al (2007) state that the kind of observations available to the researcher lie on a continuum from unstructured to structured, responsive to pre-ordinate.

Firstly, unstructured observation means that the researcher focuses on one or two aspects to observe and makes notes on those particular aspects. During this process, other issues may arise that the researcher may wish to pursue. Particular categories and checklists on a schedule are not used. Instead, the researcher writes a free description of what is observed and accepts that it is not possible for one person to notice everything. In addition, the observer goes into a situation and observes what is taking place before deciding on the significance for the research (Cohen et al, 2007).

Secondly, a structured observation is when the researcher directly observes some phenomenon and then systematically records what is being observed. This works best when the researcher has a very clear idea of what is expected and uses a structured observation schedule with observation categories which are worked out in advance. In a nut shell, a structured observation will already have its hypotheses decided and will use the observational data to confirm or refute these hypotheses (Cohen et al, 2007).

For the purpose of this research, unstructured observation was used. My reason for observing the participants' lessons was to observe the methods they employed in the classroom to teach Natural and Social Science in Grade 4. I wanted to investigate how the teachers managed the transition from the Foundation Phase to Intermediate Phase: the language shift as well as the introduction of subjects, that is, how they went about teaching content subjects in English to learners who for four years have been taught in the mother tongue, isiZulu. I also wanted to observe whether what occurred during pedagogical practice, in the classroom, was consistent with the presentation and explanation of concepts in the teaching text. By using unstructured observation, I was able to observe all aspects of the pedagogical interaction in the classroom. I observed and recorded two lessons per educator and visited their classes at the start of the third term. The lesson observations were conducted before the interviews because I wanted to observe how the teachers introduced the new modules at the start of the new term and to prevent them from being influenced by the interview questions and change both their

attitudes and lesson presentations. Interviews were scheduled to follow soon after the observations.

An audio recorder was used to ensure that the observed information was not lost or omitted. Later the tape-recorded information was transcribed into a data set which would be used for analysis purposes. These two strategies allowed me to thoroughly examine data, looking for specific themes and categories. Again, the use of a video recorder may have offered certain advantages but the audio recorder, being more compact, was less obtrusive and invasive so the educator and learners were more likely to behave naturally and give me an accurate picture of the regular occurrences of their pedagogical practices.

3.3.2. Interviews

The second technique used to collect data was the interviews. This technique is “a commonly used method of collecting information from people” (Kumar, 1999: 144). On the one hand interviewing, Kumar (1999) delineates, “can be very flexible, when the interviewer has the freedom to formulate questions as they come to mind around the issue being investigated, and on the other hand it can be inflexible, when the investigator is to keep strictly to the questions decided beforehand” ((Kumar, 1999: 144).). In Cohen's et al (2007) terms, “the use of interviews in research marks a move away from seeing human subjects as simply manipulatable and data as somehow external to the individual”. In this study I intended to use interviews as a means of examining and interpreting the teachers’ world of language usage, conceptual development and notions of transition from the Foundation Phase to the Intermediate Phase. The interviews also serve as a means for participants to articulate their views about dealing with curriculum challenges at the Grade 4 level.

Interviews are further classified as ‘unstructured’ or ‘structured’ according to their degree of flexibility (Sarantakos, 1998; Kumar, 1999; Gay et al, 2006 and Cohen et al, 2007). For the purposes of this study, I opted for unstructured interviews, also known as in-depth interviews. Within this idea , Kumar, (1999: 160) outlines, “the interviewer formulates questions spontaneously during an interview. Unstructured interviews can be carried out in a one-to-one situation or with a group of respondents” (these are called focused group or group interviews).

This approach to data collection is extremely useful in situations where either in-depth information is needed or little is known about the area. The flexibility allowed to the interviewer in what she/he asks of a respondent is an asset as it can elicit extremely rich information. As it provides in-depth information, many researchers use this technique for constructing structured research questions (Kumar, 1999).

Cohen et al (2007) outline the advantages of interviews. “Firstly, interviews allow for greater depth than other methods of data collection do in the sense that the researcher is present with the respondent so questions can be clarified. Secondly, interviews have a higher response rate than questionnaires because respondents become more involved, and hence motivated. They also enable more to be said about the research than is usually mentioned in a covering letter to a questionnaire and they are better than questionnaires when it comes to handling more difficult and open-ended questions. With interviews the researcher can probe and ask further questions to obtain more detail if the response given was insufficient or suggests that the research participant could give extra information relevant to the study. Lastly, it is easier for a participant to talk to an interviewer than write long responses in a questionnaire. This means that more detailed and descriptive data is usually collected” (Cohen et al 2007: 352).

I interviewed two Intermediate Phase educators who teach Grade 4; one teaches Natural Science and the other Social Science. The interviews were approximately half an hour long and were conducted on two separate occasions at a time and venue selected by the participants as I wanted to ensure that the participants were comfortable and at ease so they would be open to sharing the details of their teaching experiences. The interviews focus was on their experiences with working with Grade 4: how they manage the entire transition and all the curriculum challenges that come with it from the Foundation Phase to the Intermediate Phase.

The interviews also aimed at exploring how the teachers deal with the introduction of specialised concepts in these subjects, that is how these new concepts are presented, taught and learnt, in particular, how teachers and learners negotiate the language issues at Grade 4 level in Natural and Social Sciences. The interviews were recorded with an audio recorder with the teachers’ informed consent, in a place preferred by the respondents and at a time which was convenient to them. The tapes were then transcribed into MS Word documents which were then analysed. As part of analysing the transcribed data, I went carefully through the data to try to find common themes in the articulations of the respondents.

To prepare and plan exactly what information to solicit from the teachers, I had prepared standardised open-ended questions. Whilst conducting the interviews, I had to ensure that my full attention was given to the participants so that I could ask for detailed explanations or clarity if the participants' responses were vague. I also modified questions that were answered as part of conversations to avoid the participants becoming frustrated at having to repeat what was already said. To ensure that I was able to do this and to keep the conversation between the participants and myself flowing, I used a tape recorder instead of taking detailed notes. This also ensured that valuable information was not overlooked or forgotten as note taking requires summarising, and leaves the researcher at risk of not capturing all relevant information. Using a tape recorder also saved time as the participants did not have to wait for me to finish writing down the responses before moving on to the next question. Tape recording also helped me to ensure that information was not distorted and the complexity of the responses was not reduced. Although video recording would have provided more detail in terms of body language and facial expressions, the tape recorder was less intrusive so the participants were more relaxed and secure during the interview process than they would have been if they had been video recorded.

These interviews further allowed the participants to reflect on their teaching experience and approaches as they responded to questions about effective teaching at Grade 4 level. Therefore, they could possibly have identified their strengths and the areas they needed to develop. This could help them become more effective Intermediate Phase teachers. In turn, the interviews allowed me to interact with the participants on a one-on-one basis in a conversational, personal manner.

In analysing the interviews, I did have to bear in mind what Cohen et al (2007) warn about validity. Participants can behave differently when subjected to scrutiny or placed in new situations, for example the interview situation.

3.3.3. Textbook analysis

As already mentioned, the study focuses, in the main, on the introduction of specialised concepts and new academic words used by the teachers and learners in the process of knowledge building at Grade 4 level. It also aims at exploring the situation where new concepts are presented, taught and learnt, in particular, how teachers and learners negotiate the language issues at Grade 4 level in Natural and Social Sciences. For this reason, the third technique used to collect data was textbook analysis. In NS during the third term, the time in

which the class observations were to take place, Grade 4 does module 3 – Energy and Change. In Social Science they have Food and Farming in South Africa, a Geography section.

The main goal for analysing the teaching texts was to look at how specialised concepts are introduced and used at Grade 4 level in Natural and Social Sciences. To this end, I used content analysis, defined by Cohen et al (2007: 475) “as the process of summarising and reporting written data – the main contents of data and their messages”. Furthermore, they define content analysis “as a research technique for making replicable and valid inferences from texts to the contexts of their use. Texts are defined as any written communicative materials which are intended to be read, interpreted and understood by people other than the analysts” (Cohen et al, 2007: 475). I used content analysis to examine and verify the contents in textbooks, especially the use of specialised concepts, which is how the text books introduce these concepts to Grade 4 learners. I focussed on how they are defined and interpreted in order to be used effectively by learners.

For this study content analysis has several advantages. Firstly, “it is an unnoticeable technique in that one can observe without being observed. Secondly, it focuses on language and linguistic features and meaning in context. Thirdly, it is systemic and verifiable (for example, in its use of codes and categories) as the rules for analysis are explicit, transparent and public. Further, as the data are in a permanent form (textbooks), verification through reanalysis and replication is possible” (Cohen et al, 2007: 475).

Content analysis, Cohen et al (2007) assert, “takes texts and analyses, reduces and interrogates them into summary form through the use of both pre-existing categories and emergent themes in order to generate or test a theory. It uses systematic, replicable, observable and rule-governed forms of analysis in a theory-dependent system for the application of those categories” (Cohen et al, 2007: 476). In line with this assertion, in this study I used, as the theoretical framework: Vygotsky’s conceptual development (1934/1987), Maton’s LCT-semantics (2009), Brown’s MMCC (2005) and Naidoo’s Technical Lexis (2013) to examine how the text books introduce concepts to Grade 4 learners – how they are defined and interpreted in order to be used effectively by learners.

3.4. Data analysis and trustworthiness

The next step after collecting data is data analysis. “Data analysis involves organising, accounting for and explaining the data, in short, making sense of data in terms of the participants’ themes, categories and regularities by looking at a bigger picture and starting to list ‘themes’ seen emerging in the literature review and in the data collection” (Cohen et al, 2007: 461). Moreover, they state that inductive reasoning starts with raw data collected within which patterns and regularities are sought, as a basis for formulating some tentative hypotheses to explore. Finally, general conclusions and theories may be drawn (Gay et al, 2006). In this regard, I intended to look for emergent themes. I looked at how teachers present and explain concepts to learners, using classroom observations, teacher interviews, textbook analysis as well as insight gained during the review of related literature. Data analysis was an emergent language of description, looking for themes thereafter producing a detailed qualitative discussion of these themes.

This emergent type of content analysis is combined with a more deductive analysis that uses the concepts outlined in the theoretical framework as an external language of description to analyse the data. For example, I used concepts from Vygotsky’s conceptual development, Maton’s LCT-semantics, Brown’s MMCC and Naidoo’s Technical Lexis to analyse the contents of teachers’ responses to the interview questions, to deductively analyse the concepts used by teachers during their observed lessons and to examine the portrayal of concepts in the teaching texts, that is, I attempted to recognise these theoretical concepts in data.

“Theory generation in qualitative data can be emergent, and grounded theory is an important method of theory generation”, according to Cohen et al (2007: 491). Moreover, they state that “grounded theory analysis proceeds through a systematic series of analyses, including coding and categorization, until theory emerges that explains the phenomena being studied or which can be used for predictive purposes” Cohen et al (2007: 491)..

3.5. Context and sampling

This research study took place in my teaching context (Kwangobese Primary School – a pseudonym). The school is part of the greater uMgungundlovu district, in the Sweetwaters

Circuit, located on the outskirts of Pietermaritzburg, KZN. The area and the community of the school are impoverished: most learners' parents are unemployed and there are pensioners and government-grant-dependent young people. Although there is a sufficient number of classrooms and furniture, for example learners' desks, the school lacks resources such as libraries, science and computer laboratories and proper sports facilities. The school is also characterised by a severe lack of proper infrastructure such as lavatories, for both teachers and learners.

However, the school does have photocopiers and four computers accessible to the administrative personnel and teachers (albeit very few of them are computer literate). As it is a primary school, there are learners from Grades R – 7. There is a strong emphasis on teacher development so the Senior Management Team (SMT) encourages teachers to further their studies, attend curriculum workshops organised by DBE and network with partners such as Vula in Hilton College. In a bid to encourage reading, the school recently adopted the 'drop everything and read' reading strategy. To this end, time is allocated every Thursday afternoon from 1:45pm to 2:15pm. All the educators and learners are isiZulu home language speakers. At this school isiZulu is offered at Home Language level and English at First Additional Language level. The language of learning and teaching is isiZulu from Grades R-3 and English First Additional language from Grades 4-7.

The participants involved in this study are two female teachers: one teaches Natural Science and the other Social Sciences in the Intermediate Phase. Both come from non-English speaking backgrounds, and both are experienced teachers who have been teaching for over twenty years in this school and have spent a number of years working in other schools earlier in their teaching careers.

My choice of sampling is both *convenience* and *purposive* as the respondents are within my teaching context (Cohen et al, 2007). Since they teach in my school, I have easy access to them. This choice did not represent any group apart from itself; it would not seek to generalise about the wider teaching population.

In defining this type of sampling, Cohen et al (2007) state that researchers "handpick the cases to be included in the sample on the basis of their judgment of their typicality or possession of the particular characteristics being sought. In this way, they build up a sample that is satisfactory to their specific needs" (Cohen et al 2007:114). In many cases purposive sampling is used in order to access 'knowledgeable people' (in this case the two teachers), in

other words, those who have in-depth knowledge about particular issues (teaching Grade 4). This knowledge may be by virtue of their professional role, power, access to networks, expertise or experience (Cohen et al, 2007).

3.6. Validity, reliability and triangulation

Cohen et al (2007) define reliability “as a fit between what researchers record as data and what actually occurs in the natural setting that is being researched, that is a degree of accuracy and comprehensiveness of coverage. In qualitative data, validity may be addressed through depth, richness, honesty and scope of the data achieved, the participants approached, the extent of triangulation and the disinterestedness or the objectivity of the researcher” (Cohen et al, 2007: 133). Moreover, they say, in qualitative data, validity might be improved through careful sampling, and appropriate instrumenting. The use of the different methods of data collection in my study is to ensure accuracy and comprehensiveness of coverage.

The validity methods employed in this study included the “interpretive validity (the ability of the research to catch the meaning, interpretations, terms, intentions that situations and events, that is, data, have for the participants/subjects themselves, in their terms). It is similar to notions of ‘fidelity’ – what it means to the researched person or group (what is subjectively meaningful). Also of importance was theoretical validity (the theoretical constructions that the researcher brings to the research, including those of the researched). Theory here is regarded as explanation. Theoretical validity is the extent to which the research explains phenomena; in this respect is it akin to construct validity. With theoretical validity the constructs are those of all the participants” (Cohen et al, 2007: 135).

Qualitative researchers need to document the procedures of their case studies and to document as many of the steps of the procedures as possible, setting up a detailed case study protocol and database. Transcripts need to be checked to make sure that they do not contain obvious mistakes made during transcription. Drifts in the definition of codes – a shift in the meaning of the codes during the process of coding – need to be avoided. This can be accomplished by constantly comparing data with the codes and by writing memos about the codes and their definitions (Creswell, 2009).

In qualitative research, “the suitable terms for reliability are ‘credibility’, ‘neutrality’, ‘confirmability’, ‘dependability’, ‘consistency’, ‘applicability’, ‘trustworthiness’ and ‘transferability’, with the notion of ‘dependability’ being key (Cohen et al, 2007:148). In qualitative research, “reliability can be regarded as a fit between what the researcher records as data and what actually occurs in the natural setting that is being researched. Dependability involves member checks (respondent validation), debriefing by peers, triangulation, prolonged engagement in the field, persistent observations in the field, reflexive journals, negative case analysis and independent audits” (Cohen et al, 2007: 149).

Triangulation, as defined by Cohen et al (2007), “is the use of two or more methods of data collection in the study of some aspect of human behaviour”. Moreover, “triangulation attempts to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint. Triangulation is a powerful way of demonstrating concurrent validity, particularly in qualitative research. If, for example, the outcomes of classroom observation correspond with those of the interviews and textbooks analysis, the more the researcher can be confident about the findings” (Cohen et al, 2007: 141).

It should be noted that responses during interviews are subjective. Thus, to ensure trustworthiness as far as possible, both the interviews and the pedagogical observations were tape recorded and then transcribed and read by both the researcher and the supervisor. The findings were discussed with the research participants to ensure that data reflected what they had intended to say and to allow them to give information that facilitated correct interpretation.

In line with what Creswell (2009) says, the data was carefully analysed to ensure that there were no contradictions or inconsistencies and more than one method was used to collect data (triangulation). In addition to pedagogical observation, I used unstructured interviews to elicit information about the educators’ experiences with the teaching of Grade 4. It is important to point out that as only one school is used in this research, the results are not meant to be generalised. They reflect these particular teachers’ experiences of the language shift and interaction, introduction of new concepts, how the transition in Grade 4 from isiZulu to English is managed and the introduction of subjects. However, by providing detailed descriptions of the research context and by using several data collection methods, validity is

enhanced and findings could possibly apply to similar contexts (Creswell, 2009; Cohen et al, 2007).

3.7. Design limitations

One of the limitations of my study is the difficulty in forming a research team that includes colleagues from my school as research subjects. Another reservation about involving them was that they were busy trying to familiarise themselves with CAPS demands and ensure their own intended programmes materialised. The third limitation is that I might have been viewed as biased since I am in a leadership position in the school where the research took place. Open discussion with the teacher-respondents about their responses being used exclusively for this study, and not in other school-related contexts, overcame this potential limitation. This also helped to ease other constraints especially regarding the two teachers who are the research subjects, it helped to reconcile the fact that one is in leadership position. During the interviews with the teachers and lesson observation I was always mindful of this limitation and freely discussing it with the respondents in order to calm their feelings, attitudes, perceptions and their values during the research process.

The fourth limitation was the power relations in the research context, particularly during the pedagogical observation in the class. The fear was that both the teachers and learners would change their ordinary and everyday 'behaviour' since they would be aware of the researcher (the school principal) during their lesson. This limitation was overcome by ensuring a number of visits to the classrooms before the actual recording of the observed lessons, to allow both the teachers and learners to get used to the idea of a non-participant observer using a tool which does not obstruct or catch the attention of the subjects – the tape recorder.

I found the theoretical framework underlying this study to be very difficult, especially Brown's MMCC. For me it was too philosophical and abstract, particularly the way in which language is used to foreground certain concept. Lastly, the review of the related literature was also a challenge in the sense that research relating to the transition in South Africa primary education (From the Foundation Phase to the Intermediate Phase) is limited. This constrained access and the availability of relevant literature to this study.

3.8. Ethical issues

The following ethical principles were followed whilst conducting this research. Since the study was conducted in my own teaching context, I suggested a pseudonym for my school. In this study it is referred to as Kwangobese Primary School. I did the same for the two respondents. For the purposes of ‘gaining access to the school’, permission was sought from the Department of Education and I complied with the ethical procedures of the University of KwaZulu-Natal. Consent was sought from the two educators. Also, the participants were assured that all data collected would be kept confidential and that they would remain anonymous when this research is published. The purpose and the benefit of the study was made known to the two teachers. They were also advised that their participation in the study is entirely voluntary; if they wanted to withdraw from it they were free to do so without fear of personal harm and academic sanction. Finally, the participants were informed and understood fully that the purpose of the research was to gain insight into their experiences and perceptions of the language shift and interaction, introduction of new concepts, how the transition in Grade 4 from isiZulu to English is managed and the introduction of subjects. As a result, care was taken to ensure that throughout this research project emphasis was placed on building the educators’ confidence so that they were comfortable to openly speak about their experiences, rather than feel demoralised. Thus this research was beneficial to them and in no way caused harm.

3.9. Conclusion

4.1 In this chapter the research methodology and design used to conduct the research project was discussed. The study was qualitative and located within the interpretivist approach. Lesson observations, unstructured or in-depth interviews and textbook analysis were used to collect qualitative data and the data analysis process was discussed. The manner in which the validity and reliability of the study was ensured was discussed and the limitations and ethical

3 Theoretical framework

4.1 Introduction

This study focuses on Grade 4: how Grade 4 works with the introduction of new subjects and new specialised concepts in a primary school where learners in the Foundation Phase are taught in isiZulu and then switch to English First Additional Language (FAL) in the Intermediate Phase. The study tries to critically examine the concepts, interactions and new academic words used by the teachers and learners, in the process of knowledge building. I will be focusing specifically on Natural and Social Sciences in Grade 4.

The main purpose of the study is to critically examine the interactions and new academic concepts used by the teachers and learners in the process of knowledge building at Grade 4 level. This research also aims at exploring the situation when specialised concepts are presented, taught and learnt; in particular, how teachers and learners negotiate the language issues at Grade 4 level. The focus is on curriculum and pedagogy in Grade 4 to see how concepts and terminology are structured and also how teachers work with the concepts from isiZulu into English and from English into isiZulu when presenting new content knowledge in Natural and Social Sciences.

This chapter discusses the theoretical framework which underpins data analysis in this research. The key theories that support this study are Vygotsky's conceptual development (1934/1987), Karl Maton's LCT (2009), Long's Interaction Hypothesis (1996) and Brown's Multidimensional Measure of Conceptual Complexity 2005 (MMCC).

4.2. Vygotsky's conceptual development

Smagorinsky (2013) outlines "how, as a developmental psychologist, Vygotsky was concerned with the ways in which people construct concepts over time, particularly through their attribution of meaning to words that they learn through cultural engagement. Vygotsky's idea of concept development focuses on the manner in which children gravitate to the norms of relatively stable adult communities of practice in which conceptual agreement provides the mediational context of their development" (Smagorinsky 2013: 239). Concept development, Vygotsky delineates, "begins with an infant's exposure to human contact and the

expectations that others have for a child in the greater draft of human societal activity. Concepts”, he continues to argue, “epitomise the most advanced distillation of a culture’s perspective, beliefs, and constructions, representing the mental state that provides human activity with the impetus for purposeful action while simultaneously serving as a psychological means through which it is directed” (Smagorinsky 2013: 239). To assert this point, van der Veer (1994) argues that “the acquisition of mature academic concepts forms the crowning achievement of adolescence”. “Mature conceptual thinking, van der Veer further argues, positively influences the cognitive domain but also the aesthetic reactions and emotions a person has. Conversely, the breakdown of conceptual thinking in pathology will lead to severe intellectual impairment but also to emotional dullness, for example”(van der Veer 1994: 293).

4.2.1. Vygotsky’s general model of concept formation

Wellings (2003) argues that Vygotsky considers conceptual formation to be an iterative and dynamic activity. In other words, concepts develop as a result of complex problem solving. “Concepts are fluid in that other intellectual processes affect their development. The use of language is key in the process of concept development and the necessary constant movement between abstract and concrete ideas. Through a series of experiments where children, adolescents and adults sorted objects according to some criterion, Vygotsky identified three broad phases in the process of concept formation: 1) the formation of syncretic heaps, 2) thinking in complexes, and 3) concept formation” (Wellings 2003, p 3).

4.2.2. Complex, pseudoconcept, concept

To further elucidate Wellings’ (2003) assertion, Smagorinsky (2013) outlines that “Vygotsky’s concepts are distinguished by the fact that all of the individual elements they encompass are unified by a single theme. Along the path toward concepts people develop complexes and pseudoconcepts, both of which approximate the unity of elements found in concepts but include inconsistencies” (Smagorinsky 2013: 241). What follows is an outline of what Vygotsky argues to be a broad developmental sequence of moving from a complex to a pseudoconcept to a concept.

A complex, Smagorinsky (2013) explains, “lacks the unity that might be available through either scientific or spontaneous concepts. When people think in terms of complexes, any connection is sufficient to lead to the inclusion of an element in a given complex. To assert this point” (Smagorinsky 2013: 241), Wellings (2003) argues that the main function of complexes is to establish bonds and relationships. This starts with scattered impressions

being organised into discrete elements of experience into groups which can then form the basis for broader generalisations. A pseudoconcept provides the developmental bridge. Wellings (2003) provides a useful illustration of this idea in describing the way a child uses words when communicating with an adult:

‘The child learns very early a large number of words that mean the same to him and to the adult. The mutual understanding of adult and child creates the illusion that the end point in the development of word meaning coincides with the starting point, that the concept is provided ready-made from the beginning, and that no development takes place.

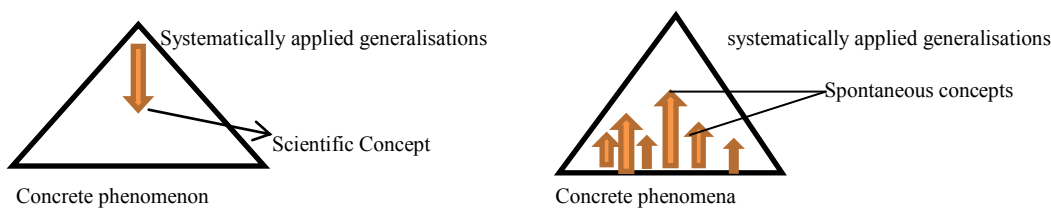
In this case, it might be assumed that the child has qualitatively similar thought to that of the adult. However, further investigation into the child’s comprehension of word meaning reveals any number of complex associations’ (Wellings, 2003, p 5)

Wellings concludes the argument by asserting that “it is valuable to consider the nature of these complexes as they represent strategies children utilise when attempting to assimilate culturally embedded concepts embedded within both school and everyday activities” (Wellings, 2003, p 5). Vygotsky, as cited by Wellings, states that, “in real life complexes corresponding to word meanings are not spontaneously developed by the child. The lines along which a complex develops are predetermined by the meaning a given word already has in the language of adults” (Wellings 2003: 5). Through the use of complexes, Wellings further argues, “the child is utilising behavioural and intellectual interactions with the world to develop relevant structures for engagement” (Wellings 2003: 5).

4.2.3 Scientific and spontaneous concepts

Vygotsky (1934/1987), as Smagorinsky (2013) argues, made a basic distinction between spontaneous and scientific concepts. Scientific concepts are very different to spontaneous concepts as they are learnt through highly specific conventions and practices that are normally clear, systematic, and build upwards on each other in logical and connective ways that are not obvious to the everyday eye. To concur with this point, Wellings (2003) argues that scientific concepts have a strong deductive base where the child learns the formal and abstract conceptual systems of different specialisations. Often the child is given the task of showing what the concept means by giving instances that show the child gets it.

Graphic representation of scientific and spontaneous concepts (Wellings, 2003: 6):



Spontaneous concepts, on the other hand, come from everyday engagement and experience of life, and because this is where the spontaneous concepts come from, this is where they also have most relevance. They tend to have strong local flavours and connections. The development of spontaneous concepts, in Wellings' view, can be considered an inductive process. Rather than taking an already existing and formal schema, the spontaneous concepts rise upwards, inductively, from the patterns of everyday (Wellings, 2003: 6).

To concur with Smagorinsky's assertion, Wellings (2013) citing Vygotsky (1934/1987) elucidates that:

“If we imagine the totality of concepts as distributed over the surface of the globe, the location of every concept may be defined by means of a system of coordinates, corresponding to longitude and latitude in geography. One of these coordinates will indicate the location of a concrete between the extremes of maximally generalised abstract conceptualisation and the immediate sensory grasp of an object – i.e. its degree of concreteness and abstraction.

The second coordinate will represent the objective reference of the concept, the locus within reality to which it applies. Two concepts applying to different areas of reality but comparable in degree of abstractness – for example, plants and animals – could be conceived of as varying in latitude but having the same longitude.

The ‘longitude’ of concept will, thus, be the characteristic of thought process, while the ‘latitude’ will be the characteristic of their objective reference. These two parameters must be sufficient to provide exhaustive information on the nature of a concept. The ‘coordinates’ of a concept determine all relations of the given concept to others, i.e. to its coordinates, superordinate, and subordinate concepts. This position of concept within the total system of concept may be called its *measure of generality*” (Wellings, 2003, pp. 1–2, citing Vygotsky, 1962, pp. 199 – 2003).

Reflecting on Vygotsky's theory, Wellings (2003, citing Wells, 1994) identifies “four main features that distinguish scientific concepts – generality; systematic organisation; conscious awareness; and voluntary control” (Wellings, 2003: 8). Of these four features, two of them

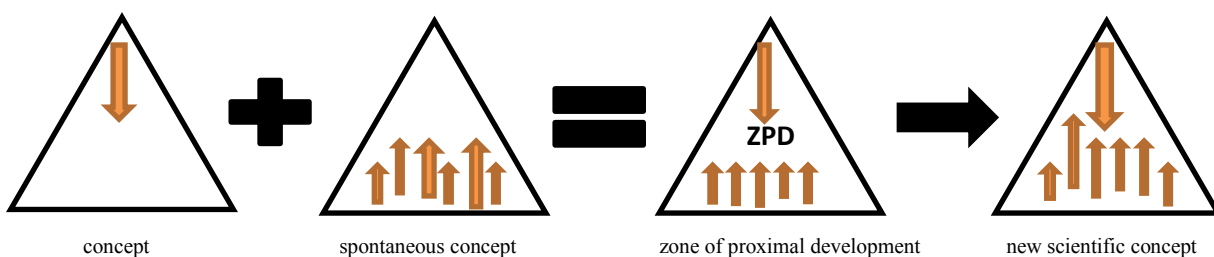
specifically distinguish scientific concepts from spontaneous concepts - generality and systematic organisation. The other two features - conscious awareness and voluntary control – also work with scientific concepts, but have more to do with how these concepts are learned and used. It is clear that scientific concepts cannot just be absorbed by hanging about in local contexts. It is important to have clearly structured and sequenced instruction in schools to enable systematic learning of scientific concepts.

Reflecting more broadly, Wellings states that Vygotsky’s theory of internalisation locates a child’s cultural development in the external social environment before migrating to the internal environment of the child’s mind.

‘Any function in the child’s cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition...it goes without saying that internalization transforms the process itself and changes its structures and functions. Social relations or relations among people genetically underlie all higher functions and their relationships (Wellings, 2003: 8, citing Vygotsky 1981b, p. 163).

The following diagram shows “the relationship between school learning and life learning – the interaction of spontaneous and scientific concepts:

Scientific concepts grow downward through spontaneous concepts, spontaneous concepts grow upward through scientific concepts” (Wellings, 2003:9).



“Spontaneous and scientific concepts play an interdependent role in the development of superordinate concepts. While spontaneous concepts begin in the concrete phenomena of everyday life and scientific concepts begin with abstracted verbal definitions, one does not replace the other in concept formation” (Wellings, 2003: 9). They are both needed.

Another way of understanding concept formation that relates to Vygotsky's model is Fauconnier and Turner's (1994) conceptual blending. This model relates to Vygotsky's theory of concept formation in that conceptual blending, as defined by Fauconnier and Turner (1994, cited by Klopper, 1999, in Buthelezi, 2008: 185) is a "momentary process of symbolisation that selectively inter-relates concepts from two separate cognitive domains, a target space and a source space to conceptualise a new perceived relationship known as a blend space". At the heart of this process is a linking of two previously unconnected concepts or processes into a new synthetic pattern that contains elements of both. This clearly has relevance for spontaneous and scientific concepts as discussed above - basically two concepts combine to form a new concept (spontaneous and scientific concepts) known as a blend, the blended concept emerges with a new meaning.

4.3. Karl Maton's Legitimation Code Theory

As stated earlier, the present study sets out to critically examine the transition from Grade 3 to 4 in order to get a picture of how new concepts are presented during lessons and in particular how certain concepts are structured in Natural and Social Sciences. I looked at textbooks in order to gain insight into the language shift from isiZulu in Grade 3 to English in Grade 4 and the shift from the everyday/general and concrete to more specific, complex and abstract concepts in both these subjects.

I now outline two theoretical frameworks that I used in order to try to critically examine the language transition from Grade 3 to 4 and the concepts shift in Grade 4. One of these frameworks that this study adopts is the framework called Legitimation Code Theory (LCT) outlined by Karl Maton (2013). The other way of theorising concept development is one presented by Devika Naidoo (2013).

LCT as a framework must be understood as a "sociological toolkit for the study of practice. It forms a core part of social realism, a broad 'coalition' of approaches which axiomatically reveal knowledge as both socially produced and real" (Maton, 2013:10). This framework, Maton further argues, takes the work of Bernstein and Bourdieu and builds on them. The model has five dimensions, however the relevant one to this study is Semantics, which Maton (2009) says arose from engagement with ideas such as grammatical metaphor and technicality, and primarily builds on the concepts *semantic gravity*, *semantic density*,

constellations and *cosmologies*. The focus of this study is on the first two concepts: semantic gravity and semantic density.

