DIFFICULTIES EXPERIENCED BY GRADE 6 ISIXHOSA-SPEAKING LEARNERS IN LEARNING SCIENCE THROUGH THE MEDIUM OF ENGLISH: A CASE STUDY AT A PRIMARY SCHOOL IN THE WESTERN CAPE

By

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A thesis submitted in fulfilment of the requirement for a Doctorate in Philosophy in the Faculty of Education, University of the Western Cape

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DEDICATION

This thesis is dedicated to my late parents, Mpumelelo and Nomantingi Jonas who, against odds, made sure that I received an education. To them I say, "Mazenethole! Ndibamba ngazibini."

ABSTRACT

This thesis examined the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through English as the medium of instruction at a primary school in the Western Cape. In 1994, South Africa became a democratic country where people were given the right to choose the language of learning and communication (Constitution of the Republic of South Africa, 1996). The assumption made in relation to the right to language was that this would provide equal opportunities and equal access to education for all learners. All learners would then be able to attain academic success. The study was pursued against the backdrop of the serious academic underachievement of African learners at schools around the country (often culminating in high matric failure rates), particularly in mathematics, science and technology (Probyn, 2005; Cleghorn, 2005; Taylor & Vinjevold, 1999).

Following a mixed-method approach (involving both qualitative and quantitative research methods), within the constructivist paradigm, the study examined the various factors which act as barriers to learning and contribute to difficulties in learning Natural Science by Grade 6 isiXhosa-speaking learners in one school in the Western Cape. It also examined the coping strategies used in dealing with the barriers by both the learners and educators in order to address the learning difficulties. The study was conducted over a period of four months, spread over two years (2008 and 2009), in the Metropole Central Education District (MCED) of the Western Cape. The following participants were involved in the study: 205 Grade 6 learners (103 learners in 2008 and 102 learners in 2009), 4 Natural Science educators (including 2 HODs), 1 principal, and 4 parents. The focus of the study was, however, on 26 isiXhosa-speaking learners (13 learners from each year in 2008 and 2009). The data were collected using the following research methods: questionnaires, classroom observation, document analysis, and interviews. The data were analysed through content analysis and (analysis of) language usage (including sentence construction), and were interpreted with respect to the study's research questions.

The findings of the research revealed that language (including both the English language of learning and teaching or LOLT, and the language of science) was a major barrier to the learning of Natural Science by Grade 6 isiXhosa-speaking learners. The language barrier was exacerbated by factors within the teaching and learning context, the school environment, as well as by social factors in the learners' own home backgrounds.

On the basis of the findings of the research and the related literature, the study makes recommendations regarding what could be done to address the difficulties, as well as proposals for future research. The key recommendations include:

- Introducing a more flexible bilingual education policy to enable additive bilingualism to be practised by both learners and educators;
- Compiling a list or glossary of *words, concepts* and *terms that matter* in Natural Science and ensuring that the learners fully understand their meaning and use them appropriately;
- Educators constantly reflecting on their own teaching styles and practices in relation to their effectiveness and impact on their learners;
- Educators constantly considering 'different and creative ways' of assessing learners for whom the English LOLT is not a home language; and
- District Offices providing systemic support for schools and creating an enabling learning environment.

DECLARATION

I declare that 'Difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science through the medium of English: A case study at a primary school in the Western Cape' is my own work, that it has not been submitted for any degree or examination in any other university, and that all sources I have used or quoted have been indicated and acknowledged by complete references.

Zola D. Jonas May 2012

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LIST OF ABBREVIATIONS

ANC	African National Congress
ASD	Autistic Spectrum Disorders
BICS	Basic Interpersonal Communication Skills
CALP	Cognitive Academic Language Proficiency
CBCLM	Cognitive Border Crossing Learning Model
DET	Department of Education and Training
DoE	Department of Education
EAL	English as an Additional Language
EFA	Education for All
HOA	House of Assembly
HoD	House of Delegates
HOD	Head of Department
HOR	House of Representatives
IEA	International Association for the Evaluation of Educational Achievement
IKS	Indigenous Knowledge System
ILST	Institutional Level Support Team
IMF	International Monetary Fund
IWB	Interactive White Board
L1	First Language
L2	Second Language

L3	Third Language
LEP	Limited English Proficiency
LiEP	Language-in-Education Policy
LOI	Language of Instruction
LOLT	Language of Learning and Teaching
MCED	Metropole Central Education District
MMR	Mixed Methods Research
MSED	Metropole South Education District
NCESS	National Committee on Education Support Services
NCS	National Curriculum Statement
NCSNET	National Commission on Special Needs in Education and Training
NECC	National Education Co-ordinating Committee
NEPI	National Education Policy Investigation
NGO	Non-governmental Organization
NRF	National Research Foundation
NS	Natural Science
OBE	Outcomes-Based Education
PRAESA	Project for the Study of Alternative Education in South Africa
RNCS	Revised National Curriculum Statement
RSA	Republic of South Africa
SGB	School Governing Body
SMT	School Management Team
STL	Scientific and Technological Literacy

TIP	Teacher In-service Project
TNC	Transnational Corporation
TST	Teacher Support Team
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund
UWC	University of the Western Cape
WCED	Western Cape Education Department
WMS	Western Modern Science

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The history of the approach to language in education in South Africa, before the advent of the current democratic order, can be divided into four distinct periods, namely, the *pre-1910 period*, the *1910-1948 period*, the *1948-1976 apartheid period*, and the *1977-1994 decline of apartheid period* (Desai, 2012; Hartshorne, 1992; Holmarsdottir, 2009; Vinjevold, 1999). In all four periods the main thrust of the language issue centred on the dominance of English and Dutch/Afrikaans as languages of learning and teaching[1](LOLT). African languages were only considered in so far as they served the interests of the white population[2]. Schools and the curriculum that was followed were thus used to restrict the access of African-language speakers to power, through language policies in education which promoted separate and unequal development for the different racial groups in the country (Hartshorne, 1992; Holmarsdottir, 2009; Soudien, 2007).

The pre-1910 period in South Africa is characterized as the phase of laissez-faire approach to the language issue with regard to speakers of African languages. It saw the state seeking to provide education in general, but with language focusing on the English- and Dutch-speaking settlers (Hartshorne, 1992; Holmarsdottir, 2009: 160; Nomlomo, 2007).

The 1910-1948 period was characterized by the struggle over the distribution of power between the English and Afrikaner white groups, with the continuing hegemony of the two official languages, English and Afrikaans (Desai, 2012; Hartshorne, 1992; Holmarsdottir, 2009; National Education Policy Investigation [NEPI[3]], 1992a; Nomlomo, 2007; Vinjevold, 1999). Where African-language speakers were concerned, it was decided that, as English had already been established in the mission schools, the status quo would be preserved and English would continue to dominate. Thus, in this period a *transitional approach* (an early exit model) was put in place, often regarded as a subtractive form of bilingualism

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[1] In this study the terms 'language of learning and teaching (LOLT)' and 'medium of instruction (MOI)' are regarded as synonymous and are, therefore, used interchangeably.

[2] This tendency seems to persist even in post-1994 democratic South Africa. In her exposition of 'the symbolism of multilingualism' in South Africa, Desai (2012: 27) notes that "Even where pupils' home language skills are focussed on, it is usually in relation to English."

[3] The NEPI was commissioned by the National Education Co-ordinating Committee (NECC), which was formed during the height of the anti-apartheid activities in 1985, to conduct a study of policy options for a new educational dispensation in South Africa (Weber, 2002).

(Holmarsdottir, 2009: 160). This is called the early exit model in that the linguistic minority children were exposed to the English LOLT from the onset of their formal schooling.