Semantic gravity (SG) captures how meaning is related to context and locality. The more local and contextual the meaning is the heavier its gravity (the closer it is to earth one could say). Maton indicates this as stronger semantic gravity (SG+). Weaker semantic gravity is where the meaning is less located and contextual, more up in the air, more rarefied, more abstract (SG-).

Maton then introduces the concept of *Semantic density* (SD) that catches a very different but related logic to SG. It is possible to get abstract terms that don't carry much meaning inside of them, and other abstract terms that pack many distinctions inside of it. Some abstract terms are denser than others, they pack more meanings in, they are more condensed. Semantic density can also be relatively stronger (+) or weaker (-). Where semantic density is stronger (SD+), symbols have packed onto them lots of different distinctions and meanings; when semantic density is weaker (SD-), symbols are more broad and general and don't contain that much extra subsections and parts to it.

The significant part of this framework is that semantic gravity and semantic density may be independently stronger or weaker along two continua of strength (SG+/-, SD+/-). This is very helpful for this study, as it is possible at Grade 4 level to start working with more abstract concepts (increasing semantic gravity) but to keep the concepts very low on semantic density to ensure learners can make sense of the abstraction without getting confused. It is also possible to keep the semantic gravity low, but to work with more distinctions (increasing semantic density. Christie and Maton (2011) also describe the process of:

- Weakening semantic gravity, such as when principles are abstracted from the concrete particulars of a specific context or case, or strengthening semantic gravity, such as when abstract ideas are made more concrete; and
- Strengthening semantic density, such as when a lengthy description is condensed into a term, or weakening semantic density, such as when an abstract idea is fleshed out with empirical details (Christie and Maton 2011: 66)

Christie and Maton (2011) argue that this process is very important because, it is movements up and down the semantic continua, not just specific states of 'stronger' or 'weaker', which are crucial to the knowledge-building attributes of disciplinarity Christie and Maton (2011).

This phenomenon of concept development relates to the emphasis made by Vygotsky in his model of concept formation. As indicated earlier in this section, Vygotsky asserts his notion of concept development by outlining a broad development sequence of moving from disorganised complex to a pseudoconcept to a highly organised concept. Vygotsky (Smagorinsky, 2013) further distinguished between scientific and spontaneous concepts.

4.4. Devika Naidoo's Technical Lexis

Naidoo (2013) also provided this study with a very useful set of analytical tools and examples of analysis. Although her work comes from similar sources to those discussed above, along with other sources like Systemic Functional Grammar. Her focus in this paper is to open out for analysis what the knowledge structure of Geography as a discipline is. The first move she makes is to explore the way Geography uses technical words. Any specialisation develops its own specific and distinctive conceptual language of description. Naidoo show how to get a handle on this dimension by analysing the 'technical lexis' of Geography. It is often the case that disciplines borrow and change terms from each other, but crucially they each develop a systematic ordering of the concepts, often through taxonomies that work in logical ways, most notably through type relations and part of relations. Types of relations refer to higher order concepts and lower order concepts in relations of superordination or subordination. Part of relations refer to part/whole relations where smaller objects or terms are parts of larger objects or terms.

Of great interest to this study was the distinction Naidoo made between vernacular taxonomies and formal scientific taxonomies. It is often the case that scientific taxonomies take over terms and relations of vernacular taxonomies and the reorder and rename large parts, before formally expanding the taxonomy to reach higher and deeper levels. In order to illuminate this description, Naidoo juxtaposes two terms, climate (everyday) and weather (formal). With regards to climate she says "everyday words and vernacular taxonomies are used to describe the weather, which are related to experience of the weather at that particular time – cold, windy, and so on. However a formal definition of weather, such as 'weather refers to the state of the atmosphere at a local level, usually on a short time scale minutes to months', is not only general, precise, denotative and depersonalised but it also sets up its difference from the term climate" (Naidoo, 2013: 159).

4.5. Michael Long's Interaction Hypothesis

This research, as has been already alluded to, delineates the experiences and the challenges faced by the teachers and pupils in their interactive encounters as teachers present and negotiate new concepts at Grade 4 level. One of the key questions that the study intends to address is how language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science subjects. It is in the light of this background that this current section explores Michael Long's Interaction Hypothesis as one of the theoretical accounts underpinning the research question referred to above.

The table (Ellis, 1991) serves to show interactional modifications involved in the negotiation of meaning. The significance of this table is to show and analyse how teachers modified their input during interactions between them and learners during the observed NS and SS lessons.

Interactional feature	Definition	Example
clarification requests	Any expression that elicits clarification of the preceding utterance.	A: She is on welfare. B: What do you mean by 'welfare'?
confirmation checks	Any expression immediately following the previous speaker's utterance intended to confirm that the utterance was understood or heard correctly.	A: Mexicans have a lot of ulcers? B: Mexicans have a lot of ulcers? Because of the food?
comprehension checks	Any expression designed to establish whether the speaker's own preceding utterance has been understood by the addressee.	A: There was no one there. Do you know what I mean ?
Self-repetitions:		
(1) repairing	The speaker repeats/paraphrases some part of her own utterance in order to help the addressee overcome a communication problem.	A: Maybe there would be... B: Two A: Yes, because one mother goes to work and the other mother stays home.
(2) preventive	The speaker repeats/ paraphrases some part of her own utterance in order to prevent the addressee overcome a communication problem.	A: Do you share his feelings? Anyone agree with Gustavo?
(3) reacting	The speaker repeats/paraphrases some part of one of her previous utterances to help establish or develop the topic of conversation.	A: I think she has a lot of money B: But we don't know that? A: But her husband is very rich.

Other-repetitions:

(1) repairing	The speaker repeats/paraphrases some part of the other speaker's utterance in order to help overcome a communication problem.	A: I think the fourth family B: Not the fourth family the third family.
(2) reacting	The speaker repeats/paraphrases some part of the other speaker's utterance in order to help establish or develop the topic of conversation.	A: I think she has three children B: This is the thing. She has three children.

Source: Based on Pica and Doughty (1985a) cited by Ellis (1991:5)

According to Moussa (2010), Michael Long (1983) introduced the Interaction Hypothesis theory to highlight the role played by interaction during the process of second language acquisition (Ellis, 1991; Gass, 1997 and Fang, 2010). Gass (1997) defines Interaction Hypothesis as a theory of second language acquisition which emphasises the role played by negotiated interaction between native speakers (NSs) and non-native speakers (NNSs) and between two NNSs in the development of a second language (L2). According to this theory (Moussa, 2010; Gass, 1997; Ellis, 1991) the modified input created within interaction can facilitate in explaining linguistic forms that learners find difficult to understand. What is meant by modified input, Moussa (2010) explains, is the input that is created through interaction by the interlocutors, in order to facilitate their comprehension.

To further define Long's (1983) Interaction Hypothesis, Ellis (1991) advances two major theoretical claims raised by Interaction Hypothesis: firstly, "comprehensible input is necessary for L2 acquisition" and secondly, "modification to the interactional structure of conversations which takes place in the process of negotiating a communication problem helps to make input comprehensible to an L2 learner" (Ellis, 1991, p 4).

Ellis (1991) traces the route of these claims back to Stephen Krashen and Evelyn Hatch. Krashen (1977, 1980) as cited by Ellis (1991) argues that the subconscious process of 'acquisition' happens when there is a strong focus simply on meaning in ways that are understandable and usable. It is crucial for beginners and foreign language learners that this is simply and clearly structured, with useful and understandable extralinguistic context to make the meanings clear.

Hatch (1978), as Ellis (1991) points out, showed very strong correlations between the interactions learners and teachers have and the way learners acquire the grammar of a second language. It is a vital point, the more a learner and teacher engage through interaction in the process of learning a language, the more the features of the interactions form a part of how the language is learnt. In many ways this is an obvious point, but it is very important,

especially in this study, as there is a focus on how the teachers and learners interact at Grade 4 level.

Interaction Hypothesis theory points to how important this interaction is, and studies how learners and teachers engage and negotiate new meanings in ways that improve the chances of learning, understanding and comprehension (Ellis, 1991; Moussa, 2010).

When referring to negotiation of meaning within the theoretical frame of Interaction Hypothesis, Moussa (2010, citing Ellis, 1999, p. 3) argues that it is considered to be the “conversational exchanges that arise when interlocutors seek to prevent a communicative impasse occurring or to remedy an actual impasse that has arisen”. Moussa (2010) shows how this works on a micro level, where teachers and learners change and shift the way they talk and clarify, the way they check and consolidate, to ensure that comprehension is enabled. Moussa (2010) further explains the idea of negotiation of meaning by bringing to our attention that learners are spontaneously able to struggle, change and adapt new information during a conversation in order to show that they understand what is happening. Often, when there is a quick indication that the learner understands what is happening, this is an indication that the learner actually does not know what is happening. It is engagement and struggle that indicates the beginnings of understanding (Ellis, 1998). It is thought that through this interactional discourse, where learners negotiate the meaning of the new input and correct each other, they are more likely to reach better levels of L2 comprehension (Ellis, 1998). The more understandable content there is and the more it is engaged with, the faster new languages and concepts are learned. A key term to catch this process is ‘comprehensible input’. In the same article, Long argued that modifications to the interactional structure of conversation were the ‘most important and widely used’ way of making input comprehensible. Long suggests that “these are especially facilitative of acquisition because they help to make unfamiliar linguistic input comprehensible”. Long does not present any arguments for differentiating the effects of the various interactional modifications, so it must be presumed that it is the “quantity rather than quality of modifications that is important for acquisition” (Ellis, 1991: 29).

Ellis (1991: 36) uses empirical evidence from Long’s (1980) and Pica’s (1987) studies to render a detailed summary of Long’s interactional hypothesis and he succinctly summarises it as a hierarchical three-part framework:

- (1) Comprehensible input is necessary for L2 acquisition (= the Input Hypothesis).
- (2) Modifications to the interactional structure of conversations which take place in the process of negotiating a communication problem help to make input comprehensible to an L2 learner.
- (3) Tasks in which there is a need for the participants to exchange information with each other promote more interactional restructuring. A situation in which the conversational partners share a symmetrical role relationship affords more opportunities for interactional restructuring (1991: 36).

4.6. N. J. S. Brown's Conceptual Complexity tool (MMCC)

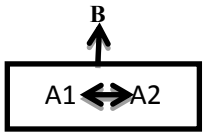
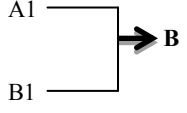
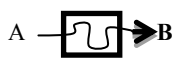

Brown (2005) advocates a multidimensional instrument that he says assesses a student's conceptual understanding. Brown describes "a two dimensional space of conceptual complexity, defined by hierarchical continua representing different degrees of conceptual depth and conceptual breadth" (Brown 2005: 6) . Brown refers to the constructs of depth and breadth collectively as Multidimensional Measure of Conceptual Complexity (MMCC).

Conceptual depth

The depth construct, as Brown delineates, characterises six levels of conceptual depth (Brown 2005: 6). These levels describe a "hierarchy of increasingly deep structures of understanding of a scientific phenomenon:

- (0) the absence of understanding
- (1) actual understanding in which the phenomenon is not seen to require any justification
- (2) understanding based upon a single causal element that lacks justification
- (3) understanding based upon a single causal element that includes justification
- (4) understanding that involves multiple causal elements, all of which are necessary but independent
- (5) understanding that involves multiple causal elements that interact within a system, eventually producing an emergent phenomenon".

The following diagrams and table expand on the nature of this hierarchy:

Level	Description of Person	Description of Response
5 Emergent 	<p>The phenomenon is seen as an emergent property of a system, made up of interacting components. The system evolves over time eventually producing the observed effect.</p>	<p>A1 and A2 happen over time; they interact and evolve, until eventual B happens. Meanwhile, A1 and B2 continue to happen.</p>
4 Multiple 	<p>The phenomenon is seen as an effect produced by multiple causal elements. All are necessary, if one is removed the effect is not produced</p>	<p>A1 and B2 cause B when they both happen at the same time.</p>
3 Justified 	<p>The phenomenon is seen as an effect produced by a single causal element Justification or a mechanism is necessary.</p>	<p>A causes B, and this is how.</p>
2 Elemental 	<p>The phenomenon is seen as an effect produced by a single causal element. Justification or a mechanism is not necessary.</p>	<p>A causes B.</p>
1 Causal B	<p>The phenomenon is seen as an instantiation of reality. No cause is necessary.</p>	<p>B happens because that is the way things are.</p>
0 Absent B???	<p>The phenomenon is surprising. No explanation seems possible.</p>	<p>I cannot explain why B happens.</p>

The qualitative levels of the depth construct Brown (2005: 6)

Conceptual breadth

The breadth construct, Brown (2005: 8-9) explains, “characterises four levels of conceptual breadth. These levels describe a hierarchy of increasingly wider ranges of applicability, that is pairs of increasingly diverse phenomena that are explained by the same causal element:

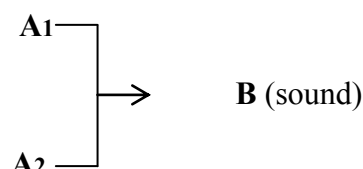
- (0) no phenomena
- (1) phenomena that share a set of actors – the objects involved in the phenomena
- (2) phenomena that share a process – the type of change (or absence of change) in which the actors are involved
- (3) phenomena that share neither actors nor processes”.

The ordering of these levels is again based upon previous research and teaching experience.

Level	Description of Person	Description of Response
substances consistent	Phenomena that share neither a type of change nor the same objects can nonetheless be caused by the same thing.	Explanations for phenomena X and Y, which share neither a process nor the same actors, are based on the same causal element.
process consistent	Phenomena that share a type of change can be caused by the same thing, even if the objects are different.	Explanations for phenomena X and Y, which share a process but different actors, are based on the same causal element.
actor consistent	Only phenomena that involve the same objects can be caused by the same thing.	Explanations for phenomena X and Y which share a set of actors, are based on the same causal element
Distinct	Phenomena are caused by different things, even when they involve the same objects.	Explanations for phenomena X and Y, which involve the same actors are based on different causal elements.

The qualitative levels of the breadth construct Brown (2005: 8)

To illustrate how the MMCC works, I first present what the prescribed Grade 4 learners' workbook says about the concept of *movement & energy in a system – movement causes sound*: “Many musical instruments use movement to make sounds. For instance, when a guitar string is plucked, the string vibrates and causes a sound wave to occur. The sound is amplified (made louder) by the air vibrating in the hollow inside of the guitar as well. We can then easily hear the sounds produced by the guitar” (Natural Science and Technology, 2013: 41). Learners will understand this concept thus: **Level 4 Multiple** – the sound is seen as an effect produced by multiple causal elements (plucking, vibration of the string). All are necessary: if one is removed, the sound is not going to be produced – **A1** and **A2** cause **B** when they both happen at the same time (the qualitative level of the depth construct) (Brown, 2005).



In terms of the qualitative levels of the breadth construct, the interpretation is: **Process consistent**, that is phenomena that share a type of change can be caused by the same thing, even if the objects are different.

Conclusion

This chapter discussed the theoretical framework which underpins data analysis in this research. The key theories were crucial in identifying the problems of the study and my research interest which are resolved by data collection. The key theoretical models that were considered were Vygotsky's conceptual development (1934/1987), Karl Maton's LCT (2009), Long's Interaction Hypothesis (1996) and Brown's Multidimensional Measure of Conceptual Complexity 2005 (MMCC).

4 Findings of the study

5.1. Introduction

This section is comprised of four sub-sections. The first two are the analysis of the NS and SS textbooks, the third is the analysis of the lesson observations and the fourth is the interview analysis. The chapter sets out first to analyse what was found in Grade 4 NS and SS textbooks during the process of data collection. As already mentioned, the study focuses, in the main, on the introduction of specialised concepts and new academic words, in the process of knowledge building, at Grade 4 level, focusing on the transition from FP to IP, the language shift from isiZulu to English LoLT as well as the introduction of subjects at Grade 4 level. One of the techniques used to collect data was textbook analysis.

The main theories that support this study are Vygotsky's concept of development, Karl Maton's LCT, and Brown's Conceptual Complexity Tool (MMCC). The study therefore used these theories as tools to analyse data gathered to try to analyse the textbooks in relation to the following key research questions that this study attempts to answer:

- How text-books introduce and negotiate new and specialised concepts as well as shifting the language of instruction when introducing new subjects and explaining new and specialised concepts at Grade 4 level in the Natural and Social Science subjects.
- How language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science subjects

5.2. Textbook analysis

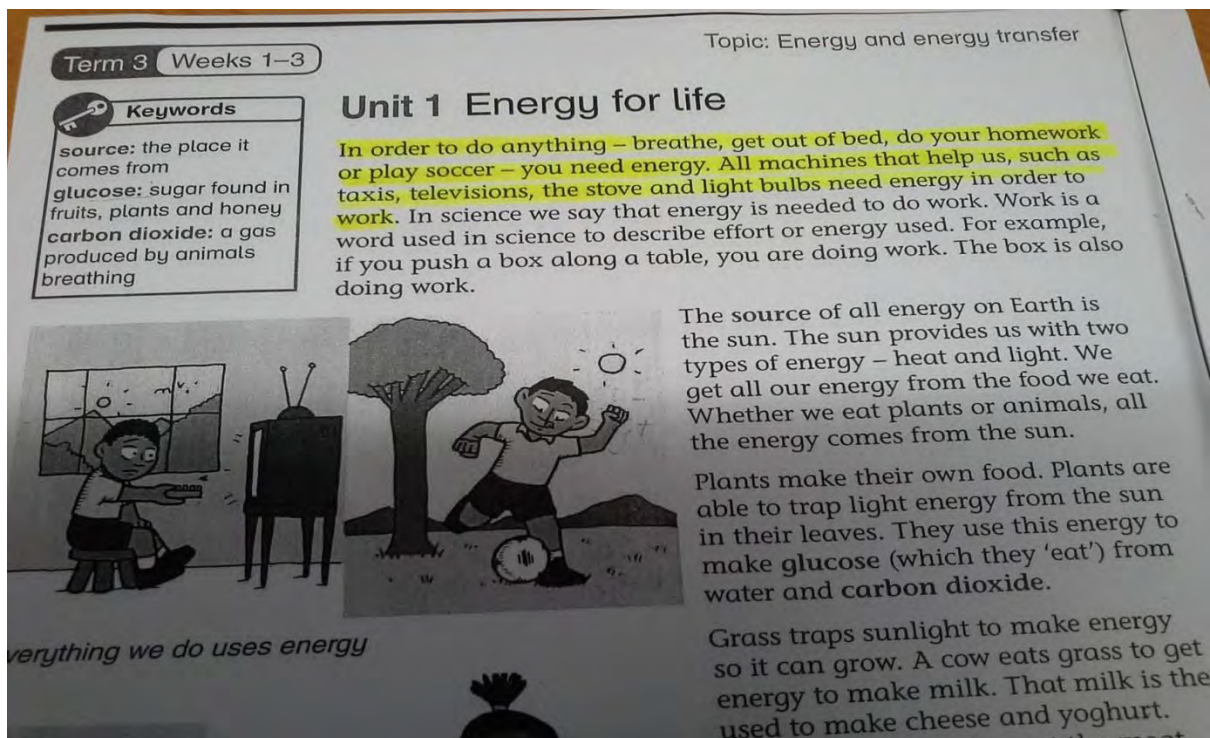
Vygotsky's conceptual development

This section deals with how text-books introduce and negotiate new and specialised concepts as well as shifting the language of instruction. The first tool that this study uses is Vygotsky's conceptual development. To briefly recap what the chapter on theoretical frame work discussed, Vygotsky's conception of concept development focuses on the manner in which children gravitate to the norms of relatively stable adult communities of practice... in which conceptual agreement provides the mediational context of their development (Smagorinsky,

2013:239). Concept development, Vygotsky delineates, begins with an infant’s exposure to human contact and the expectations that others have for a child in the greater draft of human societal activity (Wellings, 2003). Concept formation, Wellings continues, “takes place through the interaction of language and other signs with the immediacy of perceptual intellectual processes” (Wellings, 2003: 3. Wellings further argues that “the use of language becomes the mechanism through which the child focuses his or her attention, and is able to select distinctive features within the environment and analyse and synthesize them: (Wellings, 2003: 3). Vygotsky asserts his notion of concept development by outlining a broad development sequence of moving from disorganised complex to a pseudoconcept to a highly organised concept. Vygotsky (Smagorinsky, 2013) further distinguishes between scientific and spontaneous concept.

Here is how an analysis of the textbook using Vygotsky’s complex appears. Examples are drawn from ‘Spot on Natural Science’, Unit 1, Energy for Life:

A) Vygotsky’s complex

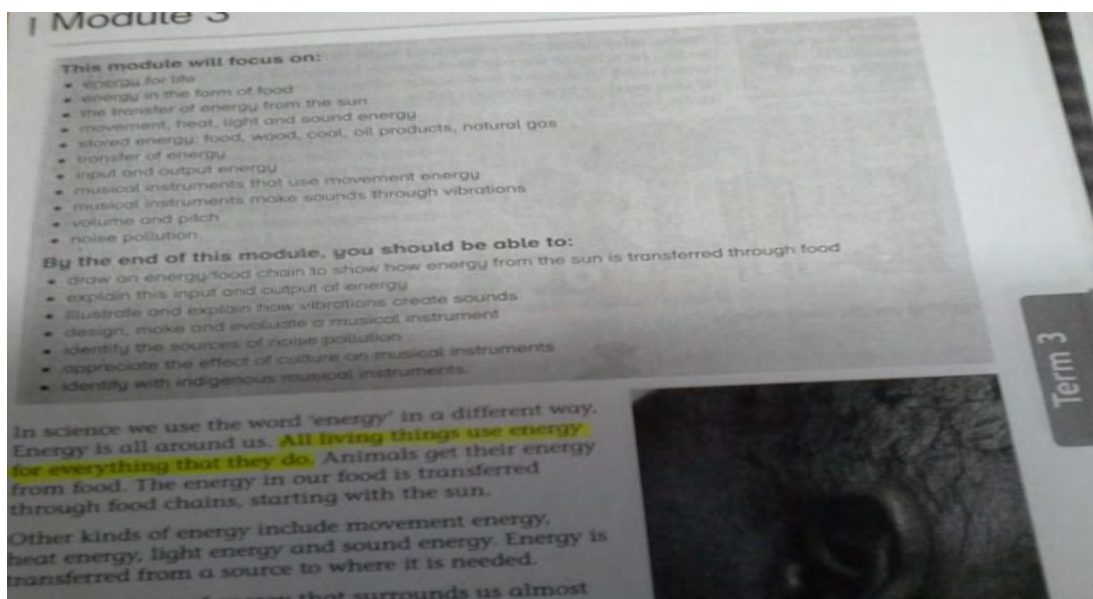


Vygotsky defines a complex as a concept that lacks the unity that might be available through either scientific or spontaneous concepts. When people think in terms of complexes, any connection is sufficient to lead to the inclusion of an element in a given complex. The above highlighted sentence is an example of Vygotsky’s complex, it reads, “In order to do anything

– breathe, get out of bed, do your homework or play soccer – you need energy. All machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to work”. The reason for classifying this concept a complex is that this concept is comprised of discrete elements which the author tries to bring together into some concept. These discrete elements include ‘do anything’, ‘breathe’, ‘get out of bed’ and ‘do you homework’. This kind of conceptualisation relates to Vygotsky’s assertion that when people think in terms of complexes, any connection is sufficient to lead to the inclusion of an element in a given complex.

B. Pseudoconcept

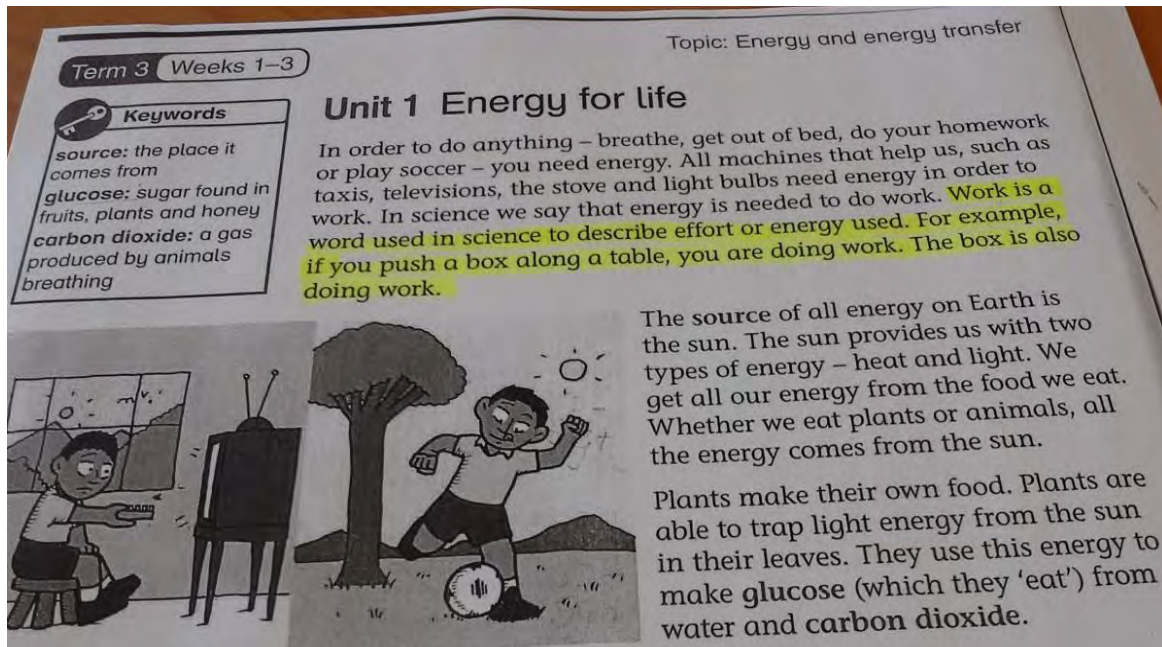
A pseudoconcept, in Vygotsky’s terms, bridges the complex and concepts developmentally. It is a system that may confound differentiation between complexes and concepts as the system appears phenotypically similar to that of a concept. In simple terms, this would be what is between a complex and the real concept. It’s a term that appears to be very close to a concept. Here is an example that was found in the NS teaching text and appears in the page inserted below: ‘all living things use energy for everything that they do’.



C. Concept

When Vygotsky refers to a concept, “there is an implicit differentiation of the concept from lesser formed structures such as syncretic images, complexes, and pseudoconcept”. Vygotsky describes concepts “as being part of a system of representation encompassing both levels of abstraction and degrees of relatedness to a reality constructed of other concepts”

(Smagorinsky 2013: 241). A concept is formed when abstract and concrete ideas are fused together, that is, when you compress complex and pseudoconcept. For example: “Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work and the box is also doing work”.



D. Spontaneous and scientific concepts

Vygotsky distinguishes between spontaneous and scientific concepts: spontaneous concepts are learned in situated, everyday practice. As a result, they are applicable primarily in context where the everyday circumstances and practices resemble those of the original context whereas scientific concepts are learnt through formal systemic instruction... apprenticeship relationships, socially organised activities under formal leadership, the workplace, and other surroundings where explicit and systematic instruction in rules, conventions and other governing knowledge is overtly provided for learners, usually by those with greater experience in a discipline, field, activity, or community of practice. Here is an example of a spontaneous concept found in a teaching-text: “All machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to

work.”

3 Weeks 1-3


Topic: Energy and energy transfer

Unit 1 Energy for life

Keywords

the place it
m
sugar found in
s and honey
xide: a gas
animals

In order to do anything – breathe, get out of bed, do your homework or play soccer – you need energy. All machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to work. In science we say that energy is needed to do work. Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work. The box is also doing work.



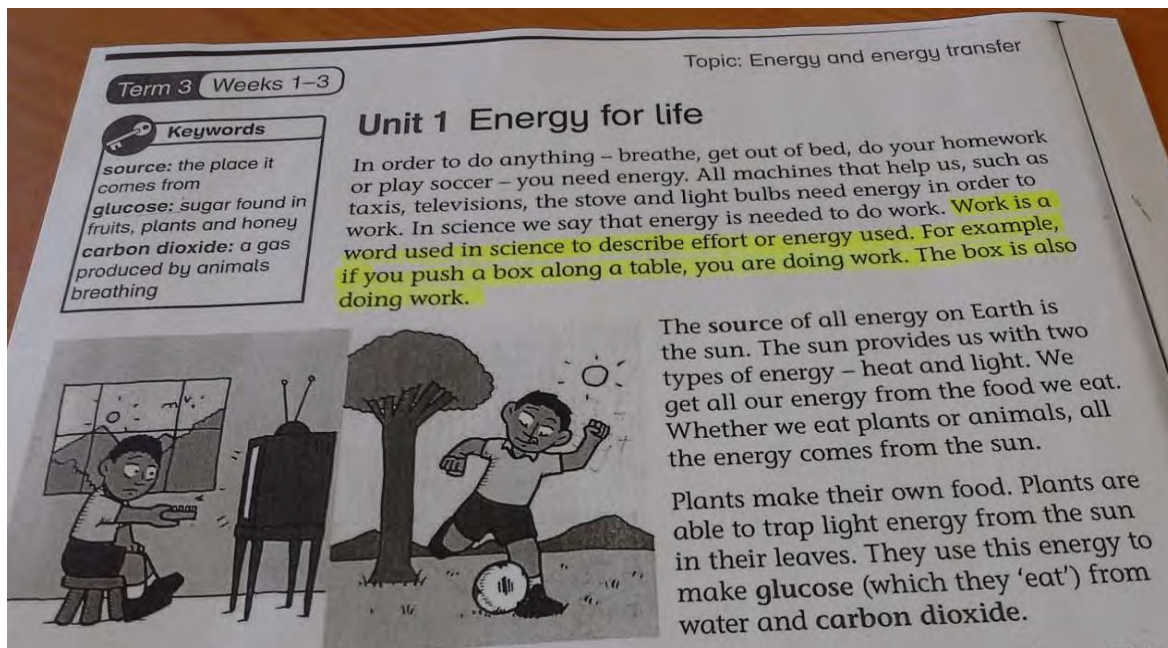
The source of all energy on Earth is the sun. The sun provides us with two types of energy – heat and light. We get all our energy from the food we eat. Whether we eat plants or animals, all the energy comes from the sun.

Plants make their own food. Plants are able to trap light energy from the sun in their leaves. They use this energy to make glucose (which they ‘eat’) from water and carbon dioxide.

This concept reflects common sense and everyday knowledge which makes it an example of a spontaneous concept. The textbook author knows that the textbook will be used at Grade 4 level hence the learners’ lived experiences and their direct experiences with the world are considered important in mastering the new content information.

Scientific concepts are realised when the textbooks depict knowledge to which learners are exposed to by a more knowledgeable person, in a formal and systematic, abstract but also general way, an example of which is: “Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work and the box is also doing work”. Here is how it appears in a text

book:



E. Conclusion

As can be seen, the textbook is very clear with the way in which it uses concepts and presents them to learners. The way these concepts interact between the complex/spontaneous and scientific concepts means that it becomes easy for the advanced reader to experience and trace the trajectory of concept development from complex, pseudoconcept to spontaneous and scientific concepts. Although Vygotsky argues that conceptual development should not take a linear path like this, the way concepts are structured and presented in the teaching text highlights the combination of everyday life and academic, abstract experiences. This therefore highlights the role of the teachers as ‘experienced adults’ in assisting the learners build new conceptual understanding through the linking of existing complexes/spontaneous and scientific concepts.