It could be argued that the inclination by many black parents to choose English as the LOLT has its roots in this period, during which the policy on language of instruction was always a very emotive and contentious issue (Holmarsdottir, 2009; Napier, 2011; NEPI, 1992a; Vinjevold, 1999). The language issue was, for example, central to the Afrikaners' Two Streams Language Policy (that is, separate Afrikaans- and English-medium schools running parallel), which was a response in protest against the Anglicization of their children in the schools in the early twentieth century (Prah, 2003). This period was characterized by the dominance of English and Afrikaans/Dutch as the LOLT in the South African education scene (Hartshorne, 1992; Napier, 2011; Prah, 2003). It is argued in this study, that the Anglicization of education (although at the time it was driven by British imperialism) could be regarded as the first step towards what culminated or emerged a century later as the globalization of (language) education. In the Bantu Education era, African children were compelled to learn in English and Afrikaans, as well as in their home language or mother-tongue (NEPI, 1992a; Vinjevold, 1999). Even in post-apartheid, democratic South Africa we find traces of the language dilemma of the early 1920s (Napier, 2011). The effects of the choice of English as the LOLT by many black parents, accompanied by the influx of black learners into former white (ex-Model C[4]) schools in South Africa, are discussed in more detail in Chapter 3 of this study.

During ***the 1948-1976 apartheid period***, the policy could be described as the segregation model, but was also a *transitional approach* as far as African-language speakers were concerned (Holmarsdottir, 2009: 160). It is also regarded as a late exit model, in that the linguistic minority children were initially taught in their home language for a few years, before having to make the transition to another language, namely English and Afrikaans (Holmarsdottir, 2009; NEPI, 1992a; Nomlomo, 2007; Vinjevold, 1999). One of the most significant developments in this period was the appointment of the Eiselen Commission whose recommendations on language in African education culminated in 1953 with the

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[4] In 1983 the apartheid government altered its constitution and created a tricameral parliament: one for whites (the House of Assembly or HOA), one for coloureds (the House of Representatives or HOR) and one for Indians (the House of Delegates or HoD) (Weber, 2002). Each of these had its own education system but the white parliament had overall control and final say. Schools under the HOA were referred to as Model C schools. Africans were excluded from the tricameral parliament and were governed under a different parliamentary and educational system.

passing of the Bantu Education Act (Hartshorne, 1992). This Act was to ensure the establishment of a central state department (the Department of Bantu Education, later called the Department of Education and Training or DET) which took over control of the schooling of Africans from the provinces and the mission churches, enforced the compulsory development of home language instruction and introduced Afrikaans in the schools. Thus, both Afrikaans and English were introduced as compulsory subjects for African children from their first year of schooling (Hartshorne, 1992).

The 1977-1994 period, which started in the aftermath of the Soweto uprisings in South Africa, is also regarded as a *transitional approach* and was an early-exit model, similar to that used in the pre-apartheid period. A policy was passed in 1979 (the Education and Training Act 90 of 1979) which reduced the number of years for home language instruction from 8 to 4 years (Desai, 2012; Hartshorne, 1992; Holmarsdottir, 2009; NEPI, 1992a; Vinjevold, 1999). The choice thereafter was either English or Afrikaans as the language of instruction. With most schools choosing English as the LOLT, the resultant situation was that of subtractive bilingualism. Although the policy was passed in 1979, its implementation was delayed until 1990 when an amendment to Act 90 of 1979 was accepted, which gave parents the right to choose the LOLT in each school (NEPI, 1992a; Vinjevold, 1999).

During all four periods of the development and implementation language in education policy, African-language speakers were excluded from decision-making in the policy formation processes and the decisions made for them, despite their protests and resistance (Desai, 2012; Hartshorne, 1992; Holmarsdottir, 2009; NEPI, 1992a; Vinjevold, 1999).

After the first democratic elections in 1994, South Africa recognized eleven official languages, and the constitution of the country gave equal status to all these languages (Department of Education, 1997a; Prinsloo, 2005; Probyn, 2005; Republic of South Africa, 1996a; Republic of South Africa, 1999). The Language in Education Policy document, which regulates the use of language in South African schools, promotes multilingualism while theoretically protecting the right of learners to be taught in the language of their choice (Cleghorn, 2005; Department of Education, 1997a; Holmarsdottir, 2009).

According to *Census 1996*, the first official census in post-apartheid South Africa released in October 1998, IsiZulu is used by 22.9% of the population, followed by IsiXhosa (17.9%), Afrikaans (14%), Sepedi (9.2%) and English (8.6%) (Napier, 2011; Probyn, 2005; Republic of South Africa, 1999). From the foregoing statistics, it is evident that for the majority of South Africans, English, which is used as the LOLT in the majority of schools in the country, is not a home language. In the Western Cape, where this study was conducted, isiXhosa-speaking learners constitute a minority language group in the ex-Model C and ex-HOR schools. Indeed, at the school of interest in this study, the Grade 6 isiXhosa-speaking learners constituted approximately 8% of the school population. The interest of this study, therefore, was to find out what challenges the isiXhosa-speaking learners faced in learning Natural Science through the English LOLT in the above (ex-Model C) context.

In South Africa, the right to choose the LOLT is vested in the individual (Department of Education, 1997a; Republic of South Africa, 1996a). The Constitution of South Africa makes it clear that everyone has the right to use the language of their choice and to participate in the cultural life of his or her choice, but that these rights may not be exercised in a manner inconsistent with any provision of the Bill of Rights (Republic of South Africa, 1996a). More specifically, the Constitution states that each person has the right to instruction in the language of his or her choice *where this is reasonably practicable* (Department of Education, 1997a; Republic of South Africa, 1999).

The qualification, 'where this is reasonably practicable', is considered to be problematic in this study. It implies that the principle of inclusive education is rendered inapplicable in that, where a school does not have the required resources (as was the case at the research school), the learners must "fit into" the system (Swart & Pettipher, 2006: 8). The argument presented in this study is that the African or isiXhosa-speaking learners (in Grade 6) in the research school were not sufficiently provided for in relation to their *linguistic* learning needs (Brock-Utne, 2000: 141; Obanya, 1980), particularly in Natural Science[5], which was the focus of this study. Firstly, the subject is taught in English, which is not their home language. Secondly, the educators who taught Natural Science at the school could not speak or understand isiXhosa and were therefore unable fully to explain or provide 'scaffold' to the learners when they did not understand a point in the lesson (Bruner, 1964; Vygotsky, 1962). Thirdly, the school followed a subtractive bilingual policy in that the learners were restricted to using only English in class and were not allowed to use their home language (if it was not English).

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[5] In this study the word 'science' is used as a broad term to refer to the discipline or field of study as a whole. 'Natural Science', on the other hand, is used as a narrower term used to refer to a specific Learning Area which is prescribed in terms of the RNCS Curriculum for the Intermediate Phase (Department of Education, (2002). In this context, therefore, science encompasses or subsumes Natural Science.

In the primary school, home language is used as the LOLT in the Foundation Phase (Grades 1 to 3), while from the Intermediate Phase (Grades 4 to 6) to the Senior Phase (Grade 7) the LOLT is by choice of the parent or guardian of the learner. This is in line with the Bill of Rights enshrined in the country's constitution (Cleghorn, 2005; Republic of South Africa, 1996a; Republic of South Africa, 1996b; Taylor & Vinjevold, 1999). In practice, however, in the Intermediate and Senior Phases isiXhosa-speaking parents and learners have no choice. The LOLT is either English or Afrikaans. In most schools in the Western Cape, as is the case in many African schools in the country, the choice of the parents has invariably been English LOLT (Alexander, 1989; Nomlomo, 2007; Prinsloo, 2005; Probyn, 2005; Taylor & Vinjevold, 1999; Villanueva, 2010).

On the basis of research, many authors argue that learning is best achieved when the learner is taught in his/her home language or mother-tongue[6] (Alexander, 1989; Brock-Utne, 2000; Brock- Utne, Desai & Qorro, 2005; Mazrui, 2002; NEPI, 1992a; Nomlomo, 2007; Obanya, 1980; October, 2002). This suggests that academic development, including learning, is achieved optimally when the home language is carried through to the LOLT at school. October (2002: 18) adds that:

> The language the child is using in the classroom needs to be sufficiently well developed to be able to process the cognitive challenges of the classroom. ... Speaking, listening, reading or writing in the first or the second language helps the whole cognitive system to develop. However, if children are made to operate in an insufficiently developed second language (e.g. in a 'submersion' classroom), the system will not function at its best. If children are made to operate in the classroom in a poorly developed second language, the quality and quantity of what they learn from complex curriculum materials and produce in oral and written form may be relatively weak and impoverished.

1.2 RESEARCH PROBLEM

Since the democratization of this country there has been a significant influx of African learners, mostly isiXhosa-speaking, from the Eastern Cape Province and other parts of the country into ex-House of Representatives (ex-HOR) and ex-Model C schools in the Western Cape, in their quest for 'better' education (Taylor & Vinjevold, 1999). This has created a challenge where both learners and educators must contend with a LOLT which is not their home language (Langenhoven, 2006). The end result is that isiXhosa-speaking learners often perform poorly academically, especially in science subjects (Desai, 2003; Nomlomo, 2005;

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[6] In this thesis, the terms, 'mother tongue' and 'home language' are regarded as synonymous and are used interchangeably.

October, 2002). Evidence suggests that the academic performance of these learners, especially in science subjects, is very poor in comparison to their English-speaking counterparts (October, 2002), implying that language is a potential barrier to learning. As mentioned earlier, research has shown that learning is best achieved through the learner's home language or mother-tongue (Alexander, 1993; Brock-Utne, 2000; Heugh, 2002; NEPI, 1992a; Nomlomo, 2007).

1.3 MOTIVATION FOR THE STUDY

In the Western Cape the official languages are Afrikaans, English and IsiXhosa (Langenhoven, 2006). The majority of Africans in the province speak isiXhosa while Afrikaans and English are spoken predominantly by the Coloured and White communities[7]. However, English is the preferred and dominant LOLT in the majority of schools in the province, especially in the urban metropolitan areas.

This study was motivated by the fact that, despite the vast amount of research (and often sentimental debate) highlighting the disadvantages of teaching and learning through a second or third language in most post-colonial societies, the practice of using one of the former colonial languages as the LOLT continues and there appears to be little indication that this situation will change soon (Brock-Utne, 2000; Desai, 2012; Ferguson, 2002; Holmarsdottir, 2006). In the case of South Africa, this practice has both historical and economic roots. The NEPI (1992a: 13) notes that:

> Parents' memories of Bantu Education, combined with their perception of English as a gateway to better education, are making the majority of black parents favour English as medium of instruction from the beginning of school, even if their children do not know the language before they go to school.

While this situation persists, learners being taught in a second or third language will continue to suffer and underperform. It was in the light of this situation that the decision to undertake this study was conceived and pursued, both to find out the difficulties that lead to underperformance and to recommend possible solutions.

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[7] It must be noted that the white-black dichotomy, especially during the apartheid era (1948-1994), resulted in extreme disparities in the services rendered to the various population groups in South Africa (du Toit, 1996; Taylor & Vinjevold, 1999). The effects of these historical disparities have continued to manifest themselves (in various forms) in the new, post-1994 era. It has, therefore, become necessary to refer to black, coloured, Indian and white population groups as previously distinguished in educational planning. It has sometimes become necessary, even in the new South Africa era, to make this distinction in order to highlight or refer to (and address) previous imbalances that resulted from apartheid policies.

Although isiXhosa is one of the three official languages of the Western Cape, it has not been formally introduced as a subject in many of the ex-HOR and ex-Model C schools (Vinjevold, 1999). Indeed, Vinjevold (1999: 206) notes that "A minority of former House of Assembly schools have introduced an African language as a subject but this has not become a widespread phenomenon in post-apartheid South Africa." In order to fulfil the requirements of the prescribed curriculum, all learners at primary school level are required to pass in one of the official languages (Department of Education, 1997a; Department of Education, 2005; Department of Education, 2011). However, because their home language is not formally taught in many of the ex-HOR and ex-Model C schools, isiXhosa-speaking learners attending these schools are forced not only to take Afrikaans and English to fulfil the pass requirements but also to learn all the other content subjects in either of the two languages. In addition, in the majority of cases, the chosen LOLT is English (Alexander, 1989; Heugh, 2002; October, 2002). As mentioned earlier, this creates a problem in that these learners tend to perform poorly in their academic subjects, particularly in mathematics and science, which is the focus of this research study.

In addition to the above-mentioned contextual challenges, the reason for pursuing this study was strengthened by Sadeck (2003), who, in her study of Peninsula Technikon (currently the Cape Peninsula University of Technology) first-year pre-service teachers' conceptions of heat and temperature, recommended that "… future studies need to pay more attention to issues relating to the language of instruction, the role of the teacher in remedying students' misconceptions and teaching science in multi-cultural classrooms" (Sadeck, 2003: iv). The relevance of the above study and its recommendation is that, firstly, it relates to the training of pre-service teachers, some of whom might well teach science at primary school level after completing their courses. As Oswald (2007: 142) pertinently notes, "Preservice teacher education can play a significant role in preparing teachers during a process of educational transformation." Secondly, the recommendation made in the study goes to the heart of the issues around learning difficulties, namely the role of the teacher in "remedying students' misconceptions" and "teaching science in multi-cultural classrooms." Both these issues are among the concerns of this study.

The researcher shares two attributes with the learner subjects of the research. First, they have a common home language, which is isiXhosa. Indeed, this was one of the reasons for deciding to research the language issue with isiXhosa-speaking learners. The advantage of this common language was that it made the researcher's communication with the learner participants easier and thus facilitated the ethnographic investigation or research process.

The researcher considered that it would be easier for him to communicate with the participant learners and their parents at a deeper level, thus minimizing the possibility of a language barrier in the research process. Secondly, as a learner in his own school days the researcher had personally been directly affected by the 50:50 Language Policy (NEPI, 1992a) that was applied in African schools during apartheid education, having only matriculated in 1970. This policy, which culminated in the so-called 'Soweto uprising' in 1976 (NEPI, 1992a; Soudien, 2007), required that students did 50% of their school subjects through Afrikaans as the medium of instruction and the remainder of the subjects through English or a home language. This effectively meant that in his school years the researcher had to learn all his school subjects through the second languages (namely, English and Afrikaans) as LOLT, except isiXhosa as a subject. He, therefore, shares the experience of having to learn science through the medium of a second language. The researcher is aware that this personal experience could cause bias in the study. However, the steps to control such possible bias are explained in Chapter 4, which discusses the Research Methodology.

Furthermore, as a circuit manager within the Western Cape Education Department (WCED) for the past ten years, the researcher has witnessed how both learners and educators struggled to deal with the difficulties associated with using English as a LOLT for African learners, especially in mathematics and science subjects. Although mathematics and science are generally difficult for all learners, isiXhosa-speaking learners seem to be doubly encumbered by the fact that these subjects are offered in a language that is not used in their home environment and, consequently, one that they experience difficulty in understanding. In addition, the terminology used in science acts as a potential barrier to learning, irrespective of the LOLT used. This is compounded by the fact that some of the educators who teach science are not English first language speakers and therefore may struggle to express themselves in the language. This could have negative implications for the learners who rely on these educators for their knowledge of the subject. It was out of a desire to support both these learners and educators that the interest in this study was born.