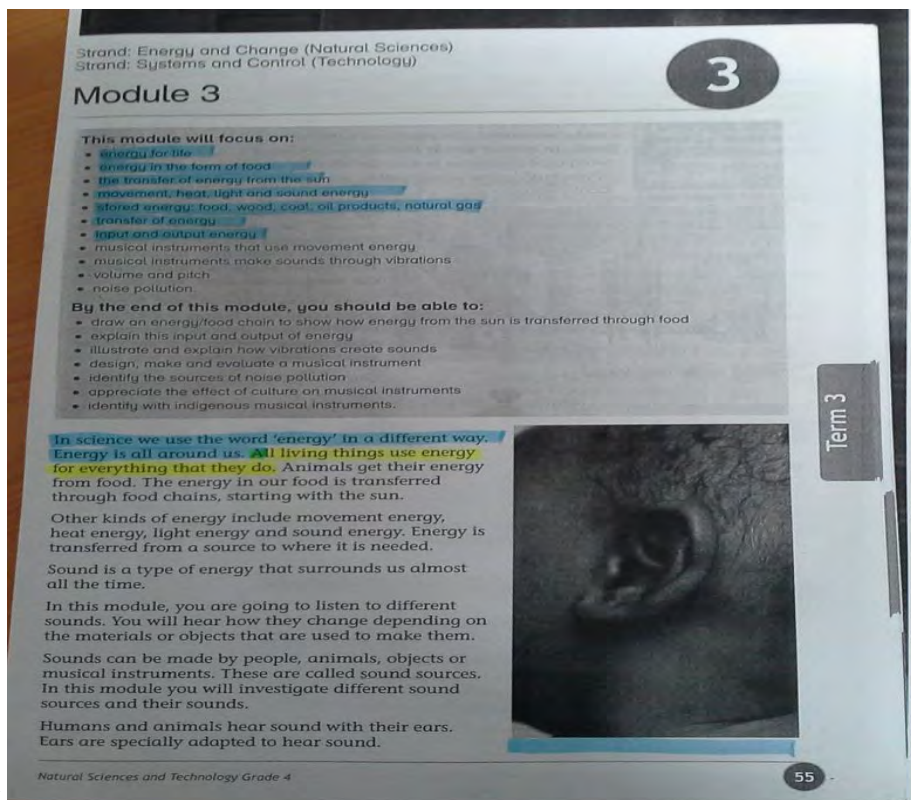
Karl Maton’s LCT – Semantic Gravity (SG) and Semantic Density (SD) in ‘Energy for Life’ NS

The second theoretical framework that this study draws on is Karl Maton’s LCT and the two concepts that were used as analysing tools were Semantic Gravity (SG) and Semantic Density (SD). This was intended to deal with how language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science. A brief recap of what

the chapter on theoretical framework discussed regarding these concepts is that *semantic gravity* (SG) refers to “the degree to which meaning relates to its context. Semantic gravity may be relatively stronger (+) or weaker (-). Where semantic gravity is stronger (SG+), meaning is more closely related to its context; where weaker (SG-), meaning is less dependent on its context. The context may be social or symbolic” (Maton, 2013:10).

A. Semantic Gravity

The module that Grade 4 learners do in the third term is ‘Energy and Change’. What follows is an analysis of the textbook using LCT’s semantics



theory.

As can be seen on this page, from the outset the text outlines the focus and outcomes of the module. However, concepts used in this outline are abstract (SG-) and very dense (SD+) (see the highlighted bullets). This puts both the teacher and the learners in a particularly difficult situation, since the teacher will have a serious challenge in explaining these concepts to the learners. Here is the list of these concepts as they appear on the above inserted page:

<u>Concept</u>	<u>Coding</u>
• Energy for life	SG-
• Energy in the form of food	SG-

- The transfer of energy from the sun SG-
- Movement, heat, light and sound energy SG-
- Stored energy: food, wood, coal, oil products, natural gas SG-
- Transfer of energy SG-

To try to concretise and bring the content to everyday knowledge the textbook depicts a picture of an ear which will be understood and be related to by all the learners since they will be able to connect that human beings receive sounds through the ear.

The opening concept says “In science we use the word ‘energy’ in a different way”. Whilst this concept is significantly different from that which will be produced in an everyday, English language classroom and Social Science, it is also not a low SG concept. It carries some degree of context independence. This is how the teaching text introduces the entire energy concept to learners: “In science we use the word ‘energy’ in a different way. Energy is all around us. All living things use energy for everything that they do. Animals get their energy from food. The energy in our food is transferred through food chains, starting with the sun”. The last part of this concept is to an extent very academic and context-independent thus it can be coded SG-.

The table below portrays the semantic profile of how the NS teaching text introduces the concept of ‘Energy for life’ to Grade 4 learners.

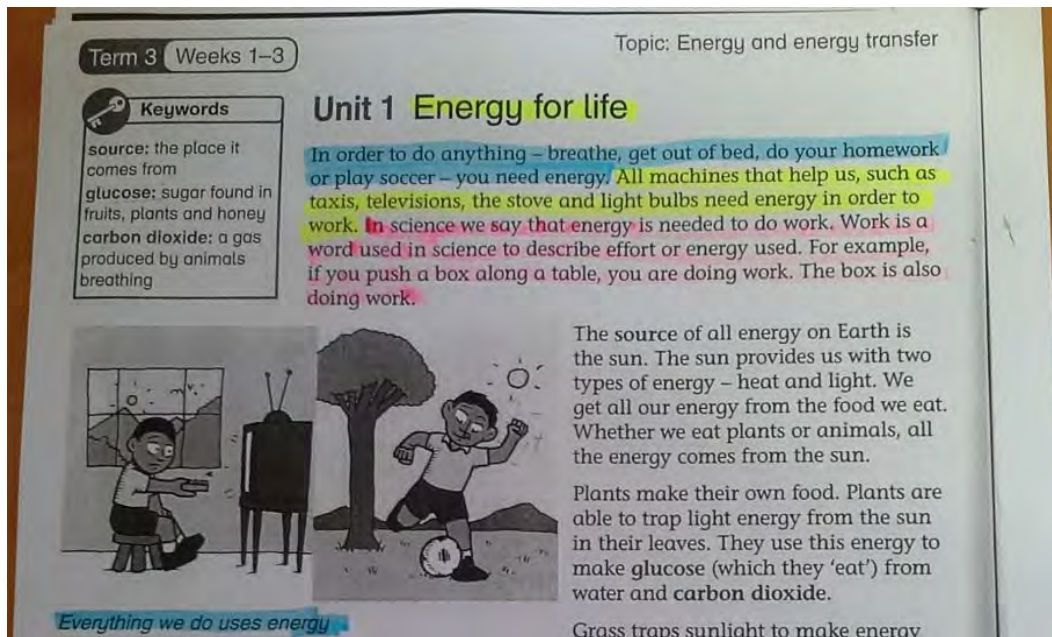
++ **Context independence** --

Local, concrete, everyday knowledge – SG ++	Some context dependence – SG+	Some context independence – SG +/-	Universal, abstract, specialised knowledge – SG-
<ul style="list-style-type: none"> • Energy is all around us. • In order to do anything – breathe, get out bed, do your homework or play soccer – you need energy. • All machines that help us, such as taxis, television, the stove and light bulbs need energy in order 	<ul style="list-style-type: none"> • All living things use energy for everything that they do. 	<ul style="list-style-type: none"> • In science we use the word ‘energy’ in a different way. 	<ul style="list-style-type: none"> • Animals get their energy from food. • The energy in our food is transferred through food chains, starting with the sun. • Energy for life • In science we say energy is needed to work. Work is a word used in science to describe effort or energy used. For example if you push a box along a table, you are doing work and the box is also doing work.

to work			
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B. Semantic Density

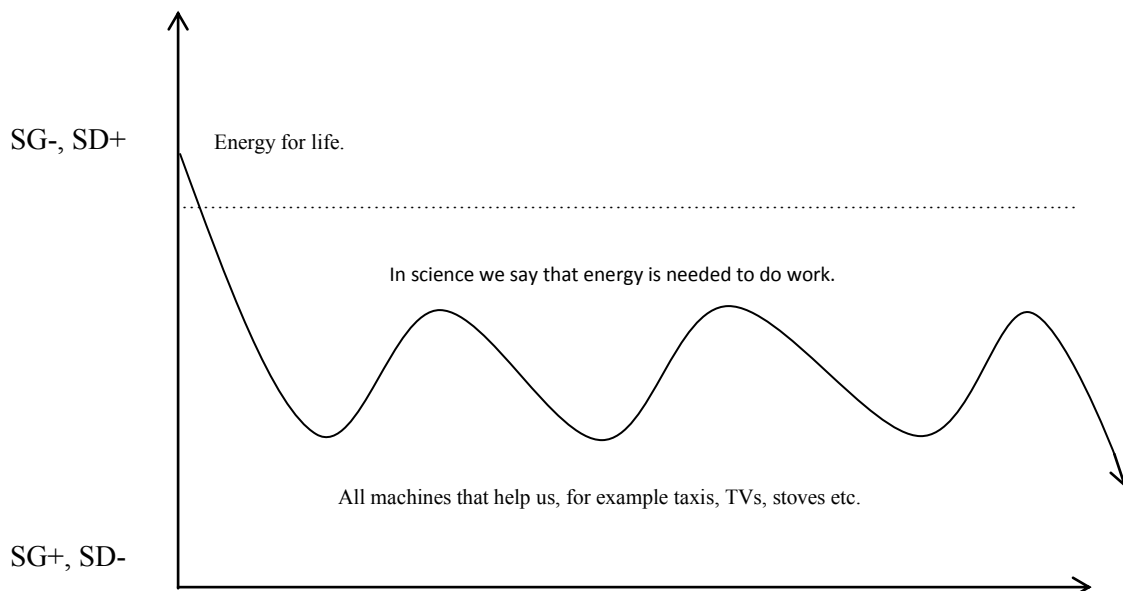
A brief summary of what *semantic density* (SD) is useful at this point. SD refers “to the degree to which meanings are condensed within symbols (terms, concepts, phrases, gestures, and so on). Semantic density may be relatively stronger (+) or weaker (-). Where semantic density is stronger (SD+), symbols have more meanings condensed within them; where semantic density is weaker (SD-), symbols condense less meaning. The meanings condensed within a symbol may be an empirical description (or other meanings with relatively direct empirical referents) or they may be feelings, political sensibilities, taste, values, morals, affiliations and so forth” (Maton, 2013:11).



The example begins with the text book introducing the concept ‘energy for life’ which is an abstract scientific concept and it also condenses a wide range of meanings within the science field. The context in which the concept is used and the fact that it is being used for the first time for Grade 4 (Whose LoLT is EFL) means it can be coded SG- and SD+.

As the teaching text starts to unpack the term by explaining and giving examples such as, “In order to do anything – breathe, get out of bed, do your homework or play soccer – you need energy. All machines that help us, such as taxis, television, the stove and light bulbs need energy in order to work”, it weakens the concepts down to everyday, and uses concrete

concepts to reinforce further this context-dependent meaning. The textbook uses pictures that have the caption: ‘everything we do uses energy’; the use of this picture further concretises the concept, thus bringing it to SG+. However, as the unit continues, the concept starts to repack – “in science we say energy is needed do to work. Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work and the box is also doing work”. This would be SG-/SD+ and this kind of movement is a common feature in this chapter: the text introduces a concept and then attempts to translate it to common sense understanding, thus reducing its abstract and dense meaning. It then starts to repack and unpack by giving definition and examples. Put graphically, conceptualisation in this chapter will produce semantic waves like the ones in a graph below:



Key: the dotted line marks level of SD+ and bottom waves indicate semantic waving in Unit 1

Also significant to note is how the word ‘work’ is used in this section, for instance ‘all machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to work.’ The word ‘work’ here carries two different ideas or meanings, an example of the first is: “in order to use / work a washing machine for you need to have energy in the form of electricity’. The second one is the actual functioning of the machine, for example ‘who is working the washing machine?’’. The other interesting use of the concept ‘work’ is: “in science we say that energy is needed to do work”. Now the use of ‘work’ is abstract and condenses a lot of meaning, hence it is coded SG- and SD+. It is unlike its use in this context:

“for example if you push a box along a table, you are doing work”. Learners will understand the meaning of this concept, its every day and concrete SG+ and SD-. However from here the meaning shifts to abstract and specialised concept: “the box is also doing work”. This clearly shows how language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural Science teaching-text. In this regard the concept ‘work’ shifts from every day and context dependent meaning to specialised, dense and abstract meaning.

As one continues to read through the page, one notices the use of other abstract, dense and specialised concepts such as ‘source’, ‘glucose’ and ‘carbon dioxide’. In order to rescue the learners and thus make the teacher’s work a little easier, the textbook defines these concepts and puts the definitions in the keywords box on the left margin of the page. The definition of these concepts does not only help to simplify the words for learners but it also heightens SG+ and reduces SD- and in this way learners will be able to relate to and understand the meaning of the concepts.

Keywords
 source: the place it comes from
 glucose: sugar found in fruits, plants and honey
 carbon dioxide: a gas produced by animals breathing

UNIT 1 Energy for life

In order to do anything – breathe, get out of bed, do your homework or play soccer – you need energy. All machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to work. In science we say that energy is needed to do work. Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work. The box is also doing work.

The source of all energy on Earth is the sun. The sun provides us with two types of energy – heat and light. We get all our energy from the food we eat. Whether we eat plants or animals, all the energy comes from the sun.

Plants make their own food. Plants are able to trap light energy from the sun in their leaves. They use this energy to make glucose (which they ‘eat’) from water and carbon dioxide.

Grass traps sunlight to make energy so it can grow. A cow eats grass to get energy to make milk. That milk is then used to make cheese and yoghurt. Some people will also eat the meat from the cow. We get all of our energy from the food that we eat. The energy in our food all comes from the sun. This energy travels through the living things (plants and animals) and is used when the living thing is eaten.

The sun also keeps the Earth warm. The average temperature of the Earth is 15° C. If we did not have a sun, planet Earth would be too cold for us to live on.

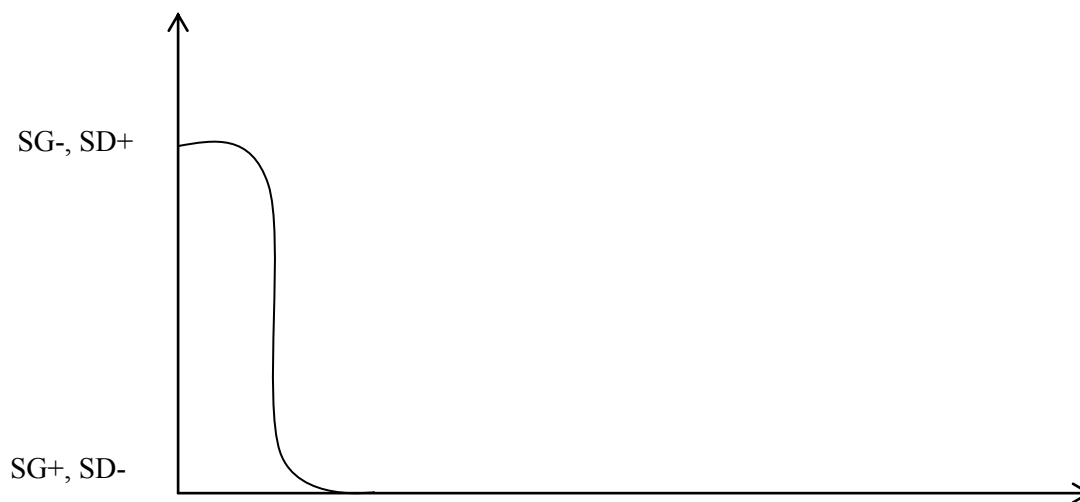
Everything we do uses energy

Light from the sun helps the maize used to make cereal grow

The next paragraph on the same page is a subtle attempt to introduce the concept of food chains without actually using the word ‘food chains’: “The source of all energy on earth is the sun. The sun provides us with two types of energy – heat and light. We get all our energy

from the food we eat. Whether we eat plants or animals, all the energy comes from the Sun”. This can be coded SD- and SG+. The textbook concretises the concept of food chain by using words that are understandable to learners such as: ‘the Sun’, ‘heat and light’, ‘food we eat’ and ‘plants or animals’.

Another concealed concept is photosynthesis which is also introduced in the next paragraph of the same page, again without explicitly using the word ‘photosynthesis’: “Plants make their own food. Plants are able to trap light energy from the sun in their leaves. They use this energy to make glucose (which they eat) from water and carbon-dioxide”. Here the textbook uses everyday language to outline the process of photosynthesis. Whilst there is use of technical terms – ‘glucose’ and ‘carbon dioxide’, this no longer presents a challenge because these two terms have been explained in the key concepts. Again this paragraph can be coded SG+ and SD-. Hence this creates downward escalators as depicted by this graph:



This trend is the same for the rest of the page, especially this paragraph: ‘Grass traps sunlight to make energy so it can grow. A cow eats grass to get energy to make milk. That milk is then used to make cheese and yoghurt. Some people will also eat the meat from the cow. We get all of our energy from the food that we eat. The energy in our food all comes from the sun. This energy travels through the living things (plants and animals) and is used when the living thing is eaten.’ The coding is SG+ and SD- and to further strengthen this coding, the textbook uses a picture with a girl enjoying her breakfast cereal. This picture helps to bring the content information to everyday and context dependent, learners will find it easy to work and identify with the meaning of these concepts introduced by the book – ‘energy source’, ‘food chain’ and ‘photosynthesis’.

Unit 2 Energy from the Sun

Unit 2 Energy from the sun

You have learnt that the sun gives energy to plants and that plants change this energy into food energy. The food made by plants is eaten by animals.

Food chains


Food chains are how energy moves through all habitats and ecosystems. They show how living plants and animals depend on each other for food. The relationships between species are very important in keeping the plants and animals that live in an ecosystem alive. Often we do not notice how important a particular species is, until it is no longer in an ecosystem. For example, some insects pollinate certain plants, so if the insects become extinct then the plants will also be lost. This will mean that any other animals that depended on that plant for food could also be in danger of dying.

All plants and animals play an important role in a food chain. If any plants or animals are missing the food chain will not be balanced. If the food chain is not balanced, some things could die because they will not get the energy they need to live.

Looking at food chains


A food chain, or energy chain, shows how living things eat and how nutrients and energy are passed from organism to organism. Food chains begin with the sun and usually end with animals. They can be different lengths, depending on the number of times that energy is passed from organism to organism.

The food chain below is a simple one that starts with grass which is eaten by rabbits. The rabbits are then eaten by wild dogs.



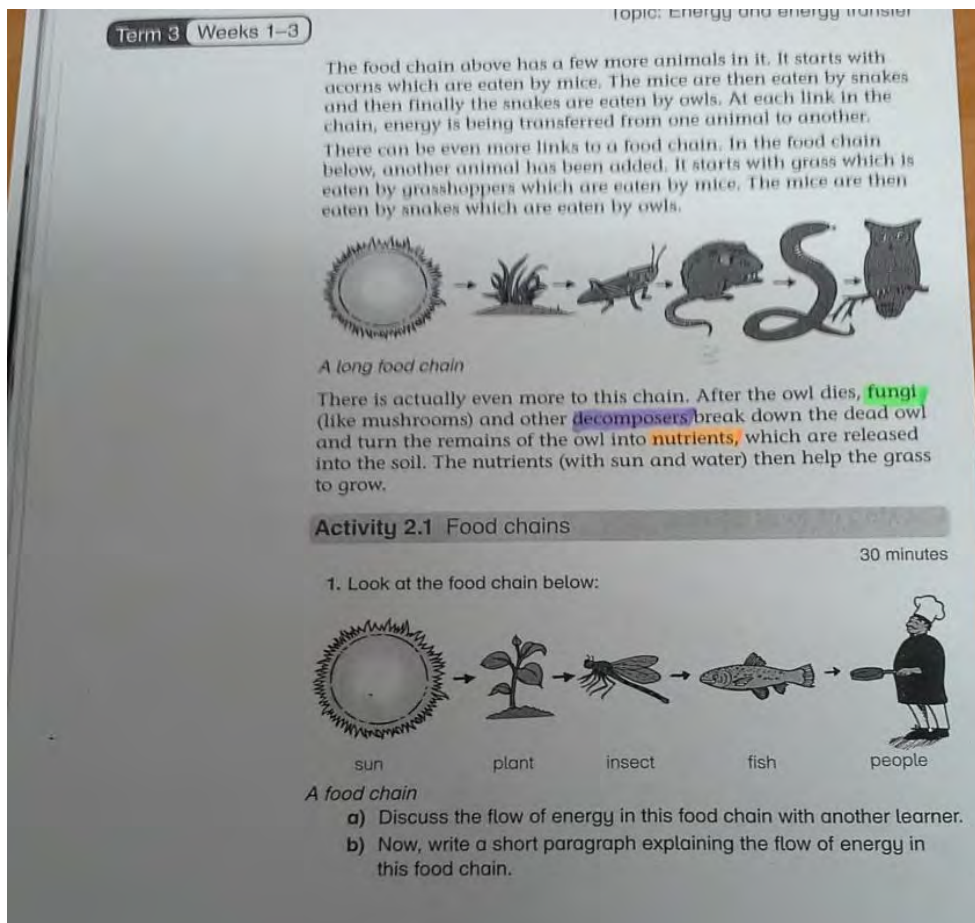
A short food chain

Food chains can have more animals in them:



This unit starts with a simple and short summary of what has been learnt thus far (Page 57 scanned documents), this too is SG+ and SD-. The unit explicitly teaches learners the concept of ‘food chains’ and defines it as “how energy moves through all habitants and ecosystems. They show how living plants and animals depend on each other for food”. Inherent in this definition is the logic of interdependence, the coding here is SG- and SD+ . It continues to define food chains : “the relationships between species are very important in keeping the plants and animals that live in an ecosystem alive. Often we do not notice how important a particular species is, until it is no longer in an ecosystem”. Up to this point the definition remains very hard for learners at Grade 4 level. This is made worse by the fact that the underlined concepts are all new to learners and the textbook does not help to define them. This makes it very hard for the English Second Language learners at Grade 4 level to fully understand the concept of ‘food chain’. The underlined concepts should have been defined especially because they are not only unfamiliar to learners but are also abstract and specialised concepts. However, the textbook attempts to reduce the density by stating as an

example “some insects pollinate certain plants, so if the insects become extinct then the plants will also be lost. This will mean that any other animals that depended on that plant for food could also be in danger of dying”. This serves to concretise and reduce density and can be coded SG+ SD-. This reduction is also reinforced by the use of the pictures at the bottom of the page. The pictures also help to make complexity simpler. The rest of the unit depicts pictures of food chains that help learners relate to the concept of food chains fairly easily. This textbook page contains other SD+ concepts.



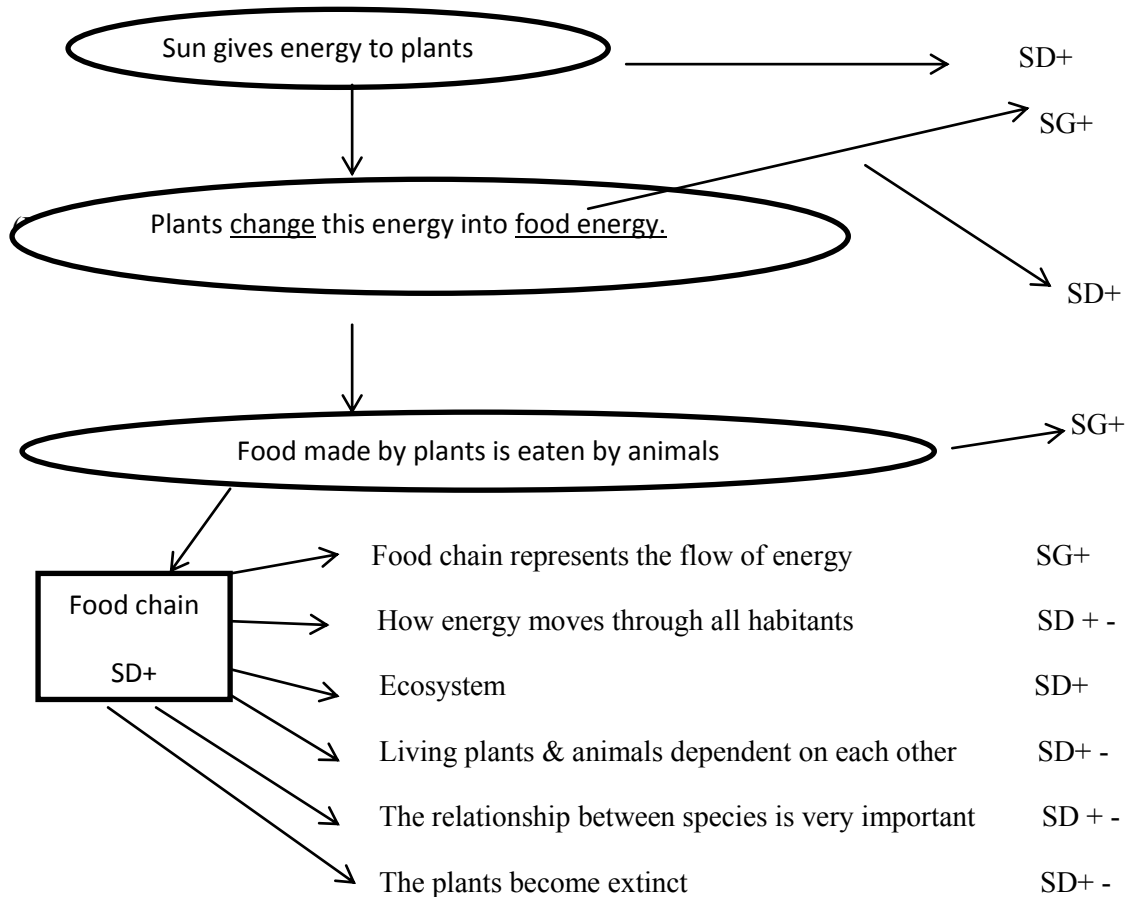
However there is still use of specialised abstract concepts: ‘fungi’, ‘decomposers’ and ‘nutrients’ which are not defined by the book (see the inserted page above). This then repacks the definition of food chains and makes it abstract and dense which gives it a coding of SG- and SD+. Again these terms should have been defined because they are not known to learners at Grade 4 level.

List of SD+ concepts found on the textbook page:

SD ++ Glucose

SD ++ Energy

- SD ++ Carbon Dioxide
- SD ++ Ecosystems
- SD ++ Food chain
- SD ++ Organisms

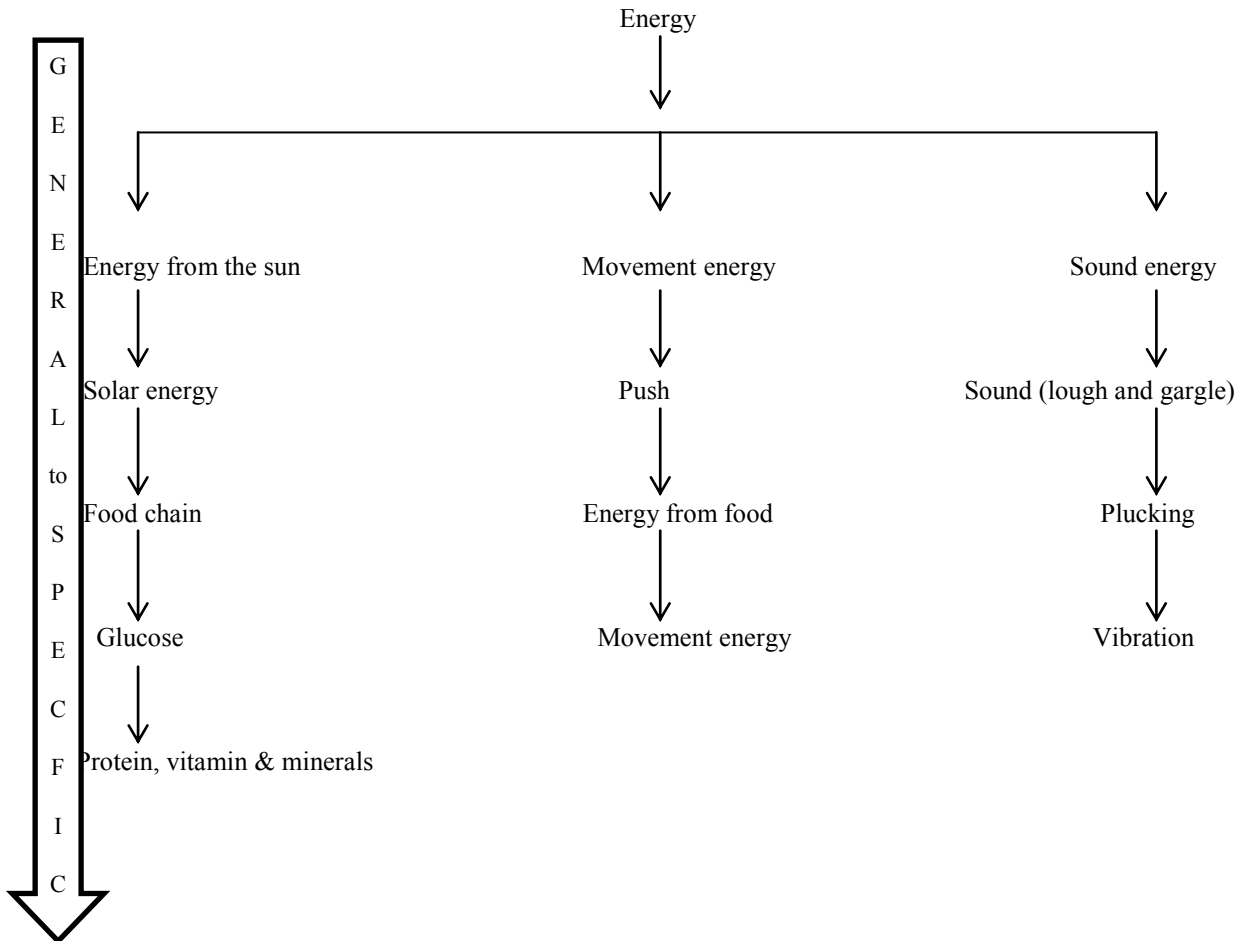


A food chain shows how living things eat and how nutrients (SD+) and energy are passed from organism (SD+) to organism.

Energy taxonomic structure

General concepts	Specific concepts
Energy to grow, play, work etc.	Energy chain
Energy from the sun	Food chain
Power	Energy source: electricity, batteries & Solar
What we eat	Glucose – a simple sugar which is an important energy source in living organisms
Light, heat energy	Solar energy
What we get from food	Protein, vitamin , minerals

Heat	Temperature
Air	Solar wind
Sound movement	Vibration
Sound	Volume, pitch
Coal, oil	Energy source
Push	Movement energy



C. Conclusion

Although textbooks do not present knowledge in a complex way, there is an attempt to shift towards complexity, dense and abstract concepts. The pattern that emerges in this chapter is that specialised concepts are being introduced at Grade 4 however the authors strengthen SG and weaken SD by providing everyday examples, concrete and context dependent definitions and pictures. Thus, in Maton's (2013) words, the semantic profiles move downwards. Most of the time this situation is like this because it is Grade 4 learners and the concepts are all new to them. There are situations where these concepts shift upwards from knowledge that is

non-technicalised, concretised and often segmented towards more condensed, technicalised knowledge that is ‘plunged into’ the constellations of meaning constituting scientific concepts like with the use of the concept of ‘work’ and other concepts – ‘carbon dioxide’, ‘glucose’, ‘nutrients’ and ‘food chain’.

Devika Naidoo’s Technical Lexis

Having discussed how Vygotsky’s model of conceptual development and Maton’s semantics distinguish everyday or common sense knowledge from educational or uncommon sense knowledge, I now bring in Devika Naidoo (2013) who also offers a means of conceptualising knowledge-building through Technical Lexis and what she calls taxonomies that are either specialised or every day and formal scientific taxonomies. To recap, briefly, what was discussed in the theoretical framework chapter about Technical Lexis: it refers to the use of terms or expressions within a specialised field that have a field specific meaning. A technical terminology that is core to the field is the means, not only for making sense symbolically, but also for more generally accepted meaning to be attributed to objects and experiences. There is a clear relationship between semantic density and Technical Lexis and what is important about Technical Lexis is that it succinctly portrays these terms, thus making it clearly visible and accessible to both teachers and learners. In order to illustrate Naidoo’s ideas I again analysed the NS chapter and this is what I found in grade 4 text book:

Term 3 Weeks 1–3 Topic: Energy and energy transfer

Unit 1 Energy for life

Keywords
source: the place it comes from
glucose: sugar found in fruits, plants and honey
carbon dioxide: a gas produced by animals breathing

In order to do anything – breathe, get out of bed, do your homework or play soccer – you need energy. All machines that help us, such as taxis, televisions, the stove and light bulbs need energy in order to work. In science we say that energy is needed to do work. Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work. The box is also doing work.

Everything we do uses energy

The source of all energy on Earth is the sun. The sun provides us with two types of energy – heat and light. We get all our energy from the food we eat. Whether we eat plants or animals, all the energy comes from the sun.