1.4 RESEARCH AIM AND QUESTIONS

This study explores the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through the medium of English in one school in the Western Cape. The *aim* of the study was to understand the difficulties as well as the strategies currently being used to address these challenges.

The research sought to answer the following *questions*:

- What are the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through the medium of English?
- What role does the language of learning and teaching (LOLT) play in the context of these difficulties?
- What factors within the teaching and learning situation contribute to these difficulties?
- How are the learners and educators currently coping with all the challenges?
- What can be done to assist both learners and educators in overcoming the difficulties?

It is hoped that this research study will contribute to the development or improvement of language policy and in so doing also contribute to 'building an inclusive education and training system' in South Africa (Department of Education, 1997b; Department of Education, 2001). The objective of inclusive education is to provide quality education for all learners within the mainstream of the education system so as to enable them to reach their full potential (Department of Education, 1997b; Prinsloo, 2001; Walton, Nel, Hugo & Muller, 2009). This in effect means, among other aims, the identification and removal of the barriers to learning and development experienced by many of the learners in our schools. The most important challenge in this process is the training and skilling of teachers in order to enable them to identify and effectively support learners who experience such barriers to learning and development in the classroom (Nel, Muller, Hugo, Helldin, Backmann, Dwyer & Skarlind, 2011; Prinsloo, 2001). Language is one of the key barriers to learning, in which this study takes particular interest (Department of Education, 1997b).

With regard to finding the most locally viable approach to building multilingual education in South Africa, the Language-in-Education Policy (LiEP) states that "With regard to the delivery system, policy will progressively be guided by the results of comparative research, both locally and internationally" (Department of Education, 1997a: 1). In the light of the foregoing statement, this study also hopes to contribute to both the established body of knowledge relating to the LOLT and to methods of teaching Natural Science. More importantly, it is hoped that it will be helpful in stimulating debate and further research on the issues which it raises.

1.5 THEORETICAL FRAMEWORK FOR THE STUDY

This study is based on the assumption that a primary learning barrier experienced by Grade 6 isiXhosa-speaking learners in Natural Science is the English medium of instruction or language of learning and teaching (LOLT). Many writers have noted that English as a second language (L2) can act as a *barrier to the learning* for African learners when it is used as a medium of instruction (Alexander, 1989; Brock-Utne, 2004; Desai, 2003; Huegh, 2002; Nomlomo, 2007; October, 2002; Probyn, 2005). In this regard, Nomlomo (in Brock-Utne et al., 2005: 269) notes that:

> While language can serve as a means of effective teaching and learning, it can also be a barrier in learning. For example, if there is a mismatch between the language of teaching and the language known by the learner, teaching and learning can be adversely affected. Likewise, if the teacher is not competent in the language of teaching, the teaching and learning process can be hampered.

This study acknowledges that there are many factors besides language which influence the learning of science. However, it is hypothesized that language plays a critical and central role in learning and understanding. It is not possible to do 'in-depth' justice to *all* 'barriers to learning' – thus I chose to focus this research study on *language,* looking at how this aspect links to other aspects in the learning of science by isiXhosa-speaking learners.

The study is framed by *constructivism*. This is a theoretical perspective which argues that knowledge is not passively received but is actively and continuously constructed and reconstructed by the individual learner, group or society (Donald, Lazarus & Lolwana, 2010). This view contrasts with, and is in opposition to positivism which views knowledge as having an objective existence, needing only to be discovered and proved. One of the central concepts in constructivist thinking is that of active agency by which people actively and continuously construct their world (Anderson & Krathwohl, 2001; Donald et al., 2010). "Constructivism is a very important, current perspective which applies to all aspects of teaching and learning. It is central to the outcomes-based approach to education" (Donald et al., 2010: 79). The concept of constructivism will be discussed in more detail in Chapter 3 of this study.

Piaget and Vygotsky helped to clarify the idea of active agency in relation to the acquisition of knowledge. Piaget saw the child as actively adapting to his environment 'from the inside out'. Vygotsky, on the other hand, saw the child as active, but mediated 'from the outside in' (Donald et al., 2010: 81). Bruner, another influential constructivist, saw the child as an active explorer and strategist (Bruner, 1964; Bruner, Oliver & Goldfield, 1966). However, Bruner also saw the child's social context and the mediation he/she experienced as shaping the form and effectiveness of his/her cognitive strategies (Donald et al., 2010). This is a process directed both from 'the inside out and the outside in' (Moll 1989, as cited by Donald et al., 2010: 81). These theories were useful in framing this study as they are congruent with the concept of constructivism and will be used in explaining how the learners in the study understood and constructed their own meaning of science knowledge.

As children grow, they gradually develop tools of cognition for representing the world (Bruner, 1964; Donald et al., 2010; Piaget, 1980). Symbolic representation, especially language, is a tool that 'shapes, augments and even takes over the child's earlier modes of processing information' (Bruner, in Donald et al., 2010: 83). It is my view that, in the case of isiXhosa speaking learners, this 'shaping' and 'augmenting' may be negatively affected or, at best, delayed in relation to the extent to which the learner has or does not have good command of this important language tool in learning Natural Science. In the ex-Model C context in South Africa, one finds isiXhosa-speaking learners who are learning Natural Science in English for the first time. Up to the end of Grade 3, they have developed their concepts (and been using concepts and symbols) in isiXhosa, but now have to switch over to an unfamiliar (English) LOLT with its attendant new symbols (Langenhoven, 2006; Vinjevold, 1999). Such learners will therefore not be able to use the 'new language symbols' at the same level as their English-speaking peers, if English is used as LOLT.

1.6 RESEARCH METHODOLOGY

This study adopts a qualitative research paradigm, using a single-site case study design. This paradigm was regarded as appropriate for the study as it enabled the researcher to obtain in-depth understanding of the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through English as the LOLT. The study is an in-depth case study involving one school in the Metropole Central Education District of the Western Cape.

Natural Science, as a subject or Learning Area, is introduced for the first time in the Intermediate Phase (Grades 4 to 6). Grade 6, therefore, is the highest level in the Intermediate Phase. This level was chosen for the research because it was assumed that the learners would have reached the highest level of maturity in this phase and would be better placed to understand the issues around Natural Science teaching and learning and better able to articulate them on the basis of their longer experience of the subject or Learning Area than learners in Grade 4.

Two groups of three Grade 6 classes (Cohorts 1 and 2) which had isiXhosa-speaking learners, were selected for the research. This was conducted in 2008 and 2009. All learners in the selected classes participated in the research except those whose parents did not give consent. The Grade 6 Natural Science educators, who taught these particular classes at the school, were also involved.

The research methods that were used included: questionnaires (for both learners and educators), documentary analysis, classroom observation, and interviews (with both the learners and the Grade 6 Natural Science educators). Data based on the above methods were collected and analysed. On the basis of the findings of the research (Chapter 5) the literature and theoretical framework reviews (Chapters 2 and 3) and a discussion (Chapter 6) recommendations were made for enhancing or more effectively promoting the learning of Natural Science by isiXhosa-speaking learners (Chapter 7).

1.7 CHAPTER OUTLINE

Chapter 1 introduces the research study and gives a brief overview of its motivation, aims, conceptual framework, and research methodology.

Chapter 2 reviews the literature relating to barriers to learning with special reference to language and learning, both in South Africa and internationally. It also covers the debates and issues around English as a language of learning and teaching (LOLT) and reviews research and debates on *the language of science* as a barrier to learning, in South Africa and internationally.

Chapter 3 discusses the theoretical framework that underpins the study. It pays special attention to theories of cognitive and language development, both in South Africa and internationally.

Chapter 4 discusses the methodology used in the study. It gives an account of the research design, participants, research process, data collection and analysis that were followed. The chapter ends by discussing ethical issues pertaining to the research process.

Chapter 5 presents the findings of the research. The findings on each research question, are presented under the sub-headings: *questionnaires, classroom observation, document analysis, and interviews*, which were the research methods used in the study. The key themes emerging from each research method were identified and summarized.

Chapter 6 discusses the findings of the study in the context of the constructivist paradigm as well as the relevant theoretical frameworks drawn from the research literature. The discussion is done under the themes which emerged from the findings. An overview of the aims and research questions of the study is made and conclusions are drawn.

Chapter 7 constitutes the concluding chapter of the thesis. It synthesizes the findings and discussion of the findings as presented in Chapters 5 and 6, and concludes by making recommendations and suggestions, based on the findings of the study.

CHAPTER 2

BARRIERS TO LEARNING AND DEVELOPMENT

2.1 INTRODUCTION

Chapter 1 of this thesis gave the background to and an overview of the study. This chapter reviews the literature relating to barriers to learning and development. Firstly, it presents the approaches to the understanding of learning difficulties. Secondly, it describes the key barriers to learning and development. Thirdly, it discusses the role of language in learning and how it can be a barrier to learning. Lastly, it explores the literature on how language can impact on the learning of science.

2.2 APPROACHES TO UNDERSTANDING LEARNING DIFFICULTIES

This study takes as its point of departure the assumption that isiXhosa-speaking learners face barriers to learning science through the medium of English. This section discusses the different approaches or models that can be used in describing or investigating learning difficulties. These include the medical model, the social model, and the ecosystems model.

2.2.1 Medical/Deficit Model of disability

The medical model, also referred to as *medical deficit* or *within-child model*, had its origin in medicine and was popular from the early 1900's. It is basically a model of diagnosis and treatment that locates the learning difficulties within the child or learner him or herself (Department of Education, 1997b; Green & Engelbrecht, 2007; Johnson & Green, 2007; Swart & Pettipher, 2006). In terms of the medical model, the learner or person with a disability is seen as the problem. Such a learner or person is expected to change and adapt to prevailing circumstances, and there is no suggestion that society or the surrounding environment must change (The Open University, 2006). When this model is applied in education, children with any type of difference or disability are singled out and the origin of the difference is looked for within the learner. The learner is then often placed in a separate or special class or school established for those with particular characteristics (du Toit, 1996; Green & Engelbrecht, 2007; Johnson & Green, 2007). Practitioners who support this view tend to follow the "find-what's-wrong-and-cure it" paradigm (Johnson & Green, 2007; Swart & Pettipher, 2006: 5).

The medical model is based on assessment of impairment from a deficit point of view, focusing on what the person cannot do, rather than what he/she can do. The tools used by this model to identify disability or learners with special needs include diagnostic tests like the IQ test, standardized achievement tests, as well as other ability-testing and classification tests. Learners who experience learning difficulties in this model are labelled as having "special educational needs", a "handicap", "disability", "defect" or "deficiency", and must therefore receive special treatment characterized by further concepts like "remedial", "diagnostic", "cases", "prognosis", "prescriptive", "segregation" and "exclusion" (du Toit, 1996: 6; Green & Engelbrecht, 2007; Swart & Pettipher, 2006: 5). This labelling has often led to the placement of such learners in 'special' institutions under 'specialist' teachers.

In seeing disability as a problem, the assumption made by the medical model is that society and the world are composed of 'normal' and 'functional' individuals and anyone who does not satisfy this category is pathological (Skrtic, 1995). The model reflects a view that disabled people need to be adapted to fit into the world as it is. If that is not possible, they should be located in specialized institutions or isolated at home, where their basic needs are supposed to be met. The emphasis is on the dependence of the person, backed up by stereotypes of disability that arouse pity, fear, and patronizing attitudes. The focus is on impairment, and the specific needs relating to that impairment. As a result of this attitude, many disabled people internalize negative views of themselves and develop feelings of low self-esteem and underachievement, which reinforce non-disabled people's assessment of their worth (Donald et al., 2010). The medical model, plus the built environment and social attitudes it creates, leads to a cycle of dependency and exclusion which is difficult to break. (www.fvkasa.org/resources/files/history-model.pdf-).

The medical model is based on the positivist and functionalist view of social reality which presupposes that social reality is objective, inherently orderly and rational, and that social human problems are pathological (Skrtic, 1995). It is as a consequence of the assumption of human pathology that children with disability (including learning difficulties) are seen as 'defective' and in need of special treatment or special education. Any assessment of learning difficulties and intervention that is framed by the medical model tends to focus on the individual learner. Intervention also tends to be done by a specialist in isolation, rather than in collaboration with the educators (Johnson & Green, 2007). Archer and Green (1996) note that when considering any form of classification one needs to ask two essential questions, namely:

How useful are the categories?; and Whose interests do the classification or categories serve? In the medical model resources are misdirected towards an almost exclusively medical focus when they could be better used in societal practices that promoted inclusion. In this view, adaptation of the disabled person's environment might be both more beneficial to society at large and financially cheaper.

The above critique of the medical model highlights the negative tendencies of the model. The medical model, however, is not entirely without merit and does have its advantages and usefulness. For example, it has been found to be useful in helping children with specific physiological/psychological needs or illnesses requiring specialized treatment, as it addresses these needs in a focused way (Johnson & Green, 2007; Swart & Pettipher, 2005). For this reason, despite the current paradigm shift in education today, "the medical model is still frequently used as an explanatory framework" (Swart & Pettipher, 2005: 5).

2.2.2 Social Model of disability

The social model locates learning difficulties in the environment in which the person or learner operates and develops (Department of Education, 1997b; Donald et al., 2010; Green & Engelbrecht, 2007). It proposes that systemic barriers, negative attitudes, and exclusion by society (purposely or inadvertently) are the ultimate factors defining who is disabled and who is not, in a particular society. The social model has been developed by disabled people, who view disability as caused by the barriers that exist within society and the way that society is organized, characterized by discrimination against people with impairments and excluding them from involvement and participation. A fundamental aspect of the social model concerns equality and often focuses on the changes required in society or the environment to bring about this equality. It holds the view that all people have the right to participate actively in society. As such, the social model adopts the affirmative standpoint of advocating the right of all disabled adults and children to be treated as valued members of their community.

In relation to the paradigm shifts of the early 1970s and 1980s, the shift to *inclusion* led to a radical move from a medical deficit or within-child model to an approach in education based on changing social systems (Nel et al., 2011; Swart & Pettipher, 2006). There is still confusion and disagreement as to the meaning of the concept of inclusion (Green & Engelbrecht, 2007). However, for the purpose of this study, inclusive education may be defined as one that acknowledges diversity and seeks to address the learning needs of all learners, irrespective of the individual challenges or barriers that they face (Department of Education, 1997b; Green & Engelbrecht, 2007; Oswald, 2007; Stofile & Green, 2007). Thus the social model of disability shifts the focus from the medical model to social intervention. It operates from the premise that barriers arise from interaction between people, and, in the educational setting, between learners and their school environments (Green & Engelbrecht, 2007; Nel et al., 2011). The social environment, which can have a direct influence on the progress of learners, is broadly defined to include, among other factors, policies, culture, infrastructure, and socio-economic status (Nel et al., 2011).