Plants make their own food. Plants are able to trap light energy from the sun in their leaves. They use this energy to make glucose (which they ‘eat’) from water and carbon dioxide.

Grass traps sunlight to make energy so it can grow. A cow eats grass to get energy to make milk. That milk is then used to make cheese and yoghurt. Some people will also eat the meat from the cow. We get all of our energy from the food that we eat. The energy in our food all comes from the sun. This energy travels through the living things (plants and animals) and is used when the living thing is eaten.

The sun also keeps the Earth warm. The average temperature of the Earth is 15° C. If we did not have a sun, planet Earth would be too cold for us to live on.

Photosynthesis

Light from the sun helps the maize used to make cereal grow

The average temperature of the Earth is 15° C. If we did not have a sun, planet Earth would be too cold for us to live on.

It is clear that the concepts that appear on this page are dense and field specific concepts.

The table below depicts the analysis of technical concepts found in the chapter. Note how concepts in the textbook shift from concepts, then specific examples and everyday language to technical, dense and field specific terms.

concepts	specific examples	everyday language (concrete)	technical language (dense)
energy	heat / power	energy to grow, play, work etc.	energy chain
energy	electricity	power	energy source: electricity, batteries & solar
food	-source of energy -glucose	what we eat	glucose – a simple sugar which is an important energy source in living organisms
energy chain	energy chains	all parts that complete it	food chain
energy from the sun	sunlight	light, heat energy	solar energy
nutrients	substances in food	what we get from food	protein, vitamins, minerals
sun	energy source	heat	temperature
wind	source of energy	air	solar wind

B. Conclusion

As can be seen, as early as Grade 4 learners are introduced to these field specific and dense concepts. The table illustrates concepts like ‘energy chain’, ‘glucose’, ‘carbon dioxide’, ‘solar energy’, ‘protein’, ‘vitamins’, ‘minerals’ and ‘temperature’. The major task of the text book, which it does very well, is to introduce these field specific concepts and unpack it to everyday language in order for the grade 4 learners to be able to understand and be able to use them effectively and meaningfully as they progress to senior grades. It can be safely said that the teaching text does provide the learners with very good knowledge building opportunities.

N. J. S. Brown’s Conceptual Complexity tool (MMCC)

The third theoretical frame work that underpins this study is Brown’s Multidimensional Measure of Conceptual Complexity (MMCC). Briefly, Brown (2005) advocates a multidimensional instrument that he says assesses student’s conceptual understanding. Brown

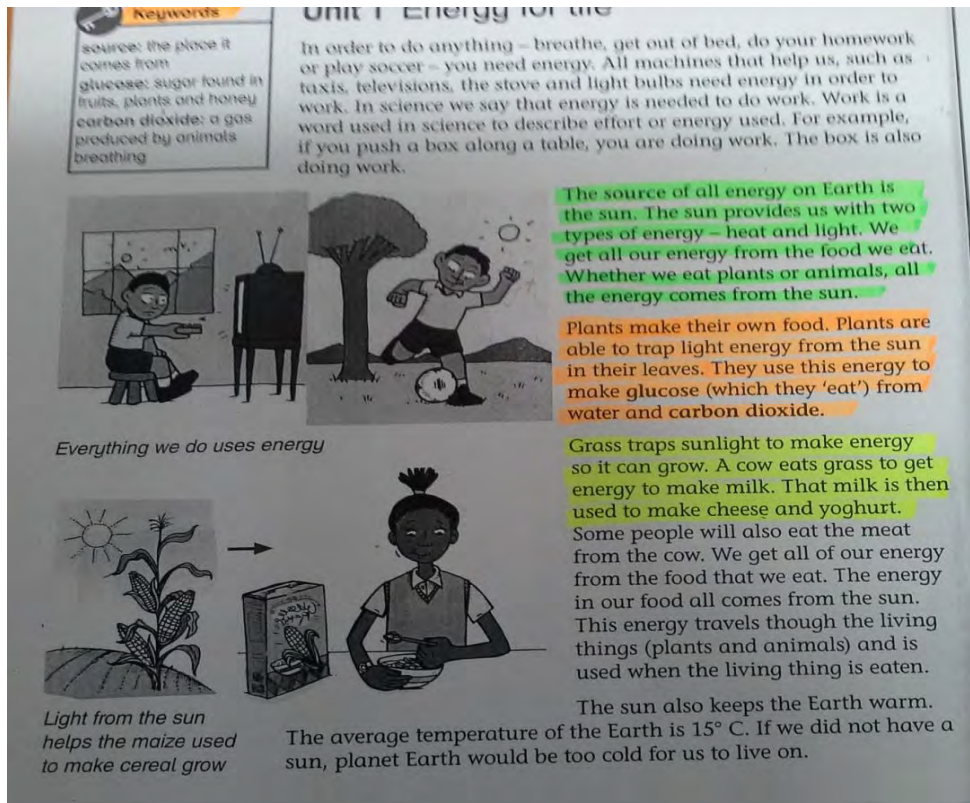
describes a two dimensional space of conceptual complexity, defined by hierarchical continua representing different degrees of conceptual depth and conceptual breadth. Brown says the constructs of depth and breadth are collectively referred to as Multidimensional Measure of Conceptual Complexity (MMCC).

A. Conceptual depth

The six levels of conceptual depth are discussed in detail in the theoretical framework chapter but, briefly, these levels “describe a hierarchy of increasingly deep structures of understanding of a scientific phenomenon with (0) as the absence of understanding; (1) as a causal understanding in which the phenomenon is not seen to require any justification; (2) as understanding based upon a single causal element that lacks justification; (3) as understanding based upon a single causal element that includes justification; (4) as understanding that involves multiple causal elements, all of which are necessary but independent; and (5) as understanding that involves multiple causal elements that interact within a system, eventually producing an emergent phenomenon” (Brown (2005)).

To illustrate how this framework works I again analysed the concept in the Grade 4 text books ‘Spot On’. This is how the concepts appeared in the textbook:

Conceptual depth



Level 1: The source of all energy on Earth is the sun.

Level 2: The source of all energy on Earth is the sun. Another example – whether we eat plants or animals, all the energy comes from the sun.

Level 3: Plants make their own food. Plants are able to trap light energy from the sun in their leaves.

Level 4:

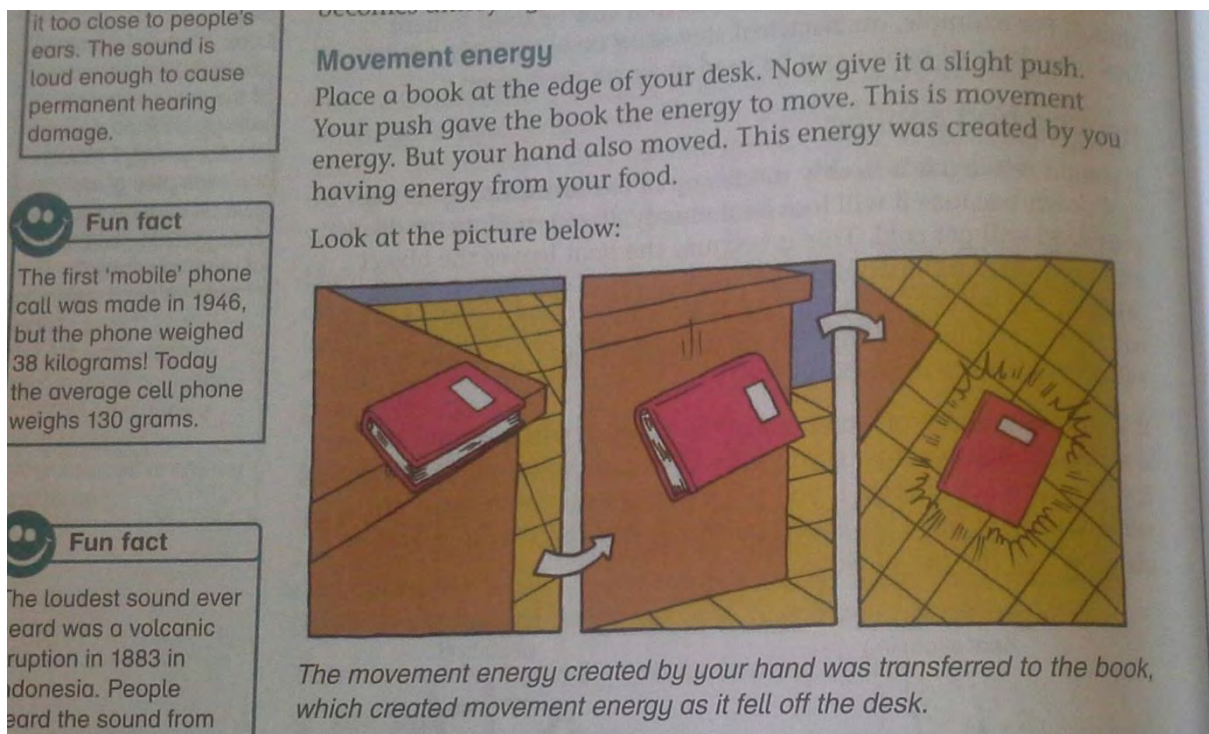
- food chain
- photosynthesis
- glucose
- carbon dioxide
- temperature

Level 5:

Movement energy – If you push a book, your push gave the book the energy to move. This is movement energy. But your hand also moved. This energy was created by you having energy

from your food. Another example, in science we say that energy is needed to do work. Work is a word used in science to describe effort or energy used. For example, if you push a box along a table, you are doing work. The box is also doing work.

Here is an example of a page from the textbook indicating how the original complex concept has been weakened and made to be everyday and context dependent:



B. Conceptual breadth

The breadth construct, Brown explains, “characterises four levels of conceptual breadth. These levels describe a hierarchy of increasingly wider ranges of applicability, that is, pairs of increasingly diverse phenomena that are explained by the same causal element: (0) no phenomena; (1) phenomena that share a set of actors, the objects involved in the phenomena; (2) phenomena that share a process, the type of change (or absence of change) in which the actors are involved; and (3) phenomena that share neither actors nor processes” (Brown (2005). The ordering of these levels is again based upon previous research and teaching experience.

Example

Substances consistent: Cooking needs energy from biomass in a fire.

Process consistent: Food chains are how energy moves through all habitants and ecosystems. They show how living plants and animals depend on each other for food.

Actor consistent: Food chains begin with the sun and usually end with animals.

Distinct: There is actually even more to this chain. After the owl dies, fungi (like mushrooms) and other decomposers break down the dead owl and turn the remains of the owl into nutrients, which are released into the soil. The nutrients (with sun and water) then help the grass to grow.

C. Conclusion

The discussion above provides evidence about concept complexities at Grade 4 level. It sheds some light on how concepts relate to each other and how they are used to foreground certain knowledge valuable to learners at Grade 4. The teacher’s awareness of the MMCC will lead to deeper insight on concepts and content knowledge particularly because of the way in which these concepts are used in the teaching text which helps to explain how things happen.

How Vygotsky, LCT, Technical Lexis and MMCC all impact on Natural Science teaching

This section summarises what the four analytical tools show together in the analysed Natural Science textbook. The word ‘**there**’ stands for saying that the concepts were found in the unit, ‘**not there**’ means concepts were not found.

A. Vygotsky’s conceptual development

Unit	Complex		Pseudoconcept		concept		Spontaneous		Scientific	
	there	not there	there	not there	there	not there	there	not there	there	not there
1. Energy for life	X		X		X		X		X	
2. Energy from the sun	X		X		X		X		X	
3. Energy around us	X		X		X		X		X	
4. Source of energy	X		X		X		X		X	
5. Input and output energy	X		X		X		X		X	
6. Movement										

and musical instruments	X		X		X		X		X	
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As can be seen in the table above, the textbook displays a balanced combination of Vygotsky’s conceptual development. The textbook shifts from complex to concepts and from spontaneous to scientific concepts and vice versa in a bid to make the content information accessible to Grade 4 learners.

B. Karl Maton’s LCT – Semantic Gravity and Semantic Density

Unit	SG+		SG-		SD+		SD-	
	there	not there	there	not there	there	not there	there	not there
1. Energy for life	X		X		X		X	
2. Energy from the sun	X		X		X		X	
3. Energy around us	X		X		X		X	
4. Source of energy	X		X		X		X	
5. Input and output energy	X		X		X		X	
6. Movement and musical instruments	X		X		X		X	

This shows that semantic relations in NS at Grade 4 interact between strong semantic gravity (SG+) and weakened semantic gravity (SG-) as well as between strong semantic density (SD+) and weakened semantic density (SD-) and vice versa. However in the situations that were SG- and SD+, the textbook simplified these by presenting pictures, everyday experiences and concrete examples.

Having looked at both Vygotsky’s conceptualisation and LCT’s semantics, one realises that Vygotsky’s scientific concepts relate to low semantic gravity (SG-). First the relationship is that scientific concepts are not context dependent; they are learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. Similarly, weakened semantic gravity (SG-) is context independent. Likewise, high semantic gravity relates to complex and pseudoconcept. For both these modes of conceptualising, meaning is more closely related to its context, concrete and learned in

situated, everyday practice. As a result, these concepts are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context of learning.

On the contrary, SD+ (high semantic density) relates to scientific concept: they are both abstract and condense more meaning. Where semantic density is weaker (SD-), symbols condense less meaning. Weak semantic density is when the terms say what they say without much extra depth needed to understand them. Thus low semantic density SD- relates to complex, pseudoconcept and spontaneous concept.

C. Technical Lexis

Unit	Everyday language		Technical language	
	there	not there	there	not there
1. Energy for life	X		X	
2. Energy from the sun	X		X	
3. Energy around us	X		X	
4. Source of energy	X		X	
5. Input and output energy	X		X	
6. Movement and musical instruments	X		X	

As can be seen in this table, learners as early as Grade 4 level are exposed to field specific and technical terms in NS. However, the text book unpacks these technical terms and brings them into everyday language through using pictures and other context dependent means.

Technical Lexis relates to Vygotsky's scientific concept and can be coded as high semantic density (SD+) and the relationship is that both are context independent; learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. However, a significant difference between the two is that for Vygotsky, concept is more than just lexis. It is about how the terms connect and combine, and thus unfold to different meanings. In that way lexis and concept are close but different. Technical Lexis is defined as the use of terms or expressions within a specialised field that

have a field specific meaning. The technical terminology that is core to the field is the means, not only for making sense symbolically, but also for more generally accepted meaning to be attributed to objects and experiences. Technical Lexis is specialised, formal scientific taxonomies unlike the everyday, localised and concrete concepts. Therefore they should be coded as SG- and SD+.

D. Conceptual Complexity tool (MMCC)

Conceptual depth

Unit	Level 0 & 1		Level 2		Level 3		Level 4		Level 5	
	there	not there	there	not there	there	not there	there	not there	there	not there
1. Energy for life	X		X		X		X		X	
2. Energy from the sun	X		X		X		X		X	
3. Energy around us	X		X		X		X		X	
4. Source of energy	X		X		X		X		X	
5. Input and output energy	X		X		X		X		X	
6. Movement and musical instruments	X		X		X		X		X	

The table above provides evidence about concept complexities at Grade 4 level. It sheds some light on how concepts manifest themselves, how they ought to be understood and how they are used to foreground certain knowledge valuable to learners at Grade 4. The teacher's awareness of the MMCC will lead to deeper insight on concepts and content knowledge particularly because of the way in which these concepts are used in the teaching text. Conceptual depth relates to SG- and SD+ and scientific concepts in that it is a tool used to describe a hierarchy of increasingly deep structures of understanding of a scientific phenomenon. The table contains examples of complex concepts that are also classified SG- and SD+.

E. Conclusion

The above summary provides evidence that the analysed aspects of the NS textbook are rich in conceptual development, semantic relations, Technical Lexis and conceptual complexity.

However, the strengths and levels of these concepts are always weakened, particularly because the intended learners are at Grade 4 level.

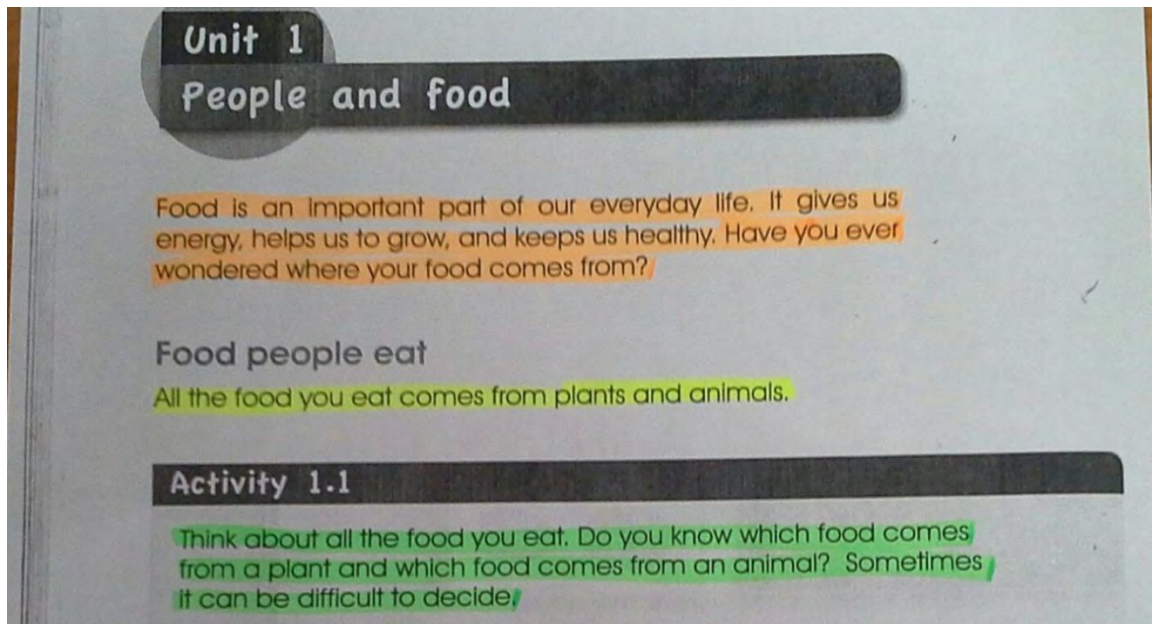
Analysis of Social Science textbook – Food and farming in South Africa

Vygotsky's conceptual development

One of tools that this study uses is Vygotsky's conceptual development. To briefly recap what the chapter on theoretical frame work discussed: Vygotsky's conception of concept development focuses on the manner in which children gravitate to the norms of relatively stable adult communities of practice... in which conceptual agreement provides the mediational context of their development (Smagorinsky, 2013: 239). Concept development, Vygotsky delineates, begins with an infant's exposure to human contact and the expectations that others have for a child in the greater draft of human societal activity (Wellings, 2003). Concept formation, Wellings continues, "takes place through the interaction of language and other signs with the immediacy of perceptual intellectual processes". Wellings further argues that "the use of language becomes the mechanism through which the child focuses his or her attention, and is able to select distinctive features within the environment and analyse and synthesise them" (Wellings, 2003, p. 3). Vygotsky asserts his notion of concept development by outlining a broad development sequence of moving from disorganised complex to a pseudoconcept to a highly organised concept. Vygotsky (Smagorinsky, 2013) further distinguished between scientific and spontaneous concept.

A. Vygotsky's complex

Below is an analysis of the textbook using Vygotsky's complex. Examples are drawn from 'Viva Social Science' (Food and farming in South Africa).



The textbook page above illustrates the following concepts:

1. Complex

‘Think about all the food you eat; do you know which food comes from a plant and which food comes from an animal?’

2. Pseudoconcept

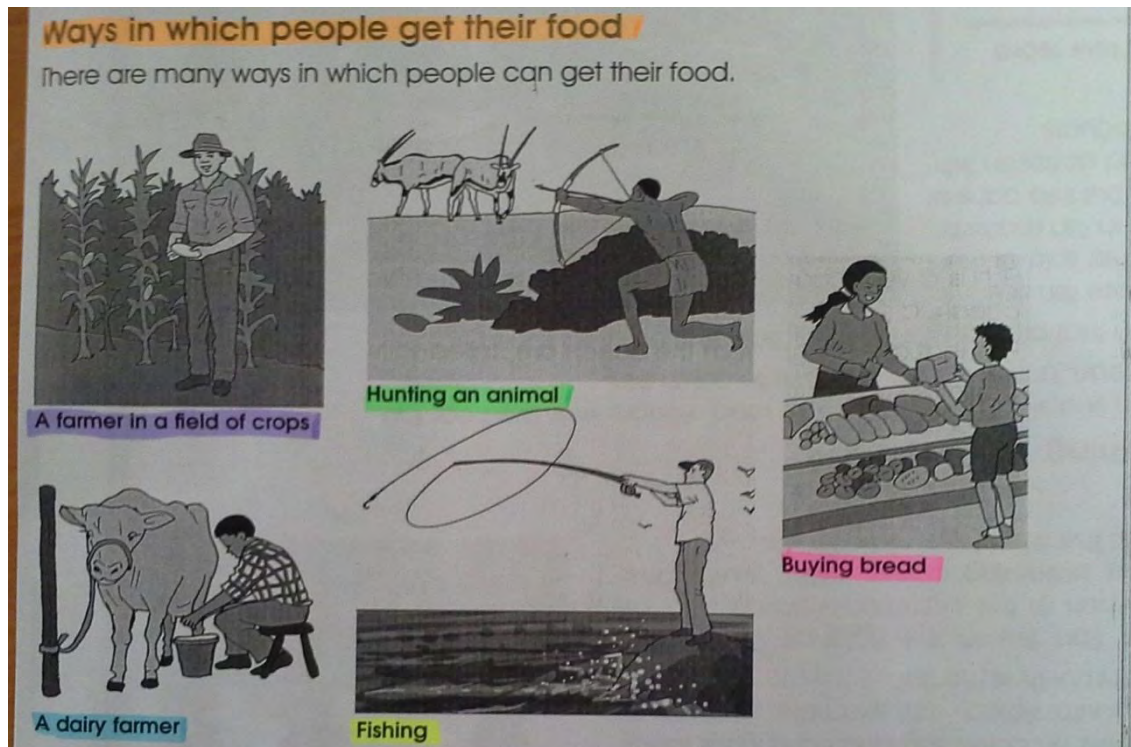
‘All the food you eat comes from plants and animals.’

3. Concept

‘Food is an important part of our everyday life. It gives us energy, helps us to grow, and keeps us healthy.’

B. Spontaneous and scientific concepts

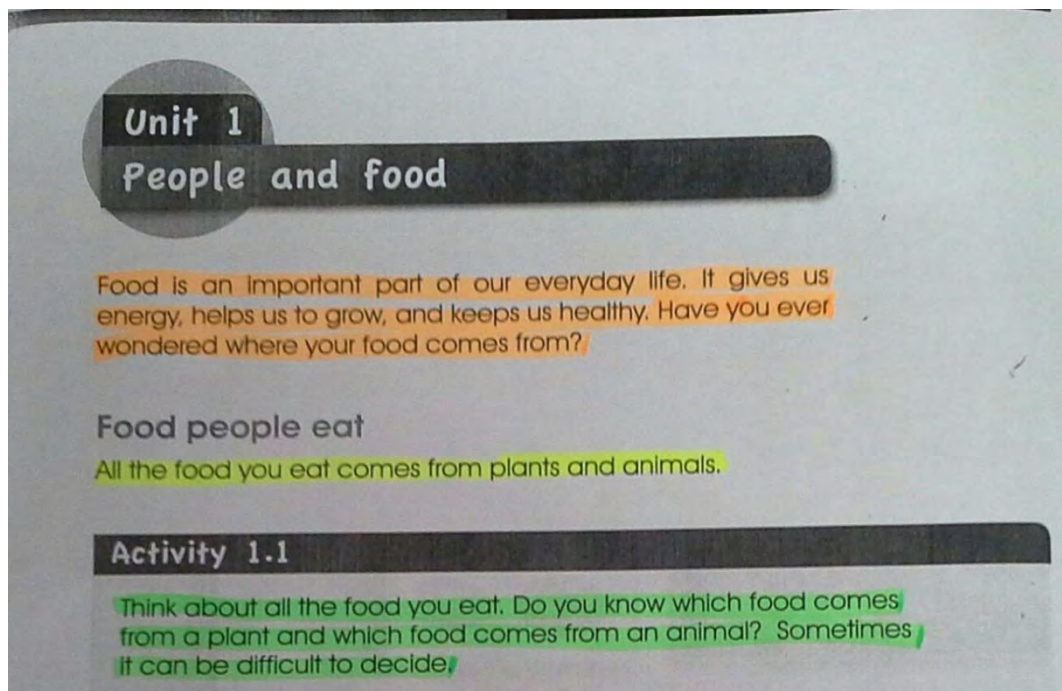
Vygotsky distinguishes between spontaneous and scientific concepts and says spontaneous concepts are learned in situated, everyday practice. As a result, they are applicable primarily in context where the everyday circumstances and practices resemble those of the original context. Here is an example of a spontaneous concept found in the teaching text:



In this example the author brings the content very close to learners' everyday life through the use of illustrative pictures as they try to illustrate what farmers do, what is meant by hunting, a dairy farmer, fishing and where bread is bought. The use of the pictures was deliberate in order to allow the learners to relate to the concept. Vygotsky argues that spontaneous concepts are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context.

C. Vygotsky's scientific concepts

These would be realised when textbooks depict knowledge to which learners are exposed by a more knowledgeable people, in a formal and systematic, abstract but also general way. Here is one example from the teaching text: 'Food is an important part of our everyday life. It gives us energy, helps us to grow, and keeps us healthy'.



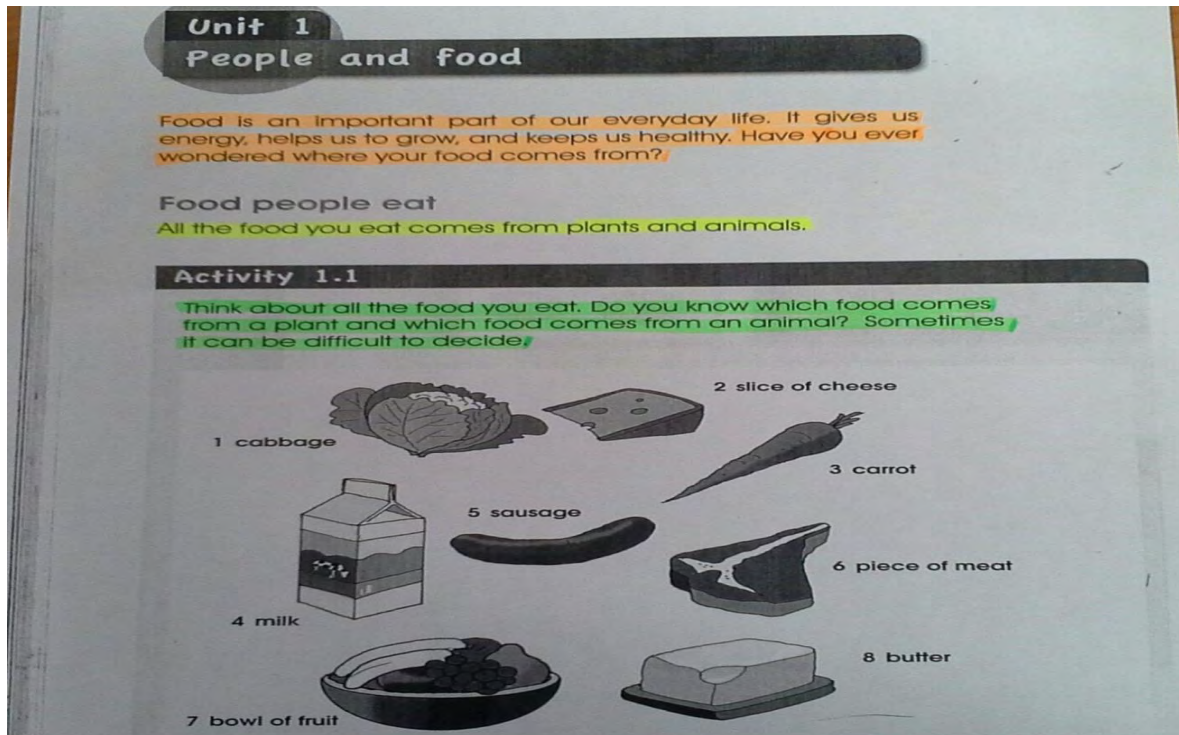
D. Conclusion

The emergent evidence clearly shows that as the SS textbook uses concepts and presents them to Grade 4 learners; there is a clear trend with the interaction of the complex/spontaneous and scientific concepts. It becomes easy for the advanced reader to experience and trace the trajectory of concept development from complex, pseudoconcept to spontaneous and scientific concepts. Although Vygotsky argues that conceptual development should not take a linear path like that, the way concepts are structured and the way they interact in the teaching text highlights the combination of everyday life and academic, abstract experiences. This therefore highlights the role of the teachers as 'experienced adults' in assisting the learners build new conceptual understanding through the linking of existing complexes/spontaneous and scientific concepts. The nature of the concepts tilts towards everyday/spontaneous concepts as the textbook introduces academic and scientific concepts

Karl Maton's LCT – Semantic Gravity (SG) and Semantic Density (SD)

The second theoretical framework that this study draws on is Karl Maton's LCT and the two concepts that were used as analysing tools were semantic gravity (SG) and semantic density (SD). This was intended to deal with how language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science. To briefly recap what the chapter on theoretical frame work discussed, semantic gravity (SG) "refers to the degree to

which meaning relates to its context. Semantic gravity may be relatively stronger (+) or weaker (-). Where semantic gravity is stronger (SG+), meaning is more closely related to its context; where weaker (SG-), meaning is less dependent on its context. The context may be social or symbolic” (Maton, 2013). Here is an analysis of the textbook using LCT:

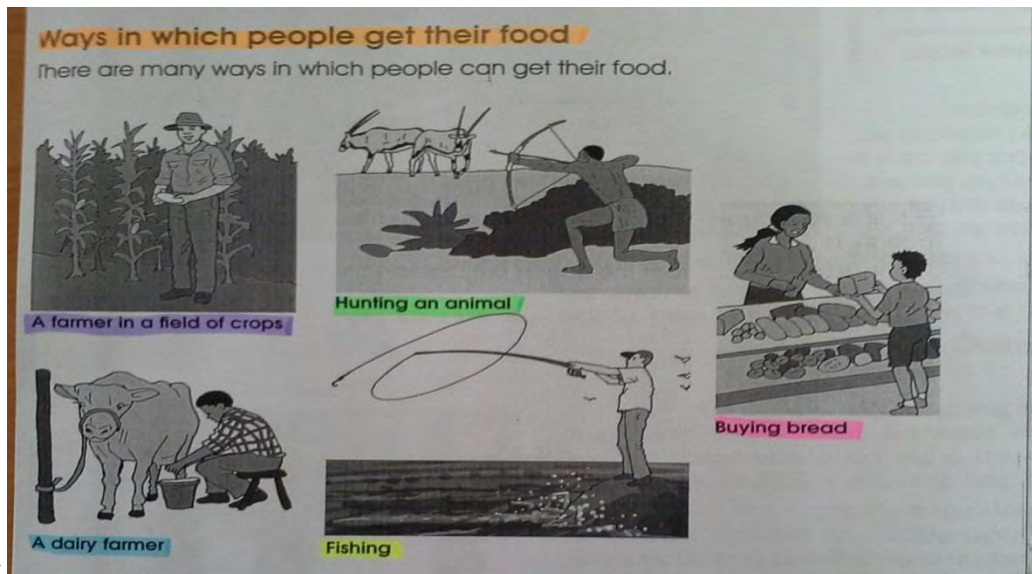


A. Semantic Gravity (SG)

The examples below come from the page inserted above; the topic of the chapter is 'Food and farming in South Africa'.