The social model emerged out of criticism of the medical model and led to more social and ecological theoretical models. This paradigm shift involved a refocusing away from adapting people who are perceived to be maladjusted and expected to 'fit' into the environment or society, towards an adaptation of the environment so that it can meet the needs of all people. The social model looks towards the removal of stumbling blocks within society to facilitate the participation of all people in the everyday life of society (Florian, Rose & Tilstone, 1998; Swart & Pettipher, 2006). This approach involves changing from attitudes, regulations and institutions that create and maintain exclusion to those which promote inclusion and creation of equal opportunities for all learners to participate in societal life (Green & Engelbrecht, 2007).

By examining the social, cultural and environmental factors which contributed to the learning difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science, this study is advocating the movement towards the social model approach to understanding the difficulties experienced. In relation to learning difficulties, the social model sees the structures within society as the problem. For example, if a learner fails to perform in Natural Science, the problem does not necessarily lie with the learner, but could lie in the social context in which the learning takes place.

The disability movement believes that the "cure" to the problem of disability lies in changing society. Thus in the example above, one needs to look at the learner and at the factors within the social environment that influence the learning process, resulting in the learner's poor performance.

Associated with the social model is the concept of "normalization". This may be explained as making available to all people conditions of everyday living which are as close as possible to the regular circumstances and ways of life of society (Du Toit, 1996: 7; Swart & Pettipher, 2006: 6). This means the right to "normal" daily routine, school and home circumstances, respect from others, and to economic and environmental standards. If the environment were made more favourable, people would be "normal" and participate actively in society as is their right. The social model implies that attempts to change, "fix", or "cure" an individual, especially against the wishes of the person concerned, are discriminatory and prejudicial. For this model, equal access for a person with an impairment or disability is a human rights issue (Prinsloo, 2001).

2.2.3 Ecosystemic Model

The ecosystemic model, which reflects a social perspective but also includes aspects of the medical model, locates the learning difficulties experienced by a learner in the interaction between the child and the (ecological) environment in which the learner operates (Bronfenbrenner, 1979; Donald et al., 2010; Johnson & Green, 2007).

According to Swart and Pettipher (2006), one of the major challenges facing the education system is understanding the web of interrelationships, interactions, and socio-cultural influences that occur between the individual learner and the multiple other systems that are connected to the learner. The ecosystems model postulates that there are layers or levels of interacting systems, which result in change, growth, and development and that what happens in one system affects, and is, in turn, affected by other systems (Bronfenbrenner, 1979; Swart & Pettipher, 2006: 10). These interacting systems also influence the extent to which the learner can benefit from instruction and make academic progress (Johnson & Green, 2007). For example, a learner who is affected by poverty at home may go to school hungry and may not be able to concentrate in class. If this situation continues unabated or without being addressed, it could lead to poor academic performance by the learner, which in turn could result in tension between the learner and the educators/school. The educators might make an effort to communicate with the learner's unemployed parents, but for various reasons, they may not respond. This lack of response from the parents may lead to strained relations and further poor communication between the school and the home, which could further impact negatively on the learner. The learner might ultimately become more despondent, act out by engaging in inappropriate behaviour or misconduct at school, and finally drop-out from school. The school drop-out (learner) might, in the end, become a very disgruntled and maladjusted member of society.

Bronfenbrenner's multidimensional model of human development likens the *ecological environment* to a set of nested structures, each inside the next, like a set of layers of concentric rings (Bronfenbrenner, 1979: 3; Donald et al., 2010; Swart & Pettipher, 2006). At the innermost level is the immediate setting containing the developing individual or learner. In the educational setting, this could be the home or the classroom. The next level looks beyond single settings to the relations between the settings. Interconnections between the settings can be as decisive for development as the events taking place within a given setting (Bronfenbrenner, 1979). For example, a child's ability to learn to read in the primary grades may depend as much on how he/she is taught, as on the existence and nature of relationships between the school and the home. The third level refers to events occurring in settings in which the person concerned is not even present, but which profoundly affect his/her development (Bronfenbrenner, 1979). For example, the advent of democracy which occurred in South Africa in 1994 has changed the course of education provision for many future generations of learners in this country. Learning is thus a product of the relations and interactions between the learner and the various layers of the ecosystem in which he/she is embedded.

This study focuses and comments on the nature and quality of these levels as they relate to the Grade 6 isiXhosa-speaking learner, and more specifically how these dynamics impede his/her learning of Natural Science through English as medium of instruction (LOLT). Figure 2.1, below, presents a summary of this model.

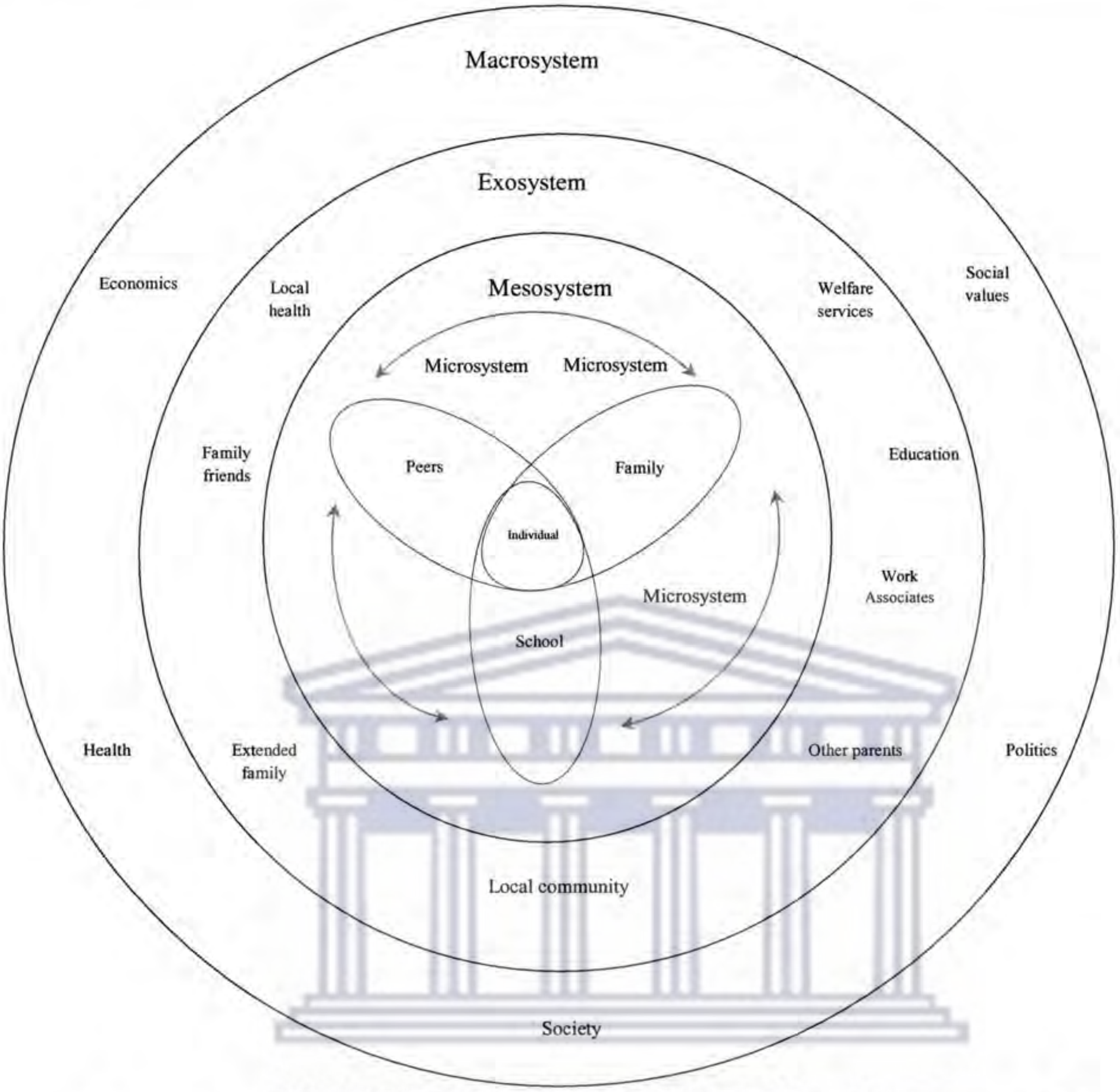

Figure 2.1: Representation of the ecosystemic model with child/learner at the centre (adopted from Swart &Pettipher, 2005: 11)