<u>Concept</u>	<u>Coding</u>
Food	SG+
Farming	SD+ -
- Where does my food come from?	SG+
People and Food	SG+
Food is an important part of our everyday life	SG+
It gives us energy, (SD+ -) helps us to grow, and keeps us healthy.	SG+
Have you ever wondered where your food comes from?	SG+

What appears on this page is that the start of the chapter is characterised by very strong semantic gravity (SG+) and weakened semantic density (SD-). Only one concept can be related to weakened semantic gravity (SG-) ‘food is an important part of our everyday life. It gives us energy and helps us to grow’. This sentence bears some degree of context independence, especially for the part that says ‘it gives us energy’ however there is no evidence of SD+ thus far. The examples of coding used in the above mentioned concepts are arrived at simply because they are every day and context dependent examples of SG+. Mostly the chapter is characterised by SG+ and the picture illustrating where different food comes from also serves to strengthen semantic gravity (see the picture below). When the teacher tries to explain and unpack these concepts to learners, the concepts become even



simpler,

and more concrete and learners can relate to these pictures with ease. Another example is, ‘farmers use the land to grow many different types of crops such as wheat. Wheat is made to make bread’. Below is an analysis of the whole page:

Growing

Farmers use the land to grow many different types of crops such as wheat. **Wheat is used to make bread.**

Collecting and hunting

In some parts of the world today, people still rely on collecting and hunting for food. In South Africa, an example of such a community is the San.

The San live in the Kalahari Desert. The women of this community spend a lot of time collecting berries, roots, plants and fruit. The men hunt wild animals.



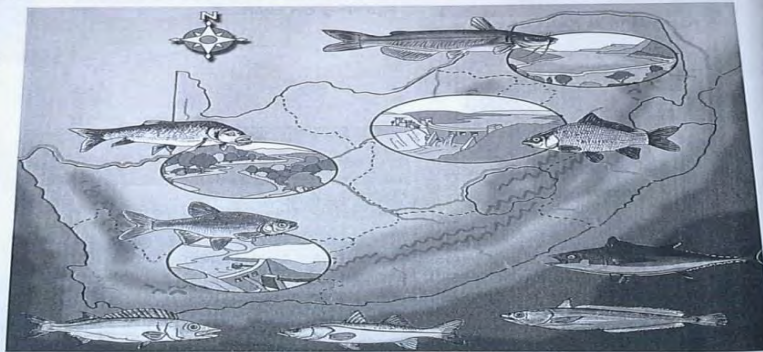
San

Fishing

Fish is a very good **source** of food. People who live near the ocean, a river or lake are able to catch fish.

Fish that are caught from the ocean are called **saltwater** fish.

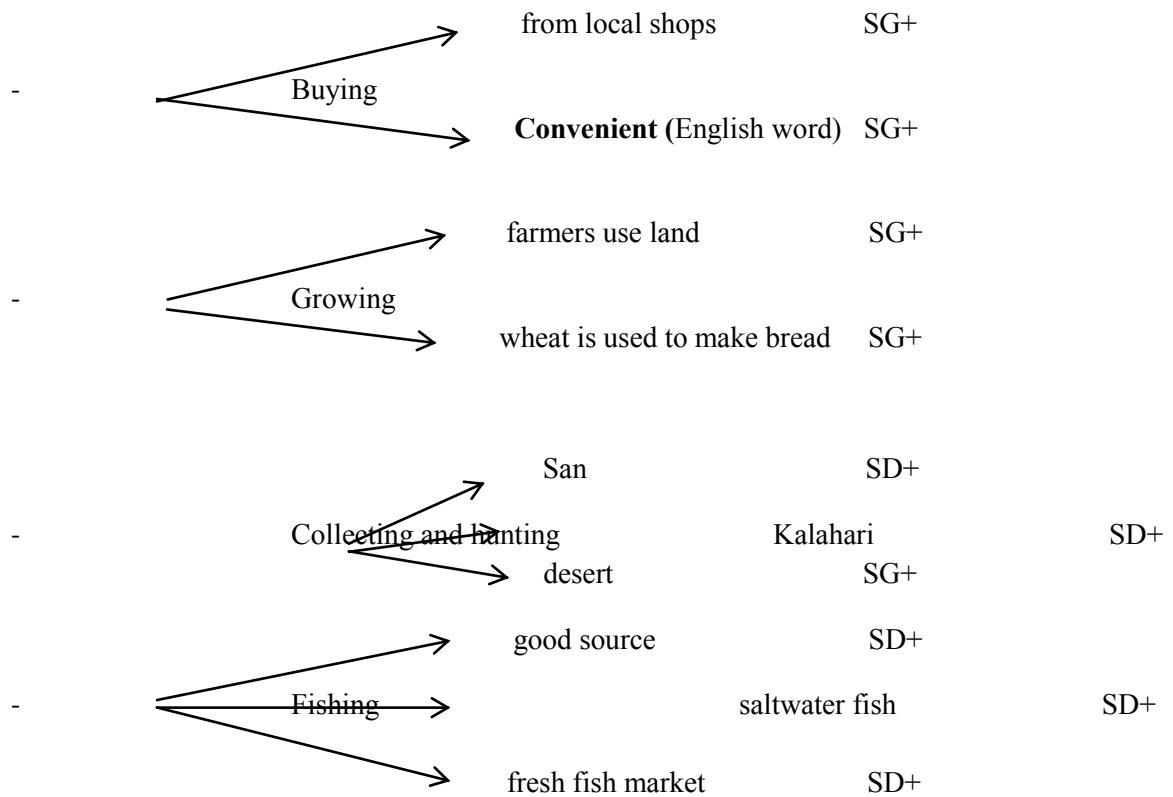
These fish are either sold at the fresh fish markets or put into cans or sold as frozen fish products.



Fishing areas of South Africa

New word

■ **source** – starting place, supply of something



The example of fishing that appeared in the page inserted above contains both SG+ and SD+. The third sentence is a particularly good example of SD+ because it increases the density by adding 'salt water fish' thus adding more weight to 'fish'.

In the example of 'farmers use the land to grow many different types of crops such as wheat. Wheat is used to make bread', the initial idea was to elaborate on ways in which people can grow their food and the elaboration is marked by a number of new concepts to Grade 4 learners who are non-English speakers. To try to make 'wheat' a little easier for the learners to understand and recall, the textbook says, 'wheat is used to make bread'. Bread is known to all learners; in this way the example becomes concrete, context-dependent and the semantic gravity is strengthened. The table below shows concepts that are found in the teaching text.

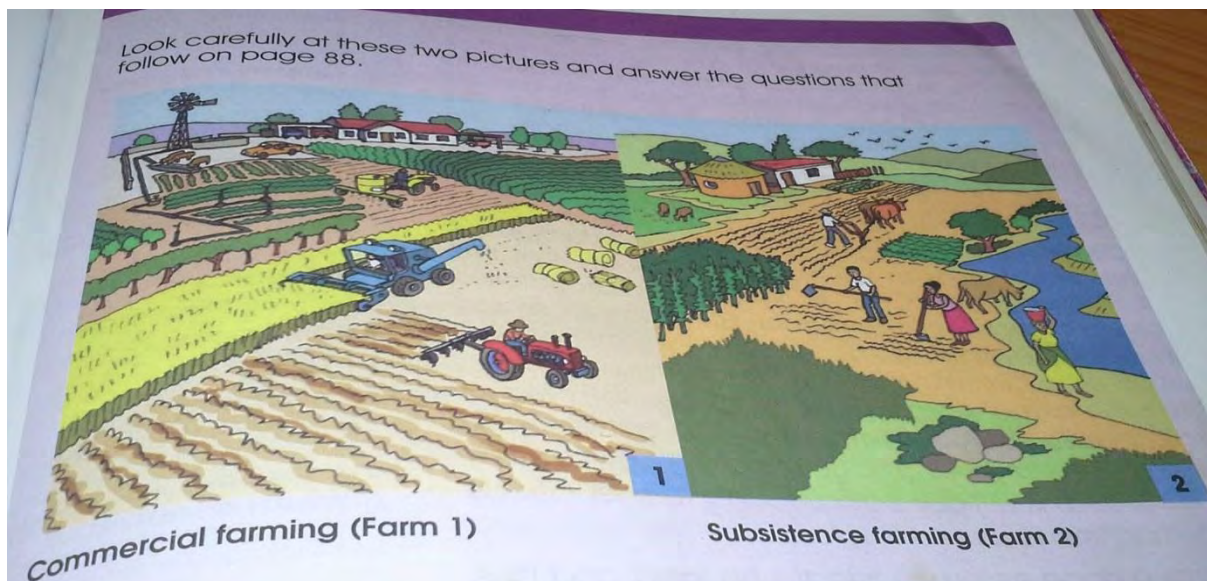
++

Context independence

--

Local, concrete, everyday knowledge	Some context dependent	Some context independent	Universal, abstract, specialised knowledge
Food Farming Wheat Pictures	Crops	Food gives us energy	-Energy -Source -San -Kalahari Desert -Saltwater fish

B. Semantic Density in Social Science Unit 2

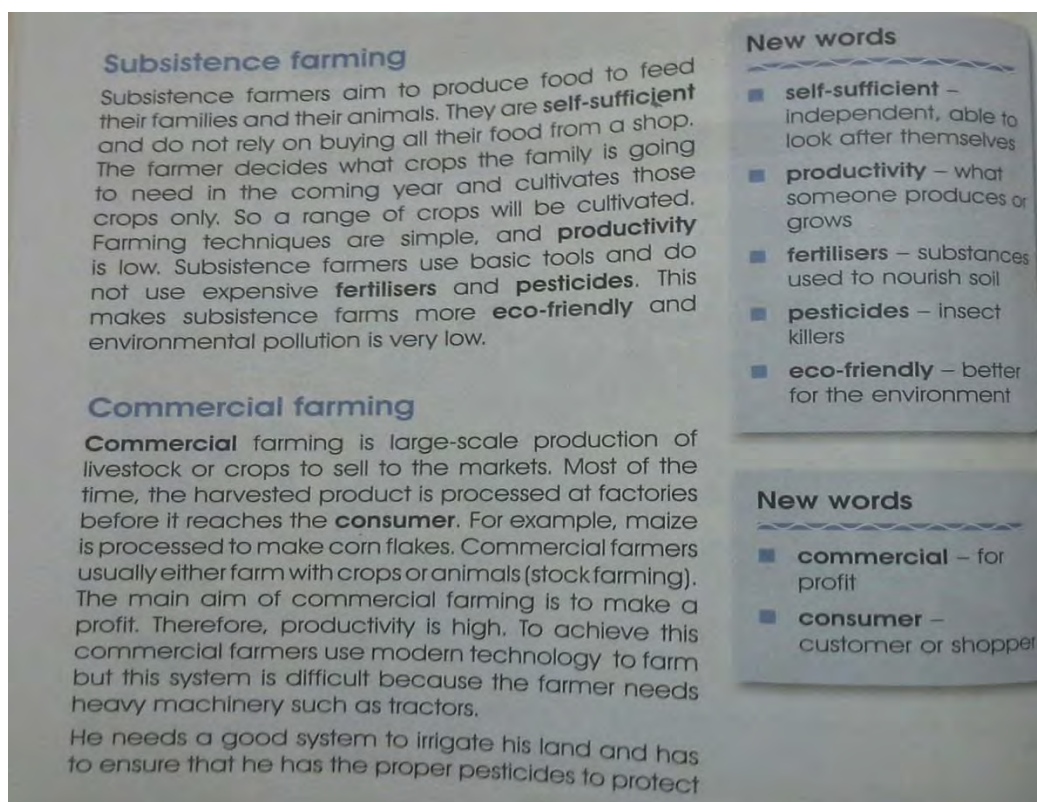


To recap, semantic density (SD) refers "to the degree to which meanings are condensed within symbols (terms, concepts, phrases, gestures, and so on). Semantic density may be

relatively stronger (+) or weaker (-). Where semantic density is stronger (SD+), symbols have more meanings condensed within them; where semantic density is weaker (SD-), symbols condense less meaning. The meanings condensed within a symbol may be an empirical description (or other meanings with relatively direct empirical referents) or they may be feelings, political sensibilities, taste, values, morals, affiliations and so forth” (Maton, 2013).

To explain further how semantic density impacts on Social Science, I took a very close look at Unit 2 ‘Ways of farming’ (see page 87 of the scanned copies). This unit outlines two concepts: subsistence farming and commercial farming. The two concepts condense a wide range of meaning. Significant to note here is that this activity starts with the presentation of two pictures to distinguish between commercial and subsistence farming. The pictures condense a lot of information about the difference between commercial and subsistence farming; the picture can be coded as SD+- since they compress a lot of information.

The next two paragraphs deal with subsistence and commercial farming and remain both context independent SG- and abstract SD +.



In trying to unpack these two concepts (commercial and subsistence farming), the authors also use other abstract terms that need to be explained or unpacked and brought to everyday

language. The textbook does this by listing the definitions of new words but the teacher still needs to further unpack these words, especially because the learners are from the Foundation Phase where learning happens in isiZulu and they have never experienced the concepts before. For example:

SD+ Subsistence farming (a specialisation and abstract concept)

SD+ Self-sufficient (abstract)

SD+ Productivity

SD+ Fertilisers

SD+ Pesticides

SD+ Eco-Friendly

SD+ Commercial farming

SD+ Large scale farming

SD+ Markets

SD+ Processed

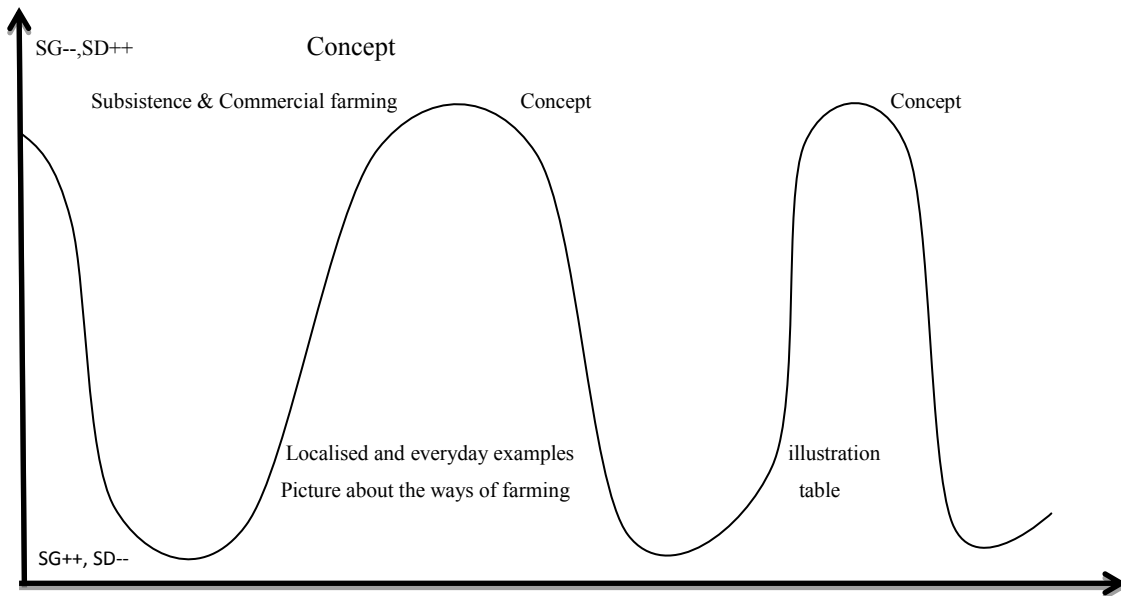
SD+ Irrigate

SD+ Labour

SD+ Environmental pollution

Semantic waves in 'Ways of Farming'

The conceptualising processes interacting in this unit are of weakened semantic gravity (SG-), expressed as specialisation concepts. In the instances where semantic gravity is weakened, the authors of the book strengthen it by either presenting a picture or by elaborating or unpacking the concepts by providing a list of new words. The graph below is illustrative of the semantic waves in this unit:



Waves: Ways of farming

The part which is the top of the graph depicts weak semantic gravity (--) and strong semantic density (++) and the bottom part indicates strong semantic gravity (++) and weak semantic density (--). The concepts in the section on 'ways of farming' condense a wide range of meaning, however, as the textbook attempts to explain these abstract terms, some more abstract terms come up. Specialised and technicalised concepts such as pesticides, fertilizers and environmental pollution were used when trying to unpack commercial and subsistence farming. These are not everyday, local and concrete concepts; they still need to be unpacked and explained for they are abstract. In trying to simplify these terms, teachers will employ other means: they will use every day examples in order for the terms to be more context dependent. This then will shift the pedagogy and learning experience to the bottom part of the graph, which is context dependent.

Unit 3

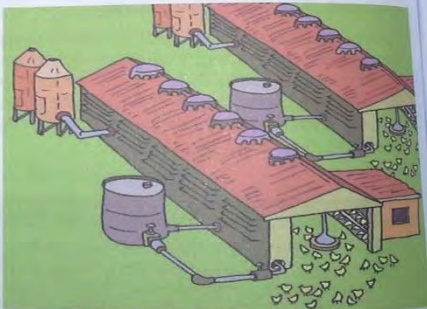
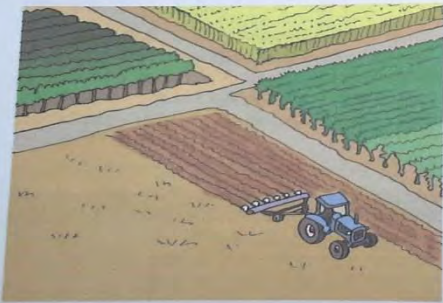
Crop farming and stock farming

Unit 3
Crop farming and stock farming

There are two different kinds of farming. There is **crop** farming and **livestock** (or stock) farming. Although farming is divided into crop farming and stock farming, many commercial farmers farm with both crops and livestock. In South Africa, **cereals** and grains are the most important crops. Stock farmers keep different kinds of animals like sheep, goats, cows, pigs and **poultry**.

New words

- **crop** – plants that are grown on a farm, such as wheat or vegetables
- **livestock** – animals that are kept on a farm, such as cows or sheep
- **cereals** – crops such as wheat, maize and oats
- **poultry** – birds such as chickens that are used as meat or produce eggs



Crop farming **Stock farming**

This unit is marked by dense concepts, especially in the beginning. The text book deals with this context independent situation by first defining the new words and concepts for learners, for example 'crop', 'livestock' and 'poultry', however it again presents two pictures on crop farming and stock farming. The pictures make it easier for the learners to understand the two concepts – 'crop' and 'stock farming'. The text starts with SD+ concepts and then unpacks them using the picture. When learners look at the pictures, they will be able to know what a crop farmer as well as a stock farmer does.

Crop farming

A crop farm grows plants such as cereals, grain, fruit, vegetables, cotton, flowers as well as food for cattle.

SG+

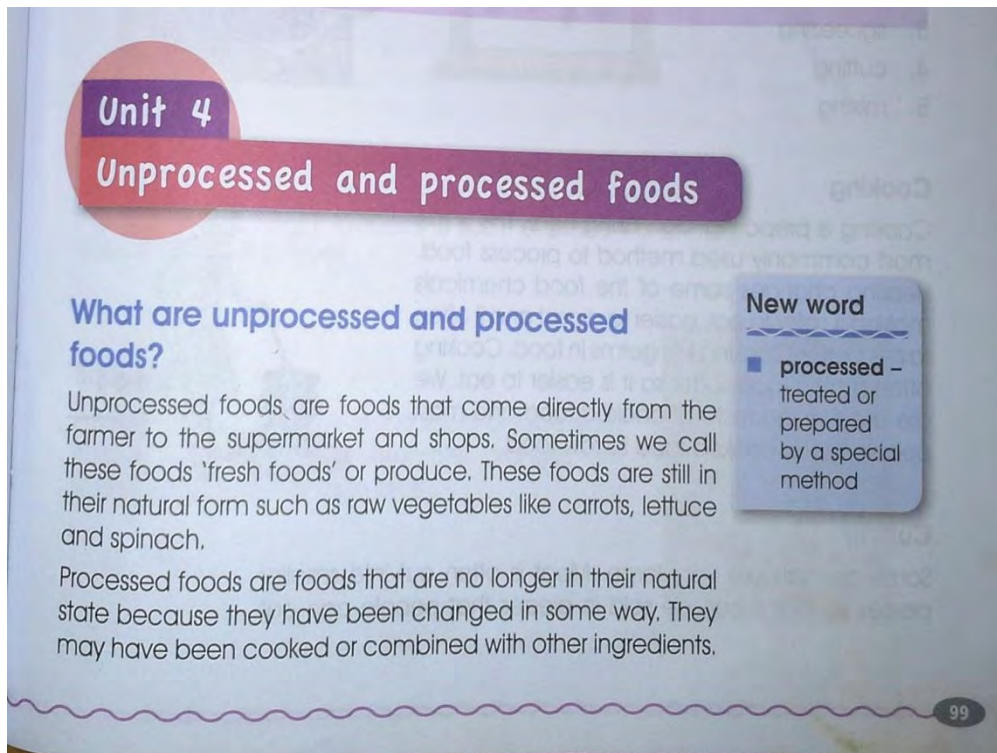
The largest crop that is produced in South Africa is maize. South Africa also produces wheat, sugar cane, sunflower seeds and flowers.

SG+

Fruit such as grapes, oranges, pineapples and apples, and variety of nuts are also grown.

SG+

Unit 4



Unprocessed and processed foods

SG- and SD+

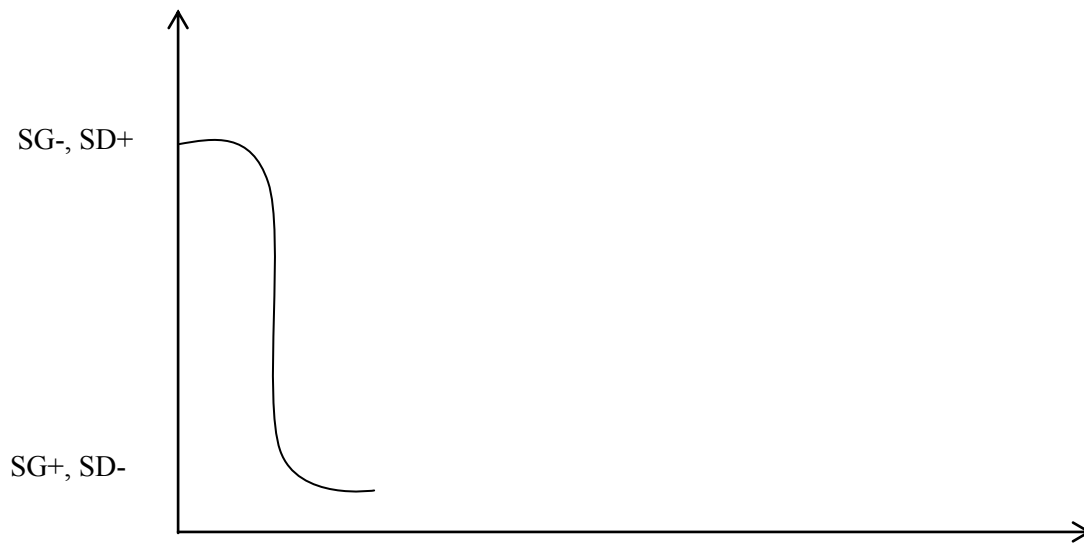
What are unprocessed and processed foods?

SG- and SD+

The definition of these two concepts strengthens their semantic gravity and weakens semantic density and as usual the textbook defines the difficult word and lists them as new words:

<u>New word</u>	<u>Definition</u>	<u>Coding of definition</u>
Processed	treated or prepared by a special method	SG+
Dehydration	the process of removing water	SG+
Preservatives	chemicals that prevent food from rotting	SG+

The graph below is illustrative of the movement the concepts take in the Grade 4 social science text book:



C. Conclusion

The analyses of these units from the social science textbook highlight downward escalator profiles of concepts to be acquired by learners. As illustrated in the above analysis, the knowledge presented by the textbook comprises shifts from highly context-independent and dense concepts (SG-, SD+) towards simpler, more concrete and context-independence, often including examples from everyday life. The textbook introduces specialised concepts and only then starts to ‘unpack’ and exemplify the concepts by listing pictures and giving everyday examples.

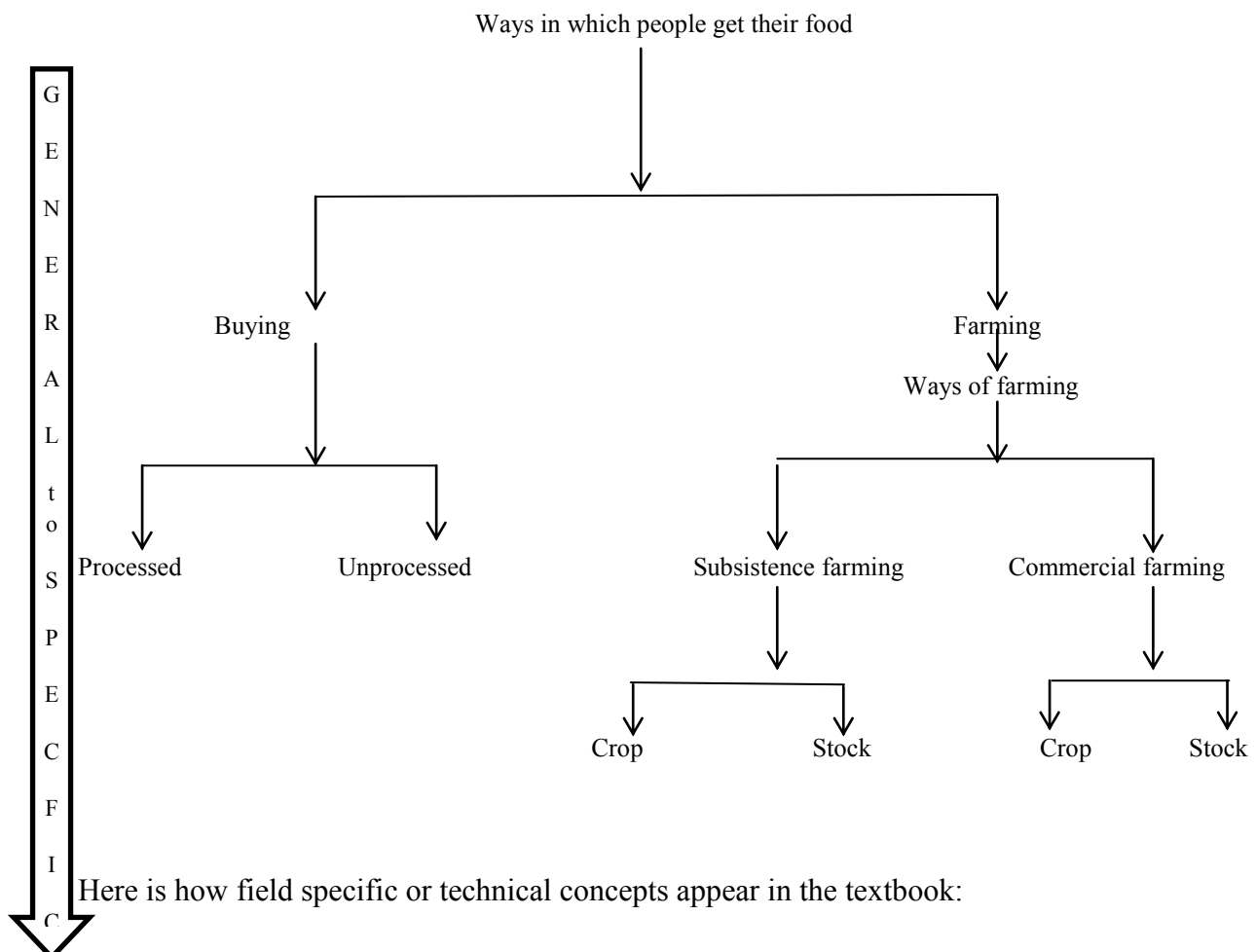
Devika Naidoo’s Technical Lexis

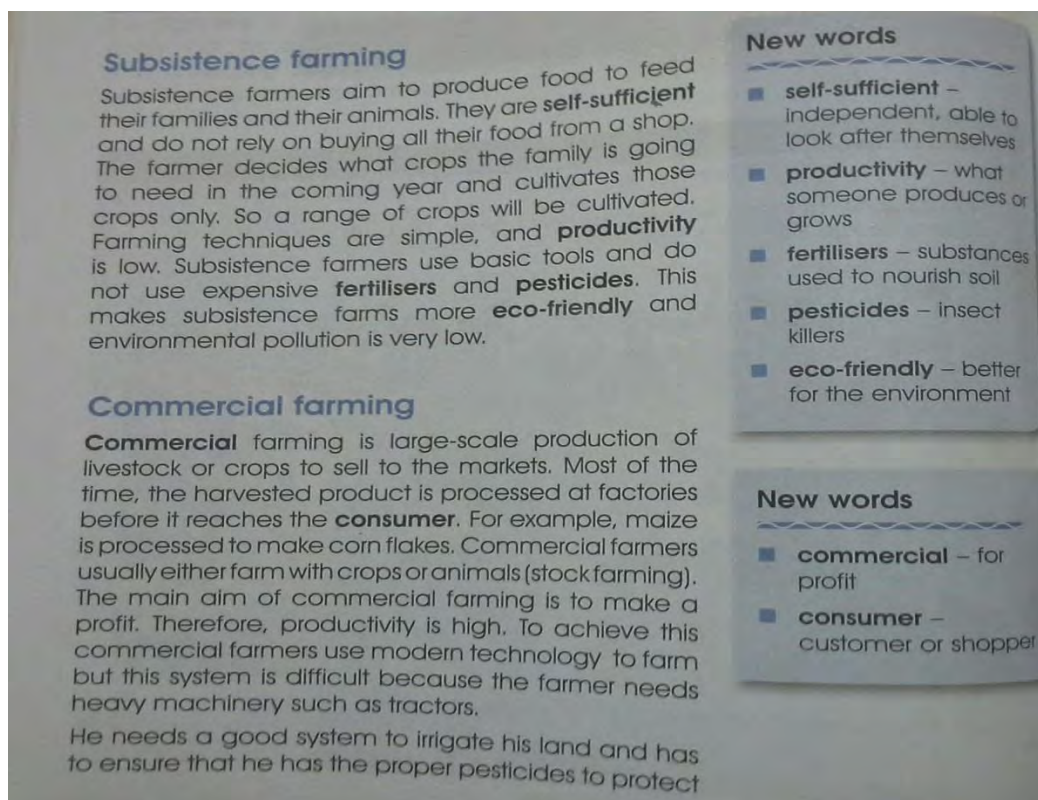
Having discussed how Vygotsky’s model of conceptual development and Maton’s semantics distinguish everyday or common sense knowledge from educational or uncommon sense knowledge, I now refer to Devika Naidoo (2013) who also offers a means of conceptualising knowledge-building through Technical Lexis and what she calls taxonomies that are either specialised or everyday and formal scientific taxonomies. As was discussed in the theoretical framework chapter about Technical Lexis, Technical Lexis refers to the use of terms or expressions within a specialised field that have a field specific meaning. A technical terminology that is core to the field is the means, not only for making sense symbolically, but also for more generally accepted meaning to be attributed to objects and experiences. There

is a clear relationship between semantic density and Technical Lexis and what is important about Technical Lexis is that it succinctly portrays these terms thus making it clearly visible and accessible to both teachers and learners.

Farming taxonomic structure

General concepts	Specific Concepts
How people get food	Farming, fishing, dairy, buying & hunting
Food	Gives energy
Processed food	Tomato sauce
Unprocessed food	Fresh foods
Energy	Gives energy: plants and animals
Ways of farming	Commercial & subsistence farming
Crop	Cereal
Chickens used for meat or to produce eggs	Poultry
Fishing	Saltwater fish
Kinds of farming	Crop and livestock / stock farming
Crop farming	Citrus & subtropical fruit
Processed foods	Cooking, cutting, squeezing, drying & Mixing





The table below shows that the concepts that appear on this textbook page are dense and field specific concepts:

A. Table illustrating Technical Lexis

Specific concepts	Specific examples	Everyday language (concrete)	Technical Language (dense)
Food	food from animals and plants	rice, meat & fish	gives energy
processed food	sauce	Prepared by a special method (cooking, drying, squeezing, cutting, cutting & mixing)	tomato sauce
unprocessed food	fruit	raw	fresh foods
Energy	food	power	gives energy: plants and animals
Farming	stock & crop farming	goats, sheep, cattle & maize, grains	commercial & subsistence farming
Crop	grains	maize & grains	cereal
poultry	poultry	chickens used for meat or to produce eggs	
Fishing	canned or frozen fish	hake, Lucky Star	saltwater fish
crop farming	fruit farming	bananas, oranges	citrus & subtropical

			fruit
--	--	--	-------

B. Conclusion

As the table illustrates, it is as early as at Grade 4 level that learners are introduced to field specific and dense concepts such as ‘give energy’, ‘commercial and subsistence farming’, ‘fertilizers’, ‘pesticides’ and ‘eco-friendly’. The major task of the textbook, which it does very well, is to introduce these field specific concepts and unpack it to everyday language in order for the Grade 4 learners to be able to understand and be able to use them effectively and meaningfully as they progress to senior grades. It can be safely said that the teaching text does provide the learners with very good knowledge building opportunities.

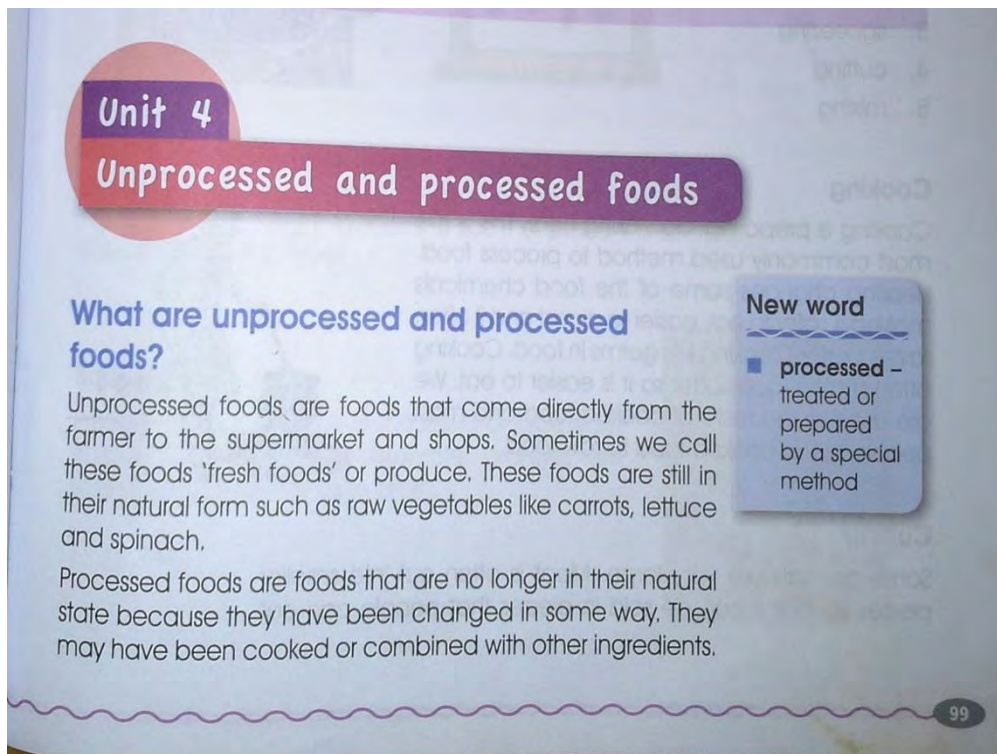
N. J. S. Brown’s Conceptual Complexity tool (MMCC)

The third theoretical frame work that underpins this study is Brown’s Multidimensional Measure of Conceptual Complexity (MMCC). Brown (2005) advocates a multidimensional instrument that he says “assesses students’ conceptual understanding. Brown describes a two dimensional space of conceptual complexity, defined by hierarchical continua representing different degrees of conceptual depth and conceptual breadth”. Brown says “the constructs of depth and breadth are collectively referred to as Multidimensional Measure of Conceptual Complexity” (MMCC).

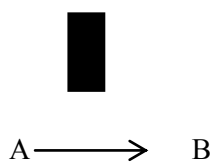
A. Conceptual depth

Only a brief summary of the six levels of conceptual depth is given here as they are discussed in detail in the theoretical framework chapter. These levels describe “a hierarchy of increasingly deep structures of understanding of a scientific phenomenon: (0) the absence of understanding; (1) a causal understanding in which the phenomenon is not seen to require any justification; (2) understanding based upon a single causal element that lacks justification; (3) understanding based upon a single causal element that include justification; (4) understanding that involves multiple causal elements, all of which are necessary but independent, and (5) understanding that involves multiple causal elements that interact within a system, eventually producing an emergent phenomenon” (Brown 2005).

B. Analysis of unprocessed and process foods using the complexity tool

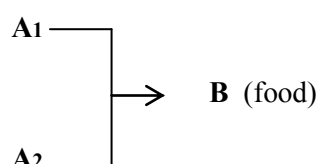


‘Unprocessed food’ is used as the example here with my understanding that this concept is on level 2 Elemental.



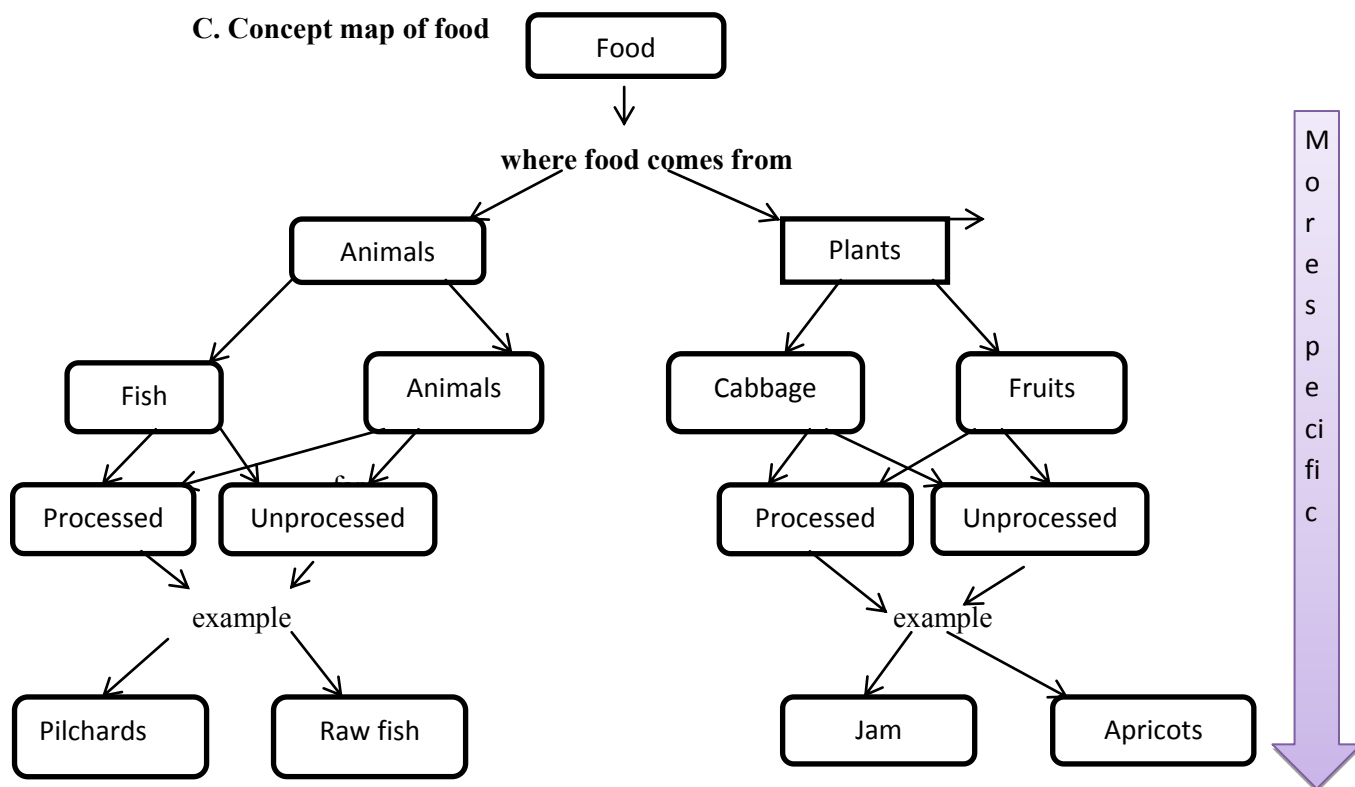
Food is seen as effect produced by a singly causal element. Justification or mechanism is not necessary, for example: Cow = Meat.

With the way in which the textbook presents ‘processed food’, on the other hand, learners will understand it as Level 4 Multiple – food is seen as an effect produced by multiple causal elements (ingredients, cooking and processing). All are necessary; if one is removed food is not going to be produced – **A1** and **A2** cause **B** when they both happen at the same time (the qualitative level of the depth construct) (Brown, 2005).



In terms of the qualitative levels of the breath construct, the interpretation is that it is process consistent, that is phenomena that share a type of change can be caused by the same thing, even if the objects are different. Significant to note is that whilst these two concepts are certainly not everyday terms, they cannot be said to be highly dense concepts for they can be coded as SG -/SD - . They are somewhere in the middle as they still need unpacking as can be seen during the observed lessons.

C. Concept map of food



D. Conclusion

The discussion above provides evidence about concept complexities in Social Science at Grade 4 level. It gives insight into the nature of concepts and how these manifest themselves and how they are used to foreground certain knowledge considered to be important for knowledge building at Grade 4 level. Relatively speaking, conceptual complexity in Social Science is unlike in the Natural Sciences. This may be due to the fact that the SG- and SD+ of Social Science is also relatively weaker. Again this is due to the nature of the subject itself. This is not to say it did not impact at all; it did happen but it was weaker and hard to identify.

The teacher’s awareness of the MMCC will lead to deeper insight on concepts and content knowledge particularly because of the way in which these concepts are used in the teaching text.

How Vygotsky, LCT, Technical Lexis and MMCC all impact on Social Science

This section summarises what the four analytical tools show together in the analysed Social Science textbook. The word ‘there’ stands for saying that the concepts were found in the unit, ‘not there’ means concepts were not found.

A. Vygotsky’s conceptual development

Unit	complex		pseudoconcept		concept		spontaneous		scientific	
	there	not there	there	not there	there	not there	there	not there	there	not there
1. people & food	X		X		X		X		X	
2. ways of farming	X		X		X		X		X	
3. crop & stock farming	X		X		X		X		X	
4. unprocessed and processed food	X		X		X		X		X	

As can be seen in the table above, the textbook displays how Vygotsky’s conceptual development impacts on the Social Science chapter. Complex, pseudoconcepts and spontaneous would impact more and very often as compared to concept and scientific concepts. The textbook shifts from concepts to complex and from spontaneous to scientific concepts and vice versa in a bid to make the content information accessible to Grade 4 learners.

Unit	SG+		SG-		SD+		SD-	
	there	not there	there	not there	there	not there	there	not there
1. people & food	X		X		X		X	
2. ways of farming	X		X		X		X	
3. crop & stock farming	X		X		X		X	

4. unprocessed and processed food	x		x		X		X	
--	----------	--	----------	--	----------	--	----------	--

This proves that semantic relations in NS at Grade 4 interact between strong semantic gravity (SG+) and weakened semantic gravity (SG-) as well as between strong semantic density (SD+) and weakened semantic density (SD-) and vice versa. However in the situations where there is SG- and SD+, the textbook simplifies the concepts by presenting pictures, everyday experiences and concrete examples.

Having looked at both Vygotsky’s conceptualisation and LCT’s semantics, one realises that Vygotsky’s scientific concepts relate to low semantic gravity (SG-). First the relationship is that scientific concepts are not context dependent; they are learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. Similarly, weakened semantic gravity (SG-) is context independent. Likewise, high semantic gravity relates to complex and pseudoconcept. For both these modes of conceptualising, meaning is more closely related to its context, concrete and learned in situated, every day practice. As a result, these concepts are applicable primarily in context where the everyday circumstances and practices resemble those of the original context of learning.

On the contrary, SD+ (high semantic density) relates to scientific concept; they are both abstract and condense more meaning. Where semantic density is weaker (SD-), symbols condense less meaning. Weak semantic density is when the terms say what they say without much extra depth needed to understand them. Thus low semantic density SD- relates to complex, pseudoconcept and spontaneous concept.

C. Technical Lexis

Unit	Everyday language		Technical language	
	there	not there	there	not there
1. people & food	x		x	
2. ways of farming	x		x	
3. crop & stock farming	x		x	

4. unprocessed and processed food	x		x	
--	----------	--	----------	--

As the above table shows, it is as early as at Grade 4 in NS that learners are exposed to field specific and technical terms. However, the text book unpacks these technical terms and brings them to everyday language through using pictures and other context dependent means. Technical Lexis relates to Vygotsky’s scientific concept and can be coded as high semantic density (SD+) and the relationship is that both are context independent, learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. However, a significant difference between the two is that for Vygotsky, concept is more than just lexis. It’s about how the terms connect and combine, thus unfold to different meanings. In that way lexis and concept are close but different. Technical Lexis is defined as the use of terms or expressions within a specialised field that have a field specific meaning. The technical terminology that is core to the field is the means, not only for making sense symbolically, but also for more generally accepted meaning to be attributed to objects and experiences. Technical Lexis is specialised, formal scientific taxonomies unlike the everyday, localised and concrete concept. Therefore they should be coded as SG- and SD+.

D. Conceptual Complexity tool (MMCC)

Conceptual depth

Unit	Level 0 & 1		Level 2		Level 3		Level 4		Level 5	
	there	not there	there	not there	there	not there	there	not there	there	Not there
1. people & food	x		x		x		x		x	
2. ways of farming	x		x		x		x		x	
3. crop & stock farming	x		x		x		x		x	
4. unprocessed and processed food	x		x		x		x		x	

The table above provides evidence about concept complexities at Grade 4 level. It sheds some light on how concepts manifest themselves, how they ought to be understood and how they are used to foreground certain knowledge valuable to learners at Grade 4. The table indicates the nature of conceptual complexity, in short levels 3 to 5 of conceptual depth were

hard to find. Relatively speaking, conceptual complexity in SS is unlike in the Natural Sciences. This may be due to the fact that the SG- and SD+ of SS is also relatively weaker; again, this is due to the nature of the subject itself. This is not to say it did not impact at all; it did happen but it was weaker and hard to identify. However the teacher's awareness of the MMCC will lead to deeper insight on concepts and content knowledge, particularly because of the way in which these concepts are used in the teaching text.

E. Conclusion

The above summary gives evidence that the SS textbook is rich in conceptual development, semantic relations, Technical Lexis and conceptual complexity. However, the strengths and levels of these concepts is always weakened particularly because the intended learners are at Grade 4 level.

Comparison of Natural Science and Social Science

This study focuses, inter alia, on how language concepts in Grade 4 are structured in Natural and Social Science. This section, therefore, compares NS and SS textbooks to establish how and what each of the textbooks I analysed, using the four theoretical frameworks as analysis tools, look like.

Firstly, both NS and SS are sciences learnt in a school context. However NS is of hierarchical knowledge structures whereas SS is more of a horizontal knowledge structure. Both are vertical discourses. This analysis of the teaching text reveals that both subjects are working carefully and constructively between the concrete and abstract, between high and low SD and SG and using different levels of complexity. Maton's model of knowledge building operates in terms of the degree to which meaning in curriculum achieves weaker semantic gravity or lesser context-dependence and stronger semantic density or greater condensation of meaning (Maton 2013). These ideas together with Vygotsky's conceptual development, Devika Naidoo's Technical Lexis and Browns MMCC were used to analyse the nature of the concepts and how they are structured in NS and SS teaching texts.

Furthermore, the textbooks analysis reveals that the authors have a clear understanding of conceptual development. I say this because this current chapter presents evidence of all four theoretical models used as analysing tools as having impacted fairly well across the board.

The NS and SS textbooks showed an adequate amount of Vygotsky's conceptual development ideas. The analysis showed how the textbooks traversed between everyday, context-dependent, non-academic and specialised, context-independent, abstract and scientific concepts. To an extent, both textbooks were rich in Vygotsky's scientific concepts and both made use of complex, pseudoconcepts and spontaneous concepts in a manner that promotes knowledge building at Grade 4 level. Quite noticeable in both the textbooks is the fact that the balance of the concepts presented to Grade 4s most of the time tilted towards the everyday, context-dependent and concrete examples. This is not an issue at all at Grade 4 level, particularly as these learners in Foundation Phase were taught all the subjects in isiZulu.

The other model which was found to have had quite a positive mark in the textbooks is the LCT's semantics codes. Both textbooks showed healthy semantic profiles. Although on most occasions the waving took a downward movement, shifting from weakened semantic gravity and strong semantic density to strong semantic gravity and weakened semantic density, through concept explanation, unpacking and the use of pictures to enhance and illustrate the new concepts presented. To a large extent both textbooks used pictures a lot and these were used to either concretise meaning or weaken semantic density of the new concepts. Again this was fairly understandable at Grade 4 level; the concepts were new and the English language was always a barrier to the learners.

The concepts' presentation in both the textbooks is largely narrative and suitable for the Grade 4s. However in both subjects there is evidence of language shift towards field specific, technicalised and specialised concepts. This includes the manner in which Vygotsky's scientific concepts, Maton's SG- & SD+ and Devika Naidoo's Technical Lexis impacted in the textbooks. Quite a number of important field specific concepts were introduced in both the subjects respectively but in both the textbooks the authors shifted these specialised concepts and weakened them to everyday and concrete examples. The idea was to gradually introduce learners to these concepts and steadily prepare them for the senior grades.

Despite these many similarities, there is one critical area where the analysis of these subjects' textbooks was sharply different – MMCC. Whilst there is evidence of the introduction and the use of specialised and field specific terms, the nature of these concepts' complexity (MMCC) varied sharply. Relatively speaking, conceptual complexity in SS is unlike in the Natural Sciences. This may be due to the fact that the SG- and SD+ of SS is also relatively

weaker. Again this is due to the nature of the subject itself. This is not to say it did not impact at all, it did happen but it was weaker and hard to identify.

Conclusion

In conclusion, conceptual presentation and the impact of the theoretical models on NS and SS are similar in many ways despite the perceived differences in the nature of the subjects themselves. However NS's conceptual complexity is more advanced than SS and this is particularly so because of the nature of the subject itself. Despite these major differences, the analysis indicates that the authors of the textbooks did make an effort in presenting new concepts at Grade 4 level.

5.3. Lesson observations

5.3.1 Introduction

This section presents and discusses the nature of the data collected during the lesson observations and the responses of the participants during the interview process, with a view to analyse how teachers introduce new subjects and explain new and specialised concepts at Grade 4 level. The views of the two participants with regard to their experiences of teaching of teaching new concepts, how they effectively manage to deal with the language transition, as well as the introduction of subjects in Grade 4 are given. The section also compares how the theoretical framework impacts the two learning areas that two educators teach. The first technique used to collect data was lesson observation.

The main theories that support this study are Vygotsky's conceptual development, Karl Maton's LCT, Browns Conceptual Complexity Tool (MMCC) and Devika Naidoo's work on Technical Lexis. The study therefore used these theories as tools to analyse data collected using the lesson observation, the teachers' interviews and the analysis of the teaching texts. Michael Long's Interaction Hypothesis was also used for the purposes of analysing the pedagogical practices. These theories were used in relation to the following key research questions that this study attempts to answer:

- How text-books introduce and negotiate new and specialised concepts as well as shifting the language of instruction when introducing new subjects and explaining new and specialised concepts at Grade 4 level in the Natural and Social Science subjects.
- How language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science subjects

5.3.2 Vygotsky's conceptual development in Natural Science Grade 4 – Energy and Change

The first tool that this study uses is Vygotsky's conceptual development. Below is a vignette drawn from Grade 4 Natural Science. This was a 30 minutes lesson. The vignette illustrates the manner in which the teacher introduced and negotiated new concepts to her learners

A. Vygotsky's complex

The extract below is an example of Vygotsky's complex:

TEACHER: Do they have a band? He plays the guitar? Alright, let's look at the guitar. We will be looking at other musical instruments, but today I want us to look at the guitar. You see the man – what type of the body part he uses to play the guitar?

LEARNERS: He use his fingers.

TEACHER: He uses what?

LEARNERS (whole class): He use his fingers.

TEACHER: Alright he uses his fingers. So these fingers are moving. Can you see that he moves his fingers to play the guitar? What happens when the fingers are being used? What does the man do to the guitar so that the guitar makes the sound? What does he do? He does the..? (complex)

The reason for classifying this concept as complex is that it is informed by very loose thinking by the teacher. This kind of thinking by the teacher which says it is the man's use of the fingers that produces the guitar sound is not only incomplete but it can also mislead the learners. They will not have a complete understanding of all the elements involved in producing the guitar sound. This kind of conceptualisation relates to Vygotsky's assertion

that when people think in terms of complexes, any connection is sufficient to lead to the inclusion of an element in a given complex.

Vygotsky further states that along the path toward concepts, people develop complexes and pseudoconcepts, both of which approximate the unity of elements found in concepts but include inconsistencies such as the ones depicted by the NS teacher, especially when she did not clarify how movement in a system causes sound. The teacher did not explicitly say to learners that sound energy (music) comes from the string vibrating. In this regard learners cannot scientifically identify where exactly music comes from. This teacher's inconsistency as opposed to the textbook's explicit explanation that 'sound is amplified (made louder) by the air vibrating in the hollow inside of the guitar' encourages me to argue that the teacher's conceptualisation is disorganised, hence a complex.

B. Vygotsky's pseudoconcept

A pseudoconcept, in Vygotsky's terms, bridges the complex and concepts developmentally. It is a system that may confound differentiation between complexes and concepts as the system appears phenotypically similar to that of a concept. In simple terms this would be what is between a complex and the real concept. It is a term that appears to be very close to a concept. Here is an example that was found from the teacher's pedagogical practice and appears in the extract below:

TEACHER: Right, there are so many musical instruments. Remember when we talk about energy, whatever we do needs what? (pseudoconcept)

LEARNERS: Energy

TEACHER: Needs what?

LEARNERS: Energy

TEACHER: Before you start playing any of these musical instruments, there must be what?

LEARNERS: Energy

TEACHER: Energy, even if you are to play the guitar, you need?

LEARNERS: Energy

The reason for identifying this above highlighted sentence as a pseudoconcept is because it appears to be incomplete. It is a term that appears to be very close to a concept, without having the technical completeness of a full concept. The same concept was also identified in the NS Grade 4 textbook and was also coded as the pseudoconcept based on this fact that it is incomplete. It is therefore strongly argued that the teacher's thinking was somehow influenced by the way in which concepts are presented in the textbook. In other words, the assertion by the teacher that 'everything we do needs energy' emanates from the perspective of the textbook and its authors.

C. Vygotsky's Concept

When Vygotsky refers to a concept, "there is an implicit differentiation of the concept from lesser formed structures such as syncretic images, complexes, and pseudoconcept". Vygotsky describes concepts "as being part of a system of representation encompassing both levels of abstraction and degrees of relatedness to a reality constructed of other concepts. A concept is formed when abstract and concrete ideas are fused together, that is, when you compress complex and pseudoconcept" (Smagorinsky 2013). For example:

TEACHER: Alright he uses his fingers, so these fingers are moving. Can you see that he moves his fingers to play the guitar? What happens when the fingers are being used? What does the man do to the guitar so that the guitar makes the sound? What does he do? He does the..?

LEARNERS: He does pluck.

TEACHER: Very good, kusho ukuthi isingisi siyafundwa ngale, **he plucks the guitar. That is plucking when the fingers are moving like this. This is a type of movement, is a type of..?**

LEARNERS: Movement (concept)

TEACHER: A type of movement that is taking place when a guitar is being played, understand that?

LEARNERS: Yes

TEACHER: I want you to look at page 41, and let's just read through the text about how the body movement affects the guitar so that we get the...

LEARNERS: sound

Although the teacher does not present the whole conceptual idea here, she is moving towards the main idea of 'movement energy'.

D. Spontaneous and scientific concepts

Vygotsky distinguishes between spontaneous and scientific concepts and says spontaneous concepts are learned in situated, everyday practice. As a result, they are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context whereas scientific concepts are learnt through formal systemic instruction in the form of apprenticeship relationships, socially organised activities under formal leadership, the workplace, and other surroundings where explicit and systematic instruction in rules, conventions and other governing knowledge is overtly provided for learners, usually by those with greater experience in a discipline, field, activity, or community of practice. Here is an example of a spontaneous concept:

TEACHER: So let's look at the guitar. The guitar is made of different parts. Can you please take out your work books? Turn to page 40 and 41; there is a picture of a man playing a guitar; there that man is playing a guitar. A guitar is a very common instrument amongst black people. They like to play a guitar. Have you got guitars at home?

LEARNERS: Yes

TEACHER: Who plays a guitar at home?

LEARNERS: My grandpa

TEACHER: Oh your grandpa

LEARNERS: Yes

TEACHER: Have you ever watched him playing a guitar?

LEARNERS: Yes

TEACHER: Who else plays at home?

LEARNERS: My uncle and his friends

TEACHER: Do they have a band? He plays the guitar?

In this example the teacher wanted to introduce learners to the concept of sound energy, in particular how the guitar produces the sound. To achieve this goal she relied on learners' everyday language and their common experiences. The teacher says, 'A guitar is a very common instrument amongst black people. They like to play a guitar. Have you got guitars at home?' This is in line with Vygotsky's assertion that spontaneous concepts are learned in situated, everyday practice. As a result, they are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context. At the everyday level, concepts are learned as a result of interacting directly with the world – developing intuitive understandings of how to do things.

E. Vygotsky's scientific concept

Scientific concepts are realised when the textbooks depicts knowledge to which learners are exposed to by a more knowledgeable person, in a formal and systematic, abstract but also general way, the example of which is:

TEACHER: Very good, kusho ukuthi isingisi siyafundwa ngale, he plucks the guitar. That is plucking when the fingers are moving like this. This is a type of movement, is a type of..?

LEARNERS: Movement

TEACHER: A type of movement that is taking place when a guitar is being played, understand that?

LEARNERS: Yes

TEACHER: I want you to look at page 41, and let's just read through the text about how the body movement affects the guitar so that we get the...

LEARNERS: Sound

TEACHER: What we hear is the sound, in your books read that in your body band..

LEARNERS: (learners reading) In your body band, you make lots of different sounds...

TEACHER: You make lots and lots of different..?

LEARNERS: Sound

TEACHER: Every sound that (signalling to learners that they should continue reading.)

The teacher's intention in the above example was to teach the learners the concept of how 'movement causes sound'. She talks about this notion and makes learners read the textbook and the learners seem to understand how the movement of the fingers causes sound. This example is therefore a scientific concept.

F. Conclusion

Although the teacher does not explicitly teach these concepts in the manner that is in line with Vygotsky's conceptualisation, the textbook does seem to provide some guideline and this is why it was possible to identify these concepts in the teacher's pedagogical practice.

5.3.2. Conceptual density gravity of lessons

The second theoretical framework that this study draws on is Karl Maton's LCT and the two concepts that were used as analysing tools were semantic gravity (SG) and semantic density (SD).

A. Semantic Gravity

Again the example analysed is 'Movement and energy in system'. Here is an analysis of the teacher's pedagogical practice using LCT's semantics:

TEACHER: So let's look at the guitar. The guitar is made of different parts. Can you please take out your work books; turn to page 40 and 41; there is a picture of a man playing a guitar; there that man is playing a guitar. A guitar is a very common instrument amongst black people; they like to play a guitar. Have you got guitars at home?

LEARNERS: Yes

TEACHER: Who plays a guitar at home?

LEARNERS: My grandpa

TEACHER: Oh your grandpa

LEARNERS: Yes

TEACHER: Have you ever watched him playing a guitar?

LEARNERS: Yes

TEACHER: Who else plays at home?

LEARNERS: My uncle and his friends

TEACHER: Do they have a band? He plays the guitar?

The example above is SG+ because the teacher's intention is to teach the learners the concept of how movement causes sound and to teach this concept the teacher relies on the learners' everyday context. She is looking for common, concrete examples. However the teacher's explanation starts to complicate a little, especially where she says, 'You see the man what type of the body part he uses to play the guitar?' Here we see a small upward movement, meaning semantic gravity starts to weaken.

Here is an example of SG-:

TEACHER: Very good, kusho ukuthi isingisi siyafundwa ngale, he plucks the guitar that is plucking when the fingers are moving like this. This is a type of movement, is a type of..?

LEARNERS: Movement

TEACHER: A type of movement that is taking place when a guitar is being played, understand that?

LEARNERS: Yes

TEACHER: I want you to look at page 41, and let's just read through the text about how the body movement affects the guitar so that we get the...

LEARNERS: Sound

This example above is coded SG- because the teacher's explanation is less context-dependent. What the teacher says is somewhat abstract. Quite noticeable throughout the teacher's lesson is that what she seems to be doing is trying to simplify and make concrete the content of her lesson so that learners will have a better understanding of what was read from the workbook.

Below is the page from the textbook which was read by the learners with the teacher explaining the difficult words for comprehension purposes. There was an attempt by the teacher to focus on explaining how sound movement and energy transfer work. This can be seen in the vignette inserted below the textbook page. What can be seen in the teacher's pedagogical practice is the presentation of the term 'movement causes sound' and the semantic code of this term is SG- but the explanation by the teacher moves it down to SG+. The reason for saying this is because the teacher's pedagogy is marked by absence of abstraction and has strong semantic gravity.

3.2 Movement causes sound

In your body band, you made lots of different sounds. Every sound that you made involved you moving a part of your body.

Many musical instruments use movement to make sounds. Let us look at a few common musical instruments.



A man plucking the strings on a guitar.

When a guitar string is plucked, the string vibrates and causes a sound wave to occur. The sound is amplified (made louder) by the

TEACHER: A type of movement that is taking place when a guitar is being played, understand that?

LEARNERS: Yes

TEACHER: I want you to look at page 41, and lets just read through the text about how the body movement affects the guitar so that we get the... (This was the concept presented to learners)

LEARNERS: Sound

TEACHER: What we hear is the sound, in your books read that in your body band..

LEARNERS: (learners reading) In your body band, you make lots of different sounds...

TEACHER: You make lots and lots of different..?

LEARNERS: Sound

TEACHER: Every sound that

LEARNERS: (Learners continued to read) Every sound that you made involved you moving a part of your body.

TEACHER: You can move every part of your body, angithi?

LEARNERS: Yes

TEACHER: Some of the people use their bodies, only their bodies to make music, angithi kunjalo?

LEARNERS: Yes

TEACHER: But others prefer using also the instrument, angithi?

LEARNERS: Yes

TEACHER: Kube mmandi (*so it becomes nice*) so as to get a vibe, like when people do traditional dance and use drum as musical instrument. Alright let's continue reading, many...

LEARNERS: (Learners continue to read) **Many musical instrument use movement to make sounds.**

TEACHER: How does that happen? Let us look... (*Here both the teacher and the textbook try to unpack the concept to learners, the code is SG+ made even stronger*)

LEARNERS: (learners read) Let us look at a few common musical instruments.

TEACHER: The first one there is a..?

LEARNERS: A guitar

TEACHER: A guitar, remember all musical instruments are made of different parts, just like your body is made out of different parts, even musical instruments. Let's look at the parts that are very important la (*here*) in the musical instrument of ours which is a guitar. Ya a man...

LEARNERS: (*Learners read a caption of a picture*) A man plucking the strings of a guitar

TEACHER: The string, what's that? There are strings; there are strings in a guitar that are plucked to make the sound, what are the strings?

LEARNERS: izincingo zesiginci (*the guitar string*)

TEACHER: Ya the guitar strings (*she signals to them to continue reading*) when a guitar...

LEARNERS: (*learners read and the teacher reads the difficult words together with them*) When a guitar string is plucked, the string vibrates and causes a sound wave to occur.

TEACHER: Right, let's look at the sequence now the order. We have a finger which does what?

LEARNERS: Plucking

TEACHER: The..?

LEARNERS: String

TEACHER: Strings and the strings make what? These strings when they plucking them. They make what..?

LEARNERS: The sound

TEACHER: The sound! What we hear, in other words, this movement of this string now, cause what?

LEARNERS: Sound

TEACHER: Cause, there is something between the sound and this movement of the fingers, before we play the sound what do the strings do, hands up, they..? (*She points to one learner*)

LEARNERS: They make the sound

TEACHER: What else, uthini omunye, yes

LEARNERS: They vibrate

TEACHER: Very good they do what?

LEARNERS: *(they all say)* They vibrate

TEACHER: There is vibration here and it is now the vibration that causes the?

LEARNERS: Sound

TEACHER: And then we dance like that for the music that you will be getting. Angithi?