At the centre of the innermost circle is the child, with his/her personality attributes, which can facilitate or constrain effective learning. The first layer or circle would be the home environment. The learner brings with him/her much of the home influences and experiences. These experiences partially determine the nature of the learner's participation in the classroom. At the next level is the broader school environment. This includes the ethos (norms and values) of the school, the school culture (the way things are done at the school), school policies, diversity, what happens during play/breaks, sports and other curricula and extra-curricula activities (the broad school curriculum).

At the next level is the community in which the school is embedded, including attitudes towards the school which determine the school-community relationship. Beyond this point is the South African context which, in turn is an integral part of the African continent and the world.

All these 'layers' of environment or social contexts have a direct or indirect impact on the learner and the learning process (Bronfenbrenner, 1979; Donald et al., 2010; Johnson & Green, 2007 Swart & Pettipher, 2006: 10). In essence, the ecosystemic theory sees different levels and groupings of social context as 'systems' where the functioning of the whole is dependent on the interaction between all the parts (Donald et al., 2010).

In this study, both the home and the school are viewed as part of a broader social context. Barriers to learning and development, in the context of this model, are viewed as the result of a break down or dislocation in the system of relations between the learner and any one or more of the layers or levels.

The ecosystemic model is a useful way of understanding the complex influences and interactions apparent in education, schools and classrooms (Engelbrecht & Green, 2001; Swart & Pettipher, 2006). In the field of inclusive education, for example, Bronfenbrenner's ecological model has relevance in emphasizing the interaction between the learner's development and the systems within his/her social context. Thus the general challenges of development are inseparable from the more specific challenges of addressing social issues and barriers to learning. This model is seen as providing a useful framework for understanding classrooms, schools and families (Swart & Pettipher, 2006: 10).

The ecosystems model was considered to be appropriate for this research for the following reasons. In this study, the nature of the school and classroom environment was examined during Natural Science lessons. In particular, it was concerned with whether the learning environment was conducive to learning, or if it was an exclusive environment that hindered such learning. The study used the ecosystems model, as it was focused on finding out what factors within the school and home environments impacted on/influenced (positively or negatively) the learning of Natural Science. It recognized that there was an interplay of factors, some within the individual (e.g. intelligence, physical condition, motivation of the learner, etc.) and others in the broad environment (e.g. home conditions such as poverty, status of the parents, nature of a community such as an informal settlement, conditions at school, including the quality of relationships with teachers and other learners), all of which contributed to the success or failure of learning and development (Bronfenbrenner, 1979;

Donald et al., 2010; Green & Engelbrecht, 2007; Johnson & Green, 2007; Stofile, 2008). Because the ecosystems model encompasses both the individual and the environment in its approach to human development, it was considered to be best suited for the purpose of the study.

2.3 FACTORS THAT ACT AS BARRIERS TO LEARNING AND DEVELOPMENT

The National Commission on Special Needs in Education and Training (NCSNET) and the National Committee on Education Support Services (NCESS) Report (Department of Education, 1997b: v) defines barriers to learning and development as, "those factors which lead to the inability of the system to accommodate diversity, which lead to learning breakdown or which prevent learners from accessing educational provision …" Although the author of the report does not offer a compact definition of barriers to learning, Prinsloo (2005: 27) describes the concept as both "an obstacle or circumstance" that "prevents communication and bars access to advancement", and as "changing social issues that impact on successful learning and teaching". Both these definitions relate to factors that frustrate or 'block' the learner from effectively accessing or achieving learning, and both see the 'obstacle' as primarily outside of the learner.

Hughes (2010) argues that views about 'barriers to learning' create the impression that these barriers exist in the child. "It implies that it is the child who holds the barriers to learning within themselves, which a trained educational professional can help to break down" (Hughes, 2010: 8). This author proposes an expanded definition which also takes into account other barriers that are created in the minds and structures of our society. For example, in some instances the manner in which research evidence is gathered to give hard data about the performance of different social and economic groups lends itself to the stereotyping and stigmatizing of children who fit into specific groups, and these kinds of barriers are much harder to identify as they are deeply embedded in our society and in our minds. The author also notes that barriers to learning for some children may be the direct result of the institution of school itself and its place in our society. For example, the very early introduction to formal schooling places undue pressure on very young children, who should otherwise be still in kindergarten. In kindergarten, the focus is on a much more holistic, play-related curriculum, thus minimizing the barriers by acknowledging that some children may not be ready for direct teaching.

The NCSNET and the NCESS Report (Department of Education, 1997b) is regarded as a useful framework for understanding the factors that contribute to learning difficulties.The report cites eleven key barriers to learning and development, which are congruent with an ecosystems approach. Since 1997, other writers have identified more specific factors that contribute to learning difficulties, but these fall within the broad categories identified by the NCSNET/NCESS Report. For example, Prinsloo (2005: 28-29) includes "unplanned urbanisation and unemployment" as well as "moral confusion and an uncertainty about values" among such factors. The following categories of barriers to learning, drawn from the NCSNET/NCESS Report, are discussed briefly below: socio-economic factors; inflexibility in the curriculum; inadequate provision of support services to schools; lack of recognition of parents' role in the teaching and learning process; and disabilities and learning difficulties that require specific support.

2.3.1 Socio-economic factors

There are factors and conditions within the social system that make it difficult, or prevent the learner from accessing educational resources in order to learn effectively. Such factors or conditions include unemployment, poverty, the scarcity or non-availability of services or resources such as (appropriate) learning centres, poor infrastructure such as inadequate roads or buildings, lack of clean water and proper sanitation, and lack of transport services as a result of rapid and unplanned urbanization (Department of Education, 1997b; Prinsloo, 2005). These factors are closely aligned with the poverty of the community. Poverty, which is linked to unemployment and other economic inequalities, often leads to the inability of families to meet the basic needs of the learner. Poor nutrition (which is associated with poverty) in the child's early years of development may cause learning impairment (Dednam, 2005; Department of Education, 1997b). Learners living in conditions of poverty are also subject to emotional stress, which adversely affects learning and development. Furthermore, poverty is associated with under-nourishment which leads to lack of concentration and the inability of the learner to engage effectively with the curriculum or the learning process (Stofile, 2008; Stofile, Linden & Maarman, 2011). This often results in poor academic performance, low self-esteem, lack of self-confidence, and, eventually, to dropping-out of school. Disabled people and their families are the worst affected by poverty, as they are often the last to be considered for employment and other similar social benefits.