LEARNERS: Yes

TEACHER: So you must know the order of how this energy is being trans...

LEARNERS: Transferred

TEACHER: How it is being transferred from the movement, from the movement of the fingers causing the strings to vibrate. What do the fingers do? Yes, ya Sihle

LEARNER: They move

TEACHER: They move! Asimshayeleni izandla bo! *(Let's give him a round of applause)*

LEARNERS: *(applauding)*

TEACHER: Remember we are looking at how energy moves from object to ...

LEARNERS: Another

TEACHER: And this movement now is the one that makes what?

LEARNERS: Sound *(another example of unpacking the concept of movement energy)*

TEACHER: What? Nxele

LEARNERS: It causes to vibration

TEACHER: Very good, it causes what?

LEARNERS: Vibration

TEACHER: There is movement that causes vibration. What is vibration, kwenzakalani? Tell me nge siZulu. *(strengthening SG+)*

LEARNERS: ukundindizela noku ngqangqazela

TEACHER: Very good, that is what

LEARNERS: Vibration

TEACHER: And from the vibration we hear the...

LEARNERS: Sound

TEACHER: So many of the musical instruments work by being plucked, angithi ke

LEARNERS: Yes

B. Semantic Density (SD)

SD refers to the degree of social condensation of meaning. The vignette below illustrates a few examples of semantic density being weakened. The teacher wanted the learners to pay attention to the word 'vibration' and this is how she achieved this goal:

TEACHER: Cause, there is something between the sound and this movement of the fingers, before we play the sound what do the strings do, hands up, they..? *(She points to one learner)*

LEARNERS: They make the sound

TEACHER: What else, uthini omunye, yes

LEARNERS: They vibrate

TEACHER: Very good, they do what?

LEARNERS: *(they all say)* they vibrate

TEACHER: There is vibration here and it is now the vibration that causes the? *(an example of semantic density)*

LEARNERS: Sound

TEACHER: And then we dance like that for the music that you will be getting. Angithi?

LEARNERS: Yes

TEACHER: sS you must know the order of how this energy is being trans...

LEARNERS: Transferred . *(Another example of semantic density)*

TEACHER: How it is being transferred from the movement, form the movement of the fingers causing the strings to vibrate. What do the fingers do? Yes, ya Sihle

LEARNER: They move

TEACHER: They move! Asimshayeleni izandla bo! *(Let's give him a round of applause)*

LEARNERS: *(applauding)*

TEACHER: Remember we are looking at how energy moves from one object to ...

LEARNERS: Another

TEACHER: And this movement now is the one that makes what?

LEARNERS: Sound *(Unpacking SD in the concept of movement energy)*

TEACHER: What? Nxele

LEARNERS: It causes to vibration

TEACHER: Very good, it causes what?

LEARNERS: Vibration

TEACHER: **There is movement that causes vibration. What is vibration, kwenzakalani?** Tell me nge siZulu. *(Here the teacher is unpacking semantic density for the benefit of those who might not have understood what vibration means)*

LEARNERS: ukundindizela noku ngqangqazela *(shake strongly)*

TEACHER: Very good, that is what?

LEARNERS: Vibration

TEACHER: And from the vibration we hear the...

LEARNERS: Sound

TEACHER: So many of the musical instruments work by being plucked, angithi ke

LEARNERS: Yes

The evidence above shows that at Grade 4 level concepts do complicate. That is why there is evidence of the teacher unpacking the SD concepts for the benefit of the learners. These are the few concepts found to be of strong semantic density and the teacher shifted them to weakened SD by either explaining them in simple terms or by making learners explain them using the mother tongue and their previously gained knowledge:

Concept

Coding

Movement energy

SD+

Energy Transfer	SD+
Vibration	SD+

C. Conclusion

The above section, using LCT's semantics, illustrates how the teacher dealt with specialised concepts. A clear trend was that the teacher tended to shift both the SG and SD to levels which would be understood by the learners. This means that the pedagogical practice takes a downward movement from SG- to SG+ and SD+ to SD-, presumably because the learners are at Grade 4 level.

5.3.3. *Technical lexis or field specific terminology of lessons*

Having discussed how Vygotsky's model of conceptual development and Maton's semantics distinguish everyday or common sense knowledge from educational or uncommon sense knowledge, I now would like to analyse the teaching practice using Devika Naidoo's (2013) theory which offers a means of conceptualising knowledge-building through Technical Lexis and what she calls taxonomies that are either specialised or everyday and formal, scientific taxonomies. To try to identify Technical Lexis of field specific concepts, a reflection on Vygotsky's meaning of a concept and scientific concept as well as LCT's weakened SG and strong SD was necessary. This exercise culminated with the conclusion that there were a few elementary examples of Technical Lexis in the teacher's pedagogical practices such as the ones that appear in the table below:

A. Table of Technical Lexis

Concepts	Specific examples	Everyday language (concrete)	Technical Language (dense)
movement energy	sound / music	how music sound is made	movement energy
energy transfer	sound / music	how music sound is made	energy transfer
vibration	sound / music	shaking strongly (ukundindizela noku ngqangqazela).	vibration

B. Conclusion

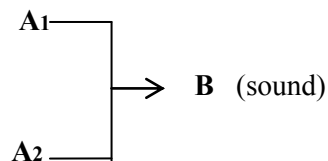
Elementary technical concepts and field specific concepts were found in the pedagogical practice. The teacher did not specifically introduce or use any of these concepts during her lesson except to unpack the ones that appeared in the teaching text and to relate it to everyday and context-dependent explanations.

5.3.4. Conceptual complexity of lessons

The third theoretical frame work that underpins this study is Brown’s Multidimensional Measure of Conceptual Complexity (MMCC). The analysed lessons did not have many examples of very deep (complex) levels of conceptual complexity. This was largely due to fact that the units that the teacher dealt with also did not have many complicated concepts. This is how the concept of ‘movement and energy in a system’ was understood using MMCC:

A. Conceptual depth

Given what the textbooks say and how the teacher presented this concept, learners will understand it as Level 4 Multiple – the sound is seen as an effect produced by multiple causal elements (plucking, vibration of the string). All are necessary; if one is removed the sound is not going to be produced – **A1** and **A2** cause **B** when they both happen at the same time (the qualitative level of the depth construct (Brown, 2005)).



In terms of the qualitative levels of the breadth construct, the interpretation is process consistent, that is phenomena that share a type of change can be caused by the same thing, even if the objects are different.

B. Conclusion

The way the teacher taught and presented the concept to learners made them simpler. This was evidenced by how she unpacked and explained the content to learners.

5.3.5. How Vygotsky, LCT, Technical Lexis and MMCC all impact on the teaching of Natural Science

This section summarises what the four analytical tools show together in the analyses of NS pedagogical practice. There was evidence of Vygotsky's concept formation impacting on the way the teacher introduced and unpacked concept to learners. It can be argued that the teacher was able to model her lesson presentation on how the textbook was presented. The reason for saying this is that the way the concepts trend in her lesson is similar to the manner in which concepts are introduced and presented in the textbook. There was no evidence of the teacher introducing new concepts that relate to the ones which are in the teaching text. The way the teacher used the concepts traversed from some context-independent concepts to everyday, common and concrete examples. This is to say that there were concepts which were identified as Vygotsky's complex, pseudoconcept, concept and spontaneous and scientific concepts. However, it must be emphasised that the teacher was not innovative in extending concepts presented by the textbook and giving examples in order to supplement and expand conceptual development and enhance knowledge building.

With regards to LCT's semantic codes, SG+ and SG- as well as SD- concepts were identified in the teacher's pedagogical practice. The way the teacher used the concepts traversed from some context-independent concepts to everyday, common and concrete examples. The same downward move was also observed for semantic density. This is to say that there were concepts which were identified as weakened semantic density and strong semantic gravity in the way the teacher presented her lesson. However, this is not to suggest that the teacher did not teach effectively, rather it says the teacher was aware that she is dealing with Grade 4 learners.

Having looked at both Vygotsky's conceptualisation and LCT's semantics, one realises that Vygotsky's concept formation relates to LCT's semantic gravity. First the relationship is that weakened semantic gravity (SG-) relates to scientific concepts and both are context independent, both are learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. Likewise, high semantic gravity relates to complex and pseudoconcept. For both these modes of

conceptualising, meaning is more closely related to its context, is concrete and learned in situated, everyday practice. As a result, these concepts are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context of learning.

On the contrary, SD+ (high semantic density) relates to scientific concept, they are both abstract and condense more meaning. Where semantic density is weaker (SD-), symbols condense less meaning. Weak semantic density is when the terms say what they say without much extra depth needed to understand them. Thus low semantic density SD- relates to complex, pseudoconcept and spontaneous concept. As has been argued, the teacher worked in such a way to simplify concepts for her learners and that is why the few concepts found in her lesson were coded as strong semantic gravity and weakened semantic density. This evidence of moving from SG- to very strong SG+ and SD+ to SD- together with code switching, that is the use of isiZulu as seen in the lessons' vignettes by the teacher to explain the content to learners, sums up the approach used by the teacher at Grade 4 level.

5.3.6. Why the Grade 4 NS teacher used isiZulu when teaching

I analysed the NS lessons to find out the reasons why, when and how the NS teacher used isiZulu when teaching. I created four different categories as a framework for determining these reasons. These categories were: explaining an everyday word, giving a concept, repetition of a concept in isiZulu, expatiating on the correct answer and pedagogical cue. There were very few situations when the teacher gave an example of the concept in isiZulu. The main reason for the teacher to use isiZulu was when she employed it as a pedagogical cue to check whether learners understood her and to command their attention and concentration. The table below indicates the above explained categories.

Explaining an everyday word	Giving a concept	Repetition	Expatiating on the correct answer	Pedagogical cue / Commanding Attention
				1. kusho ukuthi isingisi siyafundwa ngale. 2. Angithi? 3. Angithi kunjalo? 4. Angithi 5. kube mnandi

				6. uthini omunye 7. Angithi? 8. kwenzakalani? 9. angithi ke? 10. Ukwenzanjani? 11. angithi? 12. ukwenzanjani lokho?
0	0	0	0	12

The importance of Home Language to learners' conceptual development has been raised consistently in the research literature (Howie et al, 2007, Hoadley, 2010, Fleisch, 2008, Wababa, 2010, Pretorius, 2014 and Taylor and Coetzee, 2013). Language is regarded as one of the key determinants of learners' success in schooling (Hoadley, 2010). The two teachers seem to be trapped in the idea that effective teaching only involves the use of English as a language which is understood by many to be the window to the world.

5.3.7. Vygotsky's conceptual development in Social Science Grade 4 – Food and farming in South Africa

The first tool that this study uses is Vygotsky's conceptual development. An analysis of one of the observed lessons using Vygotsky's complex appears using a vignette which demonstrates the manner in which the teacher introduced and negotiated new concepts to her learners.

Stock farming in South Africa

Case study

TEACHER: Class we are going to read about stock farming in South Africa, what is stock farming?

Yes Thabethe. (*Vygotsky's concept*)

LEARNERS: Stock farming is a work

TEACHER: Another answer, thank you, ya

LEARNERS: Stock farming is farms animals

TEACHER: Ya, animals; different animals which are those animals, on a farm? Yes? (*Vygotsky's pseudoconcept*)

LEARNERS: Cow

TEACHER: Cows, yes

LEARNERS: Goats

TEACHER: Goats, yes

LEARNERS: Sheeps

TEACHER: Sheep not sheeps it has no plural form. Ya, what else?

LEARNERS: Chicken

TEACHER: Right if we don't want to call it stock farm, we call it what?

LEARNERS: Livestock

TEACHER: Very good Grade 4. Now we are going to talk about our case study; we going to learn about somebody here, do you understand? I'm starting now.

A. Vygotsky's complex

Vygotsky defines a complex as a concept that lacks the unity that might be available through either scientific or spontaneous concepts. When people think in terms of complexes, any connection is sufficient to lead to the inclusion of an element in a given complex. The extract above does not have an example of Vygotsky's complex. These were hard to find in this lesson. This was due to the fact that even the textbook did not have it in this section so it did not influence and impact the way the teacher unpacked the concepts in her lesson.

B. Vygotsky's pseudoconcept

A pseudoconcept, in Vygotsky's terms, bridges the complex and concepts developmentally. It is a system that may confound differentiation between complexes and concepts as the system appears phenotypically similar to that of a concept. In simple terms this would be what is between a complex and the real concept. It is a term that appears to be very close to a concept. Here is an example that was found from the teacher's pedagogy:

LEARNERS: Stock farming is farms animals

TEACHER: Ya, animals; different animals which are those animals, on a farm? Yes? (*Vygotsky's pseudoconcept*)

LEARNERS: Cow

TEACHER: Cows, yes, what else?

LEARNERS: Goats

The reason for arguing that this above is pseudoconcept is that both the teacher and the learners do not seem to have enough information about stock farming. They do not have complete conceptual ideas. As for the teacher, in particular, she only relies on the textbook content; she does not focus on conceptual development and use her creativity to expand learners' knowledge by adding her own concepts to what the teaching text says.

C. Spontaneous and scientific concepts

Vygotsky distinguishes between spontaneous and scientific concepts. Here are examples of spontaneous and scientific concepts found in the teacher's pedagogical practice; the scientific concept appears first and then the spontaneous concepts a little later on in the teacher's lesson:

Processed and unprocessed foods

TEACHER: Yes, today we are going to learn about unprocessed and processed foods. About what?

LEARNER: Unprocessed and processed foods (*Scientific concepts*)

TEACHER: Unprocessed foods are... (*Signalling to learners that they should all read*)

LEARNER: Unprocessed foods are foods that come directly from the farmer to the supermarket and shops.

TEACHER: Yes go on

LEARNER: Sometimes we call these foods 'fresh foods' or produce. These foods are still in their natural form such as raw vegetables like carrots, lettuce and spinach.

TEACHER: We get that?

LEARNER: Yes

TEACHER: Processed foods are foods that are? What are processed foods? (*Calling on the learners to read on their textbooks*).

LEARNERS: Processed foods are foods that are no longer in their natural state because they have been changed in some way.

TEACHER: Yes we said that there are ingredients that are added and use... (*repeating the word ingredients*), for example?

LEARNERS: (*they read in a manner that she doesn't like and she scolds them*) For example peanuts in their natural state are unprocessed food.

TEACHER: Yes, you know peanuts?

LEARNERS: Yes

TEACHER: Yes, what are peanuts? Not peanut butter. Peanuts, yes? (*pointing to a learner*)

LEARNER: (*the learner speaks softly and she tells her to speak aloud*) amakinati

TEACHER: Yes amakinati lawa owadla zonke izinku (*peanuts that you eat everyday*) you don't know that those are peanuts? You eat peanuts? (*Spontaneous concept*)

LEARNERS: (*in choral form*) Yes

TEACHER: The product that comes from peanut is called peanut butter, not kinut butter its peanut butter, ngiyaye ngizwe abantu bethi kinut, its peanut not kinut, siyezwana? But peanut butter is?

LEARNERS: (*reading*) But peanut but is made by processing the peanuts

TEACHER: Yes it is made from peanuts, siyezwana it is made from processing peanuts, right, fresh tomatoes are?

The utterance that has been coded as a spontaneous concept is when the teacher tries to explain the difference between processed and unprocessed foods by drawing on learners' everyday experience and say, 'it's peanuts that you eat every day'. However, it should be emphasised that the teacher used mother tongue in order to explain the concept and maintained the concept of processed food as a scientific concept.

The other example is coded as a scientific concept because the concepts 'processed' and 'unprocessed', in Vygotsky terms, are learnt through formal systemic instruction such as the classroom here.

5.3.8. Karl Maton's LCT – Semantic Gravity (SG) and Semantic Density (SD)

The second theoretical framework that this study draws on is Karl Maton's LCT and the two concepts that were used as analysing tools are semantic gravity (SG) and semantic density (SD).

A. Semantic Gravity

Below is an analysis of the teacher's pedagogical practice using LCT's semantics theory:

Stock farming in South Africa

Case study

TEACHER: Class we are going to read about stock farming in South Africa, what is stock farming? Yes Thabethe. (*Semantic gravity*)

LEARNERS: Stock farming is a work

TEACHER: Another answer, thank you, ya?

LEARNERS: Stock farming is farms animals

TEACHER: Ya, animals; different animals which are those animals, on a farm? Yes? (*weakened semantic gravity*)

LEARNERS: Cow

TEACHER: Cows, yes

LEARNERS: Goats

TEACHER: Goats, yes

LEARNERS: Sheeps

TEACHER: Sheep not sheeps it has no plural form. Ya, what else?

LEARNERS: Chicken

TEACHER: Right if we don't want to call it stock farm, we call it what? (*Another example of semantic gravity*)

LEARNERS: Livestock

Concept

- Stock farming

Coding

SG+

Another example of strong semantic gravity in the above vignette was when the teacher wanted the learners to name the different types of animals on a stock farm. This further strengthened an already strong semantic gravity; the examples given by the learners concretised semantics. The teacher also asked the learners to give another example of stock farming and the learners said 'livestock'. This too further concretised semantic gravity. What is observed from the teacher's pedagogical practice is that semantic profiles traverse from strong semantic gravity to even stronger semantic gravity. The vignette below illustrates examples of weakened semantic gravity (SG-):

The highlighted concepts 'processed' and 'unprocessed' foods can be coded SG- because they are not everyday concepts, especially for the Grade 4 learners. These concepts would be learnt at school with the assistance of the teacher. However both the textbook and the teacher weaken these concepts by giving explanations and examples of these to the learners.

Processed and unprocessed foods

TEACHER: Yes, today we are going to learn about unprocessed and processed foods. About what?

LEARNER: Unprocessed and processed foods (SG-)

TEACHER: Unprocessed foods are... (Signalling to learners that they should all read)

LEARNER: Unprocessed foods are foods that come directly from the farmer to the supermarket and shops.

TEACHER: Yes go on

LEARNER: Sometimes we call these foods 'fresh foods' or produce. These foods are still in their natural form such as raw vegetables like carrots, lettuce and spinach.

TEACHER: We get that?

LEARNER: Yes

TEACHER: Processed foods are foods that are? What are processed foods? (Calling on the learners to read on their textbooks)

LEARNERS: Processed foods are foods that are no longer in their natural state because they have been changed in some way.

TEACHER: Yes we said that there are ingredients that are added and use... (repeating the word ingredients) for example?

LEARNERS (they read in a manner that she doesn't like and she scolds them) For example peanuts in their natural state are unprocessed food.

TEACHER: Yes you know peanuts?

B. Semantic density

The case study on 'Stock farming in South Africa' was again analysed using the LCT's SD lenses and this is how it appeared:

TEACHER: Class we are going to read about **stock farming** in South Africa, what is stock farming? Yes Thabethe. (*Semantic density*)

LEARNERS: Stock farming is a work

TEACHER: Another answer, thank you, ya?

LEARNERS: Stock farming is farms animals

TEACHER: Ya, animals; different animals which are those animals, on a farm? Yes? (*Weakened semantic density*)

LEARNERS: Cow

TEACHER: Cows, yes

LEARNERS: Goats

TEACHER: Goats, yes

LEARNERS: Sheeps

TEACHER: Sheep not sheeps it has no plural form. Ya, what else?

LEARNERS: Chicken

TEACHER: Right if we don't want to call it stock farm, we call it what? (*another example of semantic density*)

LEARNERS: Livestock

Concept

Coding

Stock farming

SD+

The reason for arguing that the above mentioned examples are semantic density is because the teacher is seen trying to unpack the term 'stock farming' by making learners say what it means and also give another concept that relates to it which they say is livestock.

C. Conclusion

The analysis of this section reveals that the teacher's lesson was not rich in semantic profiles; the lesson mostly traversed from strong semantic gravity to even stronger semantic gravity. The same applied to semantic density. There were very few examples and the teacher tended to weaken those as well.

5.3.9. Devika Naidoo Technical Lexis

Having discussed how Vygotsky's model of conceptual development and Maton's semantics distinguish everyday or common sense knowledge from educational or uncommon sense knowledge, I will now analyse the teaching practice using Devika Naidoo's (2013) theory which offers a means of conceptualising knowledge-building through Technical Lexis and what she calls taxonomies that are either specialised or everyday and formal, scientific taxonomies.

The analysis of the observed lessons revealed that the use of technical or field specific language by the teacher was not on a very large scale. In other words, the lesson was not rich in Technical Lexis. This is evidenced by the very few examples that were found in the lesson.

A. Table illustrating technical concepts

Specific concepts	Specific examples	Everyday language (concrete)	Technical Language (dense)
processed food	sauce	prepared by a special method (cooking, drying, squeezing, cutting, cutting & mixing)	tomato sauce
unprocessed food	fruit	raw	fresh foods
stock farming	cattle, goats & sheep	animals we keep	stock farming

B. Conclusion

There were not very many examples of Technical Lexis because the lesson had specific concepts – processed or unprocessed food and stock farming or livestock farming. These concepts were then shifted to everyday language and context dependent examples.

5.3.10. *N. J. S. Brown's Conceptual Complexity tool (MMCC)*

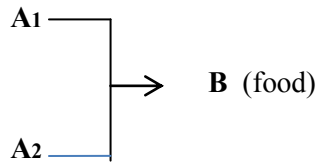
The third theoretical frame work that underpins this study is Brown's Multidimensional Measure of Conceptual Complexity (MMCC).

The analysis of the lesson on processed and unprocessed food looks like using Browns MMCC showed that this concept is on level 2 Elemental:

A → B

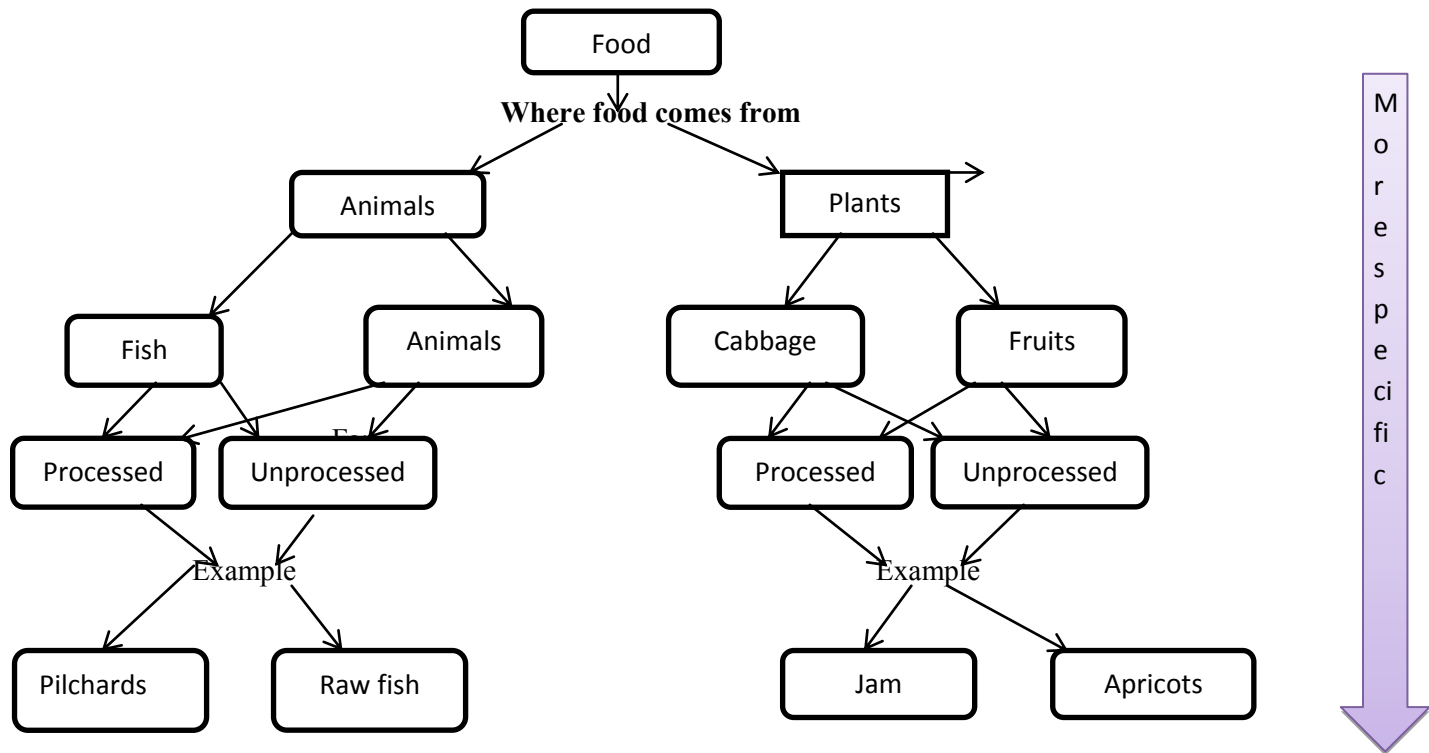
Food is seen as an effect produced by a singly causal element. Justification or mechanism is not necessary. For example Cow = Meat.

Whereas with processed food, considering how the textbook presents this concept, learners will understand it as Level 4 Multiple – food is seen as an effect produced by multiple causal elements (ingredients, cooking and processing). All are necessary; if one is removed food is not going to be produced – A₁ and A₂ cause B when they both happen at the same time (the qualitative level of the depth construct (Brown, 2005).



In terms of the qualitative levels of the breadth construct, the interpretation is that it is process consistent, that is phenomena that share a type of change can be caused by the same thing, even if the objects are different. Significant to note is that whilst these two concepts are certainly not everyday terms, they cannot be said to be highly dense concepts for they can be coded as **SG - / SD -**. They are somewhere in the middle as they still need unpacking as can be seen during the observed lessons.

A. Concept map of food



B. Conclusion

The illustrations above provide some evidence about concept complexities in Social Science at Grade 4 level. It gives insight on the nature of concepts and how these manifest themselves at Grade 4 level. Again the teacher's lessons did not reflect a lot of conceptual complexity.

However, the teacher's awareness of the MMCC will still lead to deeper insight on concepts and content knowledge.

5.3.11. How Vygotsky, LCT, Technical Lexis and MMCC all impact on the teaching of Social Science

This section summarises what the four analytical tools show together in the analyses of SS pedagogical practice. There was evidence of Vygotsky's concept formation impacting on the way the teacher introduced and unpacked the few concepts that were in the textbook, for learners. It can be argued that the teacher was able to model her lesson presentation on how the textbook was presented. The reason for saying this is because the frequency of the concepts in her lesson is equal to that in the textbook. There was no evidence of the teacher introducing new concepts that relate to the ones which are in the teaching text. The way the teacher used the concepts traversed from some context-independent concepts to everyday, common and concrete concepts. This is to say that there were concepts which were identified as Vygotsky's complex, pseudoconcept, concept and spontaneous and scientific concepts. However it must be emphasised that the teacher was not innovative in extending the concepts presented by the textbook and giving examples in order to expand conceptual development and enhance knowledge building.

With regards to LCT's semantic codes, these SG+ and SG- concepts were identified in the teacher's pedagogical practice. Again the way the teacher used the concepts traversed mostly from some context-independent concepts to everyday, common and concrete examples. This is to say that there were a few concepts which were identified as weakened semantic gravity and strong semantic gravity. This was the same with regard to concepts that were coded as semantic density.

Having looked at both Vygotsky's conceptualisation and LCT's semantics, one realises that Vygotsky's concept formation relates to LCT's semantic gravity. First the relationship is that weakened semantic gravity (SG-) relates to scientific concepts and both are context independent, both are learned under the supervision of a teacher and they tend to be associated with the appropriation of increasingly advanced literacy skills. Likewise, high semantic gravity relates to complex and pseudoconcept. For both these modes of conceptualising, meaning is more closely related to its context, concrete and learned in

situated, everyday practice. As a result, these concepts are applicable primarily in contexts where the everyday circumstances and practices resemble those of the original context of learning.

On the contrary, SD+ (high semantic density) relates to scientific concept, they are both abstract and condense more meaning. Where semantic density is weaker (SD-), symbols condense less meaning. Weak semantic density is when the terms say what they say without much extra depth needed to understand them. Thus low semantic density SD- relates to complex, pseudoconcept and spontaneous concept. The observed trend was to shift concepts from SG- to very strong SG+ and the same occurred with SD. Also observed was code switching, that is the use of isiZulu by the teacher to explain the content to learners.

5.3.12. Why the Grade 4 SS teacher used isiZulu when teaching

As previously mentioned, the main focus of this research project is on conceptual development that is how teachers at Grade 4 level negotiate the introduction of new concepts, the second and the subsidiary aim is to examine the language issue that how the teachers deal with the shift from IsiZulu (in the FP) to English First Additional Language in the (IP). For this purpose I analysed the Social Science lesson on Processed and Unprocessed foods, and created six (6) different categories as framework for determining the reasons when, why and how does a teacher in this lesson use isiZulu when teaching. These categories were: Giving a concept, Unpacking a concept, Explaining an everyday word, Repetition of a concept in isiZulu, Expatiating on the correct answer and Pedagogical cue or Commanding attention. Below is the table illustrating the results of the analysis of this pedagogical practice.

Giving a concept	Unpacking a concept	Explaining an everyday word	Repetition	Expatiating on the correct answer	Pedagogical cue / commanding attention
1. We going to read about processed and unprocessed food	2. What is processed food?	1. Its peanut not Kinut . 2. Ngiyaye ngibezwe abantu bethi kinut its peanut not kinut. 3. sinamathumbu langaphakathi, a digesta ini? Ukudla.	1. Angithi ibhotela esiyenzayo nje 2. Amagciwane 3. Kuthambe 4. Siyavuna	1. Amakinati lawa owadla zonke izinsuku. 2. Ayakugaya, angithi? 3. So ukudla ke makuphekwa kuba easy uma kudigestwa in the intestines. 4. Yes okusika	1. Siyezwana? 2. Siyezwane? 3. Angithi? 4. Siyezwana? 5. Awukho omunye ujamu eniwaziyo? 6. Nginike phela oseku processsiwe kusuka ku unprocessed 7. Hawe bantu 8. angithi siyakhumbula? 9. Angithi? 10. angithi? 11. Ama saws... ama..?

					12.angithi? 13.siyezwana? 14.Nikhathele? 16.Kuthiwa kwenziwani laphaya? 17.angithi?
1		3	5	3	16

As can be seen in the above illustration, at no stage the teacher focused on concept development and gave examples of concepts in isiZulu. The new concept to be learnt was that of ‘processed and unprocessed food’. In the main, the teacher used isiZulu as a pedagogical cue to check whether learners understood her or not and to command their attention and concentration. The second situation that appears five times in one lesson was when she repeated in isiZulu what she or learners have already said. The situations of explaining a concept and expatiating on the correct answer given by learners appear three times respectively throughout the lesson.

Again I used the same categories as framework for determining the reasons when, why and how does the NS teacher used isiZulu when teaching. At no stage the teacher gave an example of the concept in isiZulu. The main and the only reason for the teacher to use isiZulu was when she employed it as a pedagogical cue to check whether learners understood her or not and to command their attention and concentration. The table below indicates the above explained categories.

Explaining an everyday word	Giving a concept	Repetition	Expatiating on the correct answer	Pedagogical cue / Commanding Attention
				13. kusho ukuthi isingisi siyafundwa ngale. 14. Angithi? 15. Angithi kunjalo? 16. Angith 17. kube mnandi 18. uthini omunye 19. Angithi? 20. kwenzakalani? 21. angithi ke? 22. Ukwenzenjani? 23. angithi? 24. ukwenzanjani lokho?
0	0	0	0	12

The importance of Home Language to learners’ conceptual development has been raised consistently in the research literature (Howie et al, 2007, Hoadley, 2010, Fleisch, 2008, Wababa, 2010, Pretorius, 2014 and Taylor and Coetzee, 2013). Language is regarded as one of the key determinants of learners’ success in schooling (Hoadley, 2010). The NS teachers seems to be trapped in the idea that effective

teaching only involves the use of English as a language which is understood by many to be the window to the world, this can be seen in the evidence provided by the above table.

5.3.13. Comparison of Social Science and Natural Science

This study focuses, inter alia, on how language concepts in Grade 4 are structured in Natural and Social Science. This section, therefore, compares how the NS and SS teachers taught new concepts and the analysed lessons, using the four theoretical frameworks as analysis tools.