The inability of learners to access basic services such as schools, libraries, and clinics, that could contribute to their learning and development remains one of the most significant barriers (Prinsloo, 2001). The rural/urban divide also has some effect, in that in rural areas there are often long distances between the homes of learners and the centres of learning, less transport facilities and worse living conditions than in urban areas. The *Report of the Ministerial Committee on Rural Education* highlighted the specific challenges faced by rural schools (Department of Education, 2007b). However, even in the urban areas, people living in informal settlements or squatter camps are faced with impoverished conditions similar to those found in the rural areas. These conditions have a bearing, direct or indirect, on the quality of learning and learner development. For example, learners who have to travel long distances to school are prone to late-coming, tiredness on arrival, and lack of concentration. Parental communication and participation in school activities are also difficult because of the distances involved (Stofile, 2008).

Other social factors can impact negatively on the learner's social and emotional well-being, thus placing the learner at risk of learning breakdown. For example, the learner may have been subjected to robbery on his/her way to or from school, or been the victim of sexual abuse; there may have been a death in the family; or there may have been violent unrest or catastrophe in the community in which the learner lives. These conditions may force the learner to miss school and eventually to drop out. Factors such as substance abuse may also affect the learner or his/her family and lead to increased stress or family breakdown. In countries affected by civil war and other forms of violence, the learners experience not only a disruption of the learning environment but also trauma and emotional distress. Similarly, high levels of family mobility resulting from processes such as urbanization, the establishment of informal settlements, and eviction of farm workers lead to the disruption of the learning process, and, ultimately, to learning breakdown.

The safety of the learning and teaching environment may sometimes be adversely affected by high levels of violence and crime, such as gangsterism, in the neighbourhood (Lazarus, Johnson & Khan, 2012). This may compromise the safety of both learners and educators, such that effective learning and teaching may be disrupted. In this way, lack of safety in the learning environment becomes a barrier to learning and teaching (Prinsloo, 2005).

One of the main barriers to learning and development in society arises from negative and harmful attitudes towards people who are perceived to be different (Donald et al, 2010).

Discriminatory attitudes resulting from prejudice against other people, whether based on race, class, culture, ability, disability, religion, gender, sexual preference or other characteristics, are often extended and directed to learners in the education system (as was the case, for example, during the apartheid era), manifesting themselves as barriers to learning and development. In most cases, negative attitudes towards learners who are different reveal themselves in the labelling of such learners as 'slow learners', 'repeaters' and 'ineducable'. While this labelling has a negative impact on the learner's self-esteem, it has more serious consequences when it is linked to placement or exclusion. When such placement occurs as a result of the attachment of a label, rather than assessment of the learner's educational needs or what is required of the system to meet those needs, it is not only inappropriate but may also lead to the learner being marginalized.

Sometimes negative attitudes result from fear and lack of knowledge or awareness about a condition (for example, HIV and AIDS) or the particular needs of the learners or the potential barriers they may face. There have been instances where children with HIV and AIDS have been excluded from attending school with other children because of negative assumptions and misconceptions associated with the disease. Because of poor knowledge of the disease and its transmission, often from parents, these children are seen as placing others at risk of infection.

2.3.2 Inflexibility in the curriculum

Some of the most serious barriers to learning relate to the inflexible nature of the curriculum, which prevents it from meeting the diverse needs of the learners (Department of Education, 1997b). When learners are unable to access the curriculum, learning breakdown occurs. Key components of the curriculum, which are critical in either facilitating or undermining effective learning, include the style and pace of teaching and learning, what is taught, the way in which the classroom is organized and managed, as well as the materials and equipment used in the teaching and learning process (Department of Education, 1997b).

Sometimes the educators, due to inadequate training, use teaching styles which may not meet the needs of some of the learners. An educator may teach at a pace which only accommodates learners who learn very quickly. Conversely, the educator's style and pace may limit the initiative and involvement of learners with high levels of ability by not accommodating their need for extra stimulation (Johnson, 1998; Taylor & Vinjevold, 1999). Sometimes, learners are excluded from certain aspects of the curriculum as a result of ignorance and prejudice. For example, disabled learners may be prevented from playing sport, or denied the opportunity to do so. Similarly, male and female learners are pressurized to take certain subjects at school according to their gender in preparation for stereotypical male or female jobs.

Inadequate provision of materials or equipment which learners may need, such as appropriate textbooks, science laboratories, computers and library, Braille facilities and other equipment for disabled learners, constitutes one of the most serious ways in which learners are prevented from accessing the curriculum.

Teaching and learning through only one language may restrict access to the curriculum and limit participation by learners who do not speak the dominant language (Prinsloo, 2005). The resultant failure to master and succeed in the learning activities may result in low self-esteem and less motivation for further participation (Uys, 2005). Thus language and communication becomes a barrier to learning and development. This barrier is discussed in more detail in section 2.4 below.

2.3.3 Inadequate provision of support services to schools

Due to lack of funds, schools are not always provided with the resources they require to render effective support to learning and teaching (Department of Education, 1998; Sayed & Soudien, 2010). This includes textbooks and other resource documents. Furthermore, schools often struggle to raise funds either for building or to buy equipment for science and technological laboratories, computer centres, or equipment to support disabled learners.

Basic support services which may help learners and the system to minimize and/or remove barriers or prevent them from arising, are often lacking or limited in poor communities. Schools in rural areas are the worst affected (Dednam, 2005). This situation is exacerbated by fragmented and unsustainable human resource development strategies (Adelman & Taylor, 2006; Nel et al., 2011; Oswald, 2007). The absence of ongoing in-service training of educators often leads to insecurity, uncertainty, low self-esteem and lack of innovative practices in the classroom (Mant, Wilson and Coates, 2007; Oswald, 2007; Stofile & Green, 2007; Swart & Pettipher, 2007). In turn, this may lead to resistance to those learners who experience learning breakdown or to particular enabling mechanisms such as inclusion and cultural diversity (Nel et al., 2011). In the field of 'special educational needs', the present need in South Africa is not only to train new special needs educators, but also to upgrade the training of the existing, inadequately-trained educators, particularly those in mainstream education (du Toit, 1996; Nel et al., 2011; Oswald, 2007; Stofile & Green, 2007).

"A holistic and integrated approach" to the provision of educational support services is suggested (du Toit, 1996: 16). However, at school level, the strategy of using general teachers with basic skills to identify or recognize problems and infuse intervention strategies into classroom practice is often frustrated by both the large classes and the number of administrative tasks associated with and required by the curriculum. At district level, medium-skilled educators can be based at community centres and work on an itinerant basis to support teachers, but this has resulted in the withdrawal of skilled teachers from the very schools which need them, to serve at the district centres. This leaves the learners further disadvantaged. Furthermore, support for science teachers is lacking in the rural areas (Gray, 1993). This may be due to the scarcity of science teachers in general at our schools and the lack of incentive for teachers to teach in rural areas (Department of Education, 1997b). The difficulty of convening workshops due to the long distances between (rural/farm) schools is also a contributing factor (Stofile, 2008).

The Ministry of Education notes that the key to reducing barriers to learning and development in all education and training lies in a strengthened support service (Johnson & Green, 2007; Department of Education, 2001). This could be achieved through intervention at the district level (comprising staff from provincial district, regional and head offices, as well as special schools) and the institutional level (comprised of educators and strengthened by expertise from the local community, district support teams, and higher education institutions) (Johnson & Green, 2007).

2.3.4 Lack of recognition of parents' role in teaching and learning process

Active parent and community involvement in the teaching and learning process of the school is central to effective learning and development (Department of Education, 1997b; McKenzie & Loebenstein, 2007; Nomlomo, 2009; Stofile et al., 2011). For this to happen, parents must be recognized as the primary care givers of their children and, as such, are key role players and an essential resource to the education system. Motivated and active parents