Firstly, both teachers were similar in that they both reflected the use of Vygotsky's concept formation theory and LCT semantics. They were also similar in the sense that it was mostly spontaneous concepts and semantic gravity strengthened. They were also trending towards the everyday, concrete and context independent concepts.

Neither teachers had a lot of technical concepts in their lessons, and conceptual complexity was also not convincingly rich in their pedagogical practices. This was presumed to be largely due to the fact that the textbook units that were taught by the teachers were also not very rich in this direction.

The other striking similarity was that both teachers used isiZulu during their lessons; however, both use it mostly to command attention and to ensure that learners understood what was said in the textbook content. There was no focus on concepts or giving of examples to enhance learners' conceptual development.

5.4. Interview analysis

5.4.1. Brief background about the focus of the study

This study focuses, in the main, on the introduction of specialised concepts and new academic words used by the teachers and learners in the process of knowledge building at Grade 4 level, in particular, how the language issues are negotiated at Grade 4 level. The focus is on how the transition from FP to IP occurs, the language shift from isiZulu to English LoLT as well as the introduction of subjects at Grade 4 level. The second technique used to collect data was the interviews with the teachers. The interview questions were set in relation to the following key research questions that this study attempts to answer:

- How text-books introduce and negotiate new and specialised concepts as well as shifting the language of instruction when introducing new subjects and explaining new and specialised concepts at Grade 4 level in the Natural and Social Science subjects.
- How language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social Science subjects

5.4.2 Interviews with the teachers

There were two semi-structured interviews conducted as part of the data collection process. I interviewed two Intermediate Phase educators both of whom taught Grade 4; one is a Natural Science teacher and the other a Social Science teacher. The interview focus was on the teachers' experience with teaching Grade 4, how they manage the shift from isiZulu into English as well as the shift into subjects. The interviews also aimed at exploring how the teachers deal with the introduction of specialised concepts in these subjects, that is how these new concepts are presented, taught and learnt, in particular, how teachers and learners negotiate the language issues at Grade 4 level in Natural and Social Sciences.

There were four common emergent themes, namely: teachers' experience with Grade 4, approaches teachers felt were useful, learners' experience with the subject and approaches teachers felt specifically helped the learners. I have changed the participants' names to Mrs Magwaza and Mrs Vilakazi to protect their identities.

5.4.3 The Natural Science teacher

The Natural Science teacher said she has more than thirty years' experience teaching Grade 4. She started teaching in 1983 at a primary school in Impendle; at that time NS was called General Science. She also revealed that she got formal training to teach General Science. The school principal asked her to take a load since there was no one to teach it hence she became an expert. Despite being an experienced Grade 4 teacher, Mrs Magwaza pointed out that teaching Grade 4 is a challenge because in Grade 3 learners are taught in isiZulu and when they come to Grade 4, at first teachers have to translate from isiZulu to English and it takes a long time. She stressed the language issue as the major cause for learning barriers in Grade 4. However, she said that despite this barrier learners do get used to it as the year progresses.

Regarding the approaches that she feels help her overcome the learners' problems, she indicated that at times at the beginning of the year she uses isiZulu when teaching and translates into English. She also works with the Grade 3 teachers so as to help learners overcome problems. The reason for working with the Foundation Phase teachers is that in Grade 4, learners will be struggling with concepts such as vertebrates, living things, life processes like breathing and so on, therefore by consulting their former teachers she can find out how they taught these concepts in isiZulu so as to assist her learners. She said the main problem is that the learners lack the correct English vocabulary to explain how the person breathes, for example, but when asked to demonstrate the process of breathing and explain it in isiZulu, the learners would be able to do so. The other strategy that she said is helpful is to ask learners to bring pictures of the animals to be learnt and discuss in class and also to consult their parents about the topic to be learnt the next day as this is really helpful against the backdrop of Learning and Teaching Resource Management (LTSM) shortages. As a teacher, she said, one must be friendly to ones learners so as to create a positive learning environment.

The third emergent theme was learners' experiences of Natural Science. She said at the beginning of the year most learners find it difficult but groups differ. Sometimes she works with the most difficult group and the following year she may have a very good group which is very easy to teach. She said learners fear the English language so much that they do not want to talk but when you first allow them to speak in their mother tongue, especially at the beginning of the year, they do open up and talk and she says you have to build on that going forward. When learners give answers in their mother tongue, she said she uses the other learners in class to then translate what the learner has just said. They translate it into English but she encourages them that they must not rely on presenting in isiZulu because all the questions will be asked in English and must be answered in English.

The fourth theme that emerged as I analysed her responses to the interview questions was what approaches she felt specifically helped her learners. She spoke of motivation and encouragement: motivating learners to be active in class and not to fear speaking English. She said the class discussions held after the learners have brought the pictures and the information from parents and elders at homes also help a lot to enable learners not only to take part in the lesson, but also to be actively engaged with the process of teaching and learning. She also mentioned code-switching as an aid when introducing new English words to learners. First she will give the English concept and then give the isiZulu equivalent. It is

helpful, she says, but learners are told that as time goes on it will be English only and there will be no code-switching. This explains the reason why the NS teacher hardly used isiZulu during her lesson. During the interviews the teacher said that she does not like to use isiZulu when explaining new concepts for these reasons “ I don’t like to use IsiZulu because using too much of IsiZulu will make them not to know English words I have to use more English as it is the medium of teaching and learning.” She said that this would make her learners not to get used to English language where as during assessments learners will be required to give answers in English.

The other important claim that was made by the NS teacher, when asked if there were any concepts that her learners found difficult, was that “Like ‘living things’, when we talk about ‘living things’, what living things can do? They cannot present themselves in English so we have to start first going... like for instance talking about ‘breathing’ some of them will show by inhaling in and out.” This indicates that the teacher relies more on everyday examples to explain abstract of field specific terms. She does not use the advantage of the learners’ Mother Tongue to try and find them an equivalent isiZulu word. Other examples of using learners’ everyday experiences and concrete examples that were confirmed by the teacher during the interview session were: cutting out pictures from newspapers and magazines so as to explain new and difficult concepts. She also said that she relies on information from parents at home with regard to some of the things that her learners might not know.

5.4.4. Conclusion

In the main, the teacher revealed that learners have problems with the English language as they come to the Intermediate Phase. However, as learners steadily progress they improve and get used to the fact that, unlike in the Foundation Phase, teaching and learning in the Intermediate Phase happens in English. As the year steadily progresses they become better in their English proficiency.

5.4.5. Social Science teacher

This section discusses the Social Science teachers’ responses to the interview questions which were thematically clustered in the same way as the NS discussed above. Mrs Vilakazi, the Social Science teacher, said she only has five years’ teaching experience in Grade 4 and she says it is very difficult because it is not easy for the learners to shift from isiZulu to English. They do not pronounce English words correctly and they do not like to read in English as even one word at a time is difficult for them to read. The language shift is always a

challenge; the English language remains foreign to Grade 4 learners. However, she has been a teacher for 23 years and for most of those years she had been teaching Grade 6. She found them to be better than Grade 4 because they have some exposure to the English language. Despite these difficulties, Mrs Vilakazi continues, learners never despair because they are excited by learning the new language and subjects in English.

Concerning the approaches that she feels help her overcome the learners' problems, she mentioned that giving small chunks of work in English, for example short phrases, short sentences and paragraphs, helps a lot. She spoke of shifting the learners slowly from their mother tongue by introducing these phrases and short paragraphs because they do not know English. She says she is never harsh with them; they need to trust you as a teacher. She keeps the pace of teaching and learning slow when necessary. Mrs Vilakazi also spoke of collaborating with the other teachers in the Intermediate Phase in order to find out what works for them. She also uses teaching resources, for example pictures and charts, to assist the learners come to terms with what is being taught and learnt.

The other ideas that she says work is that she sends learners home to enquire more about the topic to be taught the next day and use the information that they come back to class with as the vocabulary building block. She also uses newspapers and magazines to enhance their vocabulary and she groups learners according to their abilities. All these, she says, help her overcome her problems in Grade 4. Again all these methods that she uses illustrate that she also moves learners from the known / everyday experience to their known experiences yet again. They do not progress to the abstract/ dense and the technical terms.

The third emergent theme was learners' experience of Social Science as a subject. She said at the beginning of the year learners find it difficult, especially at the start of the first term, because in the Foundation Phase they were taught in their mother tongue. Most of them have difficulties understanding concepts such as 'landscape'. She said learners do not know what a 'map' is let alone the whole concept of 'geography' but when you talk to them in their mother tongue about what it is, they understand.

The fourth theme that emerged as I analysed her response to the interview questions was what approaches she felt specifically helped her learners to deal with all the problems she mentioned in the preceding paragraph. First she said she relied on her colleagues and some of them have helped her by telling her how to give learners homework help, short homework, class work and by letting them talk in the classroom and give them time to write because it is

difficult for them to write long notes. So she does rely on her colleagues and said some of them help her with assessment as well and they told her to work with the learners individually in order to see if they understand, to see if they are able to read and write because some of them are just ‘lazy’ but if encouraged they are able to produce adequate work. It could also be confidence they are lacking, she continued.

The other reason for consulting her colleagues is to get information about increasing the learners’ pace when taking notes or writing anything. She says she would consult the Foundation Phase teachers in order to help learners about managing time in the classroom.. She also sends the learners to do research about the information that she has to teach and to let them use resources such as charts and case studies provided in the learners’ textbooks. She gives them questions the day before and explains the questions before they answer them at home as homework. She also makes them write the new words that are needed for each section in their diaries to develop their vocabulary.

She said teaching resources such as pictures and maps are also useful. She groups learners according to their abilities and whilst the learners work in groups, she moves around checking on the m and also tapping into their previously learnt knowledge to see if they are able to combine it with the new information presented by the picture in front of them. She also made mention of diagrams and said they are a very useful resource to stimulate class discussion. As learners continue discussing she allows them to use their mother tongue sparingly so as to enhance the learners’ content understanding.

As they shift between English and isiZulu so that they understand, she tries to see that each learner focuses on what is being done by using leading questions so that they concentrate on the task they are doing and try to use English as much as possible with minimal teacher correction. The other thing she mentioned as being helpful is making use of local examples, for example writing about local leaders and local landmarks.

5.4.6. Teachers’ common responses (summary phrases)

The tables below contain the teachers’ common answers to the interview questions herein presented as summary phrases:

❖ Teachers’ experience with Grade 4

Social Science teacher	Natural science teacher
<ul style="list-style-type: none"> • 5 years’ experience with Grade 4 • It’s not easy to teach this class 	<ul style="list-style-type: none"> • Over 30 years with Grade • It’s a challenge to teach Grade 4

<ul style="list-style-type: none"> • The problem is the switch from isiZulu to English • Language shift is a challenge • The English language remains foreign to Grade 4. • Despite the difficulties, learners never despair because they are excited about learning the new language and subjects in English. 	<ul style="list-style-type: none"> • The problem is the switch from isiZulu to English • Although language is a problem learners do get used to it.
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❖ Teachers' helpful approaches

Social Science teacher	Natural science teacher
<ul style="list-style-type: none"> • Giving small chunks of work in English for example short phrases, short sentences and paragraphs. • Shift them slowly because they don't know English. • You should not be harsh with them; they need to trust you as a teacher. • Collaborating with other teachers in order find out what works for them. • The use of teaching resources • Send learners home to enquire more about the topic to be studied • Vocabulary building exercises, the use of newspapers and magazines • Group learners according to their abilities 	<ul style="list-style-type: none"> • At the beginning of the year the teacher uses isiZulu at times when teaching and translates into English. • At the beginning of the year she works with the Grade 3 teachers so as to help learners overcome problems • New concepts a problem such as 'vertebrates' • There is always a problem of LTSM shortages • Ask learners to come to school with the pictures of animals to be discussed in lesson or ask their parents at home about the topic to be learnt in the next lesson • As a teacher you must be friendly to your learners

❖ Learners' experience with the subject

Social Science teacher	Natural science teacher
<ul style="list-style-type: none"> • At first (during the start of the first term) they find it very difficult • Most of them would have difficulty understand concepts such as 'geography' 	<ul style="list-style-type: none"> • Its only at the beginning of the year that they find it difficult but groups differ • Learners fear the English language so much that they do not want to talk • Concepts such as 'vertebrates' are a problem for Grade 4 especially because they do not know English • The don't have the correct vocabulary to explain how the person breathes, for example, in English

❖ What helps the learners

Social Science teacher	Natural science teacher
<ul style="list-style-type: none"> • Teaching resources such as pictures and maps • Grouping them according to their ability groups • Tapping into previously learnt knowledge • Picture and diagrams are very useful resources • Using the mother tongue sporadically to enhance the learners' content understanding • Making the use of local examples, for example writing about local leaders and local landmarks in Geography 	<ul style="list-style-type: none"> • Pictures and information from their parents at home. • Motivation and encouragement • Class discussions after they have brought in their pictures • Code switching but learners are told that as time goes on it will be English only

5.4.7. Conclusion

Mrs Vilakazi mentioned the English language as one of the major problems in Grade 4 especially because in the previous phase learners were taught and learnt in their mother tongue. However, she also indicated that as they progress in the academic year the learners' situation improves. For her, academic success is dependent on the learners' English proficiency. She did not clarify how she deals with conceptual development. She only focused on the English language in the interview and her main concern was that in the previous classes learners were instructed in their mother tongue, a practice that she says made the teaching of Grade 4 very difficult.

5 Discussion

6.1. Introduction

This section discusses what was found in the study during the process of data analysis. The techniques used to collect data were the observation of classroom practices, teacher interviews and textbook analysis. This research aims at analysing the situation when new concepts are presented, taught and learnt, in particular, how language issues are negotiated at Grade 4. The focus was also on how concepts in Grade 4 are structured and how teachers work with concepts known in isiZulu into English and in English into isiZulu when presenting new content knowledge in Natural and Social Sciences.

The key theories that support this study are Vygotsky's concept of development, Karl Maton's LCT, Long's Interaction Hypothesis, and Brown's Conceptual Complexity Tool (MMCC). The study used these theories to analyse data gathered and to try to make sense of the analysis in relation to the key research questions that this study attempts to answer.

6.2. Vygotsky's conceptual development

This section relates to the first research question that aims to find out how text books introduce and negotiate new and specialised concepts as well as shifting the language of instruction. In terms of Vygotsky's conceptual development, there were four concepts that were used as codes or tools for analysing data collected: complex, pseudoconcept, spontaneous and scientific concepts. What emerged was that, as the analysis of the text books shows, in both the subjects (NS and SS) textbooks are very clear with the way in which they use concepts. Textbooks follow a clear trend when presenting new concepts; it becomes easy for the reader to see the distinction between spontaneous and scientific concepts. The most common examples of spontaneous concepts in NS were, 'In order to do any – breathe, get out of bed, do your homework or play soccer – you need energy.' and in SS we find, 'Food is an important part of our everyday life.' Another one is, 'All the food you eat comes from plants and animals'.

Textbooks did try to strike a balance between spontaneous and scientific concepts. The examples in NS that were found for scientific concepts were, 'In science we use the word

energy in a different way. Energy is all around us. All living things use energy for everything that they do.’ And in SS, ‘Food gives us energy, help us to grow and be able to play’. Trends like this were recognised throughout the chapters that were analysed.

However, there emerged a discrepancy between the way in the concepts are presented in textbooks and the way in which the teachers present these to learners during the lessons, which relates to the second aspect of the first research question – how teachers introduce new subjects and explain new and specialised concepts at Grade 4 level. In one of the observed NS lessons, the teacher could not explicitly say to learners that sound energy (music) comes from the string vibrating. In this regard learners cannot scientifically identify where exactly music comes from. This teacher’s inconsistency as opposed to the textbook’s explicit explanation that ‘sound is amplified (made louder) by the air vibrating in the hollow inside of the guitar as well we can then easily hear the sounds produced by the guitar’ makes me argue that the teacher is, in Vygotsky’s terms, performing on a ‘shadow of the concept – pseudoconcept’.

To a certain extent, the same will apply to the Social Science teacher. She also did not give learners an isiZulu equivalent term to ‘processed food’. She merely gave examples of processed foods. The Zulu dictionary for scholars defines processed food as ‘ukudla okulondolozliwe’. This dictionary definition connects to what the SS textbook says ‘processed foods are foods that are no longer in their natural state because they have been changed in some way. They may have been cooked or combined with other ingredients. For example, peanuts in their natural state are unprocessed food. But peanut butter is made by processing the peanuts’. Ultimately, the learner when asked to define processed food in her own words will only give examples because she would have not got the proper definition of the term. That is what emerged in terms of Vygotsky’s theoretical concepts.

6.3. Karl Maton’s LCT

With regards to the second research question that says how language practices and the teaching of specialised concepts interact at Grade 4 level in the Natural and Social science subjects, it was found that the two concepts that were used as analysing tools were semantic gravity (SG) and semantic density (SD). The teaching texts displayed good examples of SG and SD although mostly it was semantic gravity that was found. This was perhaps due to the

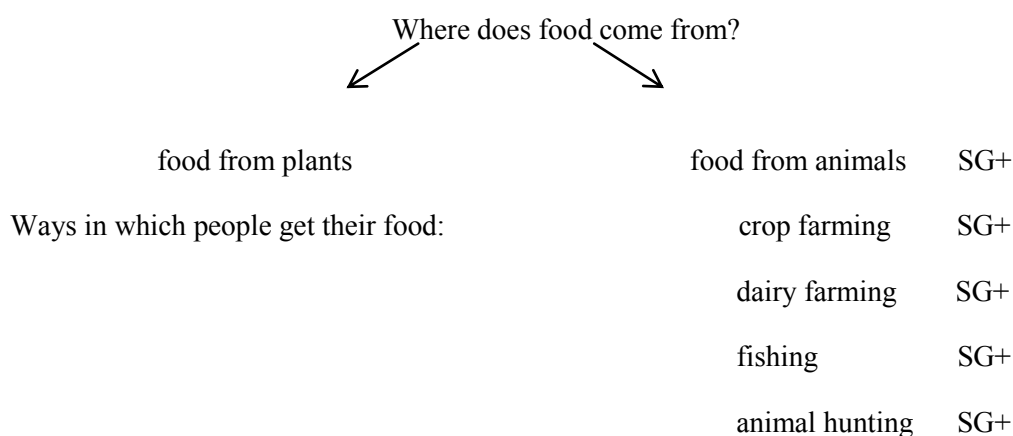
fact that it is at Grade 4 level where English is taught and learnt as a second language. Graphs such as the one below were used to depict the semantic profiles found in the SS teaching text:

++ **Context independence** --

Local, concrete, everyday knowledge	Some context dependent	Some context independent	Universal, abstract, specialised knowledge
Food Farming Wheat Pictures	Crops	Food gives us energy	-Commercial farming -Subsistence farming -Processed and -Processed food

The trend was the same in all the units that were analysed: the teaching texts try to focus on concept development. Here are a few examples showing the semantic profiles in Social Science:

6.3.1. Semantic Gravity



6.3.2. Semantic Density

SD++ Subsistence farming (a specialisation and abstract concept)

SD++ Self-sufficient (abstract)

SD++ Productivity

SD++ Fertilisers

SD++ Pesticides

SD+ Eco-Friendly

SD++ **Commercial farming**

SD++ Large scale farming

- SD+ Markets
- SD++ Processed
- SD+ Irrigate
- SD+ Labour
- SD+ Environmental pollution

The teaching texts, as they deal with conceptual development, depict very interesting semantic profiles. As a researcher, I was able to trace the semantic ranges between their highest and lowest strengths. This then leads to the conclusion that the semantic waves of the textbooks, when depicted graphically, take the form of downward escalators that indicate a shift from either weakened SG and strengthened SD as the result of the textbooks trying to unpack the new concepts to learners. This highlights possibilities for sound and meaningful knowledge and conceptual building at Grade 4 level, unlike what was discovered in the analysis of pedagogical practices. The SS teacher as well as the NS teacher did not focus on conceptual development. This is so even when the teachers were code switching from isiZulu to English and vice versa. There is no attempt, on the part of the teachers, to focus on semantic and concept development. The teachers taught in a way that focused on everyday language by helping learners to read well and pronounce properly. There was little attempt to focus on knowledge building and conceptual development.

6.4. Devika Naidoo’s Technical Lexis

Having demonstrated how Vygotsky’s concepts and Maton’s semantics interacted in the teaching texts, Naidoo’s (2013) means of conceptualising knowledge-building through Technical Lexis and what she calls taxonomies that are either specialised or everyday and formal scientific taxonomies is also useful. Here are some of the examples that came up when the NS and SS textbooks were analysed:

Energy in NS & Technology

Concepts	Specific examples	Everyday language (Concrete)	Technical Language (dense)
energy	heat / power	energy to grow, play, work etc.	energy chain
food	- source of energy - glucose	what we eat	glucose – a simple sugar which is an

			important energy source in living organisms
energy chain	energy chains	all parts that complete it	food chain
nutrients	substances in food	what we get from food	protein, vitamin , minerals

Food and farming in NS

Specific concepts	Specific examples	Everyday language (Concrete)	Technical Language (dense)
food	food from animals and plant	rice, meat & fish	source of energy
processed food	sauce	prepared by a special method (cooking, drying, squeezing, cutting, cutting & mixing)	tomato sauce
unprocessed food	fruit	raw	fresh foods

The above two tables highlight the complexity and the technicality of the concepts and terms that are used in Grade 4 textbooks. This also indicates the textbooks' potential for knowledge building and conceptual development. Again the discrepancy lies with the teachers, the way they teach and their own conceptual understanding which is not in line with how the teaching texts display both the concept and content knowledge.

6.5. Interaction Hypothesis

Long's Interactional Hypothesis was also used to analyse the data collected, especially the teachers' pedagogical practices. The following concepts were used as tools to try to make sense of the classroom practices: clarification requests, confirmation checks, comprehension checks, self-repetitions (repairing, preventive, reacting). The emergent codes were repetition by the teachers, confirmation checks and confirmation checks that were later coded as pedagogical cues. Here are some of the examples that emerged during the process of analysing the pedagogical practice: 'Angithi?' ('Isn't'), 'Siyezwana?' ('Do you get me?'), 'Angithi Siyezwana' ('I'm sure you get me') and 'Angithi?' ('Isn't?').

It seems teachers relied on these kinds of interaction to teach both the content and ‘English language’ as there was no attempt to focus on conceptual development. Again, there is little indicating awareness of the teachers’ ability to code switch between the two languages and to promote meaningful and effective conceptual development.

6.6. Brown’s Conceptual Complexity (MMCC)

Brown’s (2005) multidimensional instrument was also used as one of the analytical tools and the focus was on how conceptual depth interacted, especially in the teaching text. I also analysed how the NS teacher presented these concepts. The learners’ workbook says, ‘Many musical instruments use movement to make sounds. For instance, “when a guitar string is plucked, the string vibrates and causes a sound wave to occur. The sound is amplified (made louder) by the air vibrating in the hollow inside of the guitar as well we can then easily hear the sounds produced by the guitar” (Natural Science and Technology). This clear understanding of conceptual depth was not displayed by the two teachers. Instead they demonstrated severe misunderstanding about how the concepts work and how they should be explained to learners.

6.7. Conclusion

This section has discussed what was found in the study during the process of data analysis. In the main, the teaching texts were in line with the theoretical frameworks that are employed in this study in the sense that both NS and SS textbook analysis reveal that both subjects are working carefully and constructively between the concrete and abstract, between high and low SD and SG and are using different levels of complexity. However, discrepancies were, in most cases, displayed by the teachers who mostly did not focus on conceptual development; instead they wanted to ensure that learners learnt content as much as possible. Teachers focused on content and neglected concept by not explaining concepts in a developmental way. For instance there were very few occasions where they directly and openly explained these concepts in English or by giving isiZulu equivalents and deliberately used code-switching to explain technical and field specific terms. Their main focus was on how well learners read and pronounced English words. The positive was that some degree of teaching

and learning did happen but the theories suggested by the theoretical framework did not come up clearly during the observed pedagogical practices.

7. Conclusions, implications and recommendations

7.1. Introduction

The previous chapters have detailed the planning and unfolding of this research work and have examined the finding in details. This final chapter firstly summarises the findings of the study then reports its implications, considering what they might mean for pedagogical practices in primary schooling, particularly in the Intermediate Phase. It also considers the limitations of the study and speculates on future research opportunities.

Briefly, the main concern of this project was the experiences of the people. Therefore, its research style was a case study, qualitative approach, and an interpretive design. Efforts were made to get inside the teaching and learning situation and to understand it from within by observing the teachers whilst teaching, interviewing them and conducting an extensive textbook analysis. Central to the study were the meanings and interpretations of the participants' language practices. The study therefore attempted to get into the micro fibre of pedagogical practices and explored the presentation of new concepts at Grade 4 level. It also was chiefly aimed at gaining insight on how the shift in the LoLT was effectively dealt with whilst simultaneously dealing with introduction of subjects at Grade 4 level. To this end the study employed as its data collection methods analysis of the conceptual structure of the textbooks, lesson observations and interviews with the teachers.

7.2. Summary of key research findings

Looking at the key research findings, in the main especially on the question that says that how text books introduce and negotiate new and specialised concepts as well as shifting the language of instruction, the study revealed that the teaching texts are in line with the theoretical frameworks that were employed in this study in the sense that in both the NS and SS textbook analysis it emerged that both subjects are working carefully and constructively between the concrete and abstract concepts, between high and low SD and SG concepts and using different levels of complexity. Maton argued that it is these kinds of semantic profiles (the movement up and down the semantic continua), not just the specific states of 'stronger' or 'weaker', which are crucial to the knowledge-building attributes of disciplinarity (Maton,

2011). Relatively speaking, the teaching text contained a number of specialised concepts and indicated a fair degree of conceptual complexity for learners at Grade 4. However, with regards to the second aspect of the question that says how teachers introduce new subjects and explain new and specialised concepts at Grade 4 level, discrepancies were, in most cases, displayed by the teachers who mostly did not focus on conceptual development; instead they wanted to ensure that learners learnt content as much as possible. This came out very clearly during the lesson observations; teachers did not do much to expand learners' conceptual development. They did not use the mother tongue to the advantage of the learners, conceptually.

Teachers focused on content and neglected concept by not explaining concepts in a developmental way. For instance there were very few occasions where teachers directly and explicitly explained these concepts in English or gave isiZulu equivalent concepts; there were also very few instances where they deliberately used code-switching to explain technical and field specific terms. Their main focus was on how well learners read and pronounced English words. The interviews did not reveal much in terms of the employed theoretical framework. The two interviewed teachers mentioned the English language as one of the major problems in Grade 4 especially because in the previous three years (in the Foundation Phase) learners were taught and learnt in their mother tongue. However they also indicated that as they progress in the academic year the learners' language situation steadily improves.

This in no way suggests that there was no learning that took place, some degree of teaching and learning did happen but the theories suggested by the theoretical framework did not come up clearly during the observed pedagogical practices. The teachers also did their level best; perhaps it is the lack of exposure to how knowledge and concepts are presented in the teaching texts and how these should be imparted to learners. This too was evident during the interviews with the educators: they could not directly and adequately respond to questions relating to how they teach new content information and concepts to learners. Their major concern was the lack of fluency on the part of the learners.

7.3. Implications

The findings of this study suggest a number of implications. This study explored how Grade 4 negotiates the introduction of subjects whilst simultaneously changing the language of

instruction. The emergent ideas were that teachers find it difficult to work with the learners, especially at the beginning of the year. Teachers mentioned problems like poor reading and communication skills on the part of the learners. They said, at first, learners are not able to actively take part in class because of the English language barrier. This, they said, had serious effects on the acquisition of new content information, especially in the new content subjects introduced in Grade 4. In the main, teachers saw the language barrier as the major problem experienced by Grade 4 learners.

Secondly, concerning how specialised practices and the teaching of specialised concepts interact at Grade 4, again the observed lessons indicated that teachers do not focus on specialised concepts. They ignored their role in the *zone of proximal development* as a guide to assist the learners in building new conceptual understandings through the linking of existing spontaneous/concrete and scientific/abstract concepts. Rather teachers focused on how well the learners read the English words. In other words, teachers did not demonstrate the capacity of moving carefully and clearly between concrete/spontaneous and abstract/specialist or technical terms.

The main concern is that both teachers did not work with the concepts across the two languages, that is the learner's Mother tongue and English, through code-switching. The Natural Science teacher used isiZulu only to command learners' attention. The analysis of her lessons reveals that at no stage did she use it to explain the concepts or to give examples and to expatiate on the learners' correct answers. In most cases the Social Science teacher used isiZulu to command learners' attention. There were very few occasions of isiZulu used where she repeated the learners' responses and expatiated on them. There were also two occasions where she used isiZulu to explain concepts. Again, just like the NS teacher, at no stage did she give a direct and explicit example of a concept in isiZulu.

Lastly, on the question of how specialised concepts are introduced and used at Grade 4, the textbooks revealed that both subjects are working carefully and constructively between the concrete and abstract concepts, between high and low SD and SG concepts and using different levels of complexity. This kind of conceptual development promotes cumulative knowledge building in the classroom level. The analysed textbooks are in line with CAPS and reflect the shift and the nature of conceptual development from everyday/concrete to abstract/specialised concepts. However the teachers that use these textbooks do not reflect the transition. This is crucial and is an indication that although curriculum policy changes and is

reviewed timeously, the pedagogy of the teachers remains unchanged. Teachers are still trapped in teaching approaches that do not highlight their explicit role of scaffolding learners to accumulative knowledge building experiences. There needs to be consistency and systematic use of isiZulu across the curriculum so that teachers can help to improve the learners' conceptual understanding of the content subjects, such as the Natural and Social Sciences.

7.4. Recommendations

- Teachers in the Intermediate Phase require exposure and explicit guidance to teaching methodologies that would enable cumulative knowledge building. The theoretical framework chapter discussed in this study intended to provide some knowledge and guidance to achieve such learning experiences. These theories proclaim that learners will learn higher-order principles (emphasising knowledge, skills and procedures, or knowledge code) capable of application in new contexts – weak semantic gravity and strong density (Maton 2009).
- The teacher in-service training/workshops or subject advisors' intervention programmes ought to empower teachers with the ways of making the organising principles of knowledge visible to learners through explicitly teaching discipline-specific language resources that create and shape the knowledge of their disciplines. Macnaught et al (2013) state that without such explicit instruction, many students remain limited to a range of meanings lower on the semantic scale, that is relatively strong semantic gravity and weaker semantic density. In this regard the teachers concerned need to be equipped with innovative ideas intended to promote semantic and conceptual development ideas across the curriculum so that they can be helped to improve their teaching and learning of content subjects such as NS and SS.
- The language in which children are instructed in primary school is one of the most important inputs into the education production function (Taylor and Coetzee, 2013). This language role illuminates another important recommendation – reading literacy development and the role teachers should play to this end. First and foremost, in the new Curriculum and Assessment Policy Statements (CAPS) (DBE, 2011) there is a clear and direct reference to higher order comprehension task development and reading strategies. This therefore requires teachers to instruct reading literacy skills. Teacher should be able to employ high qualities of being effective teachers of reading

by being able to move literacy activities up or down the cognitive scale as the NS and SS curriculum dictates (Zimmerman and Smit, 2013). This in turn will help to stimulate and develop high levels of literacy in language and other school subjects such as numeracy/Mathematics.

- The understanding of concepts play an important role in learning and much of what children learn comes from others (Gelman, 2009). Teachers therefore, should be aware and equipped with the understanding of learners' background knowledge (barriers to learning opportunities) as lack of conceptual understanding results in learners' poor performance. Teachers are therefore regarded as embodying expert knowledge which then they should transmit to novices (the learners). To achieve this, teachers need to broaden their own conceptual understanding of the learning areas they teach.
- Curriculum developers/textbook authors ought to consider translating key concepts and new terminology from English to African languages in order to enhance learners' acquisition and effective conceptual understanding, especially in the scientific and mathematical subjects.

7.5. Limitations of this study and future research possibilities

This sampling scope of this study was limited to Grade 4 level and to the teachers in particular. However, the experiences of learners were backgrounded although the Grade 3 teachers and learners were excluded from the study.

Areas for further research include: a study reviewing learners' conceptual development and the learners' performance in the two primary exit classes that is Grade 3 and 6 in conceptual subjects like Mathematics, Natural and Social Science. This study would entail the review of teaching methodologies, the review of the teachers' curriculum (CAPS) understanding and assessment strategies.

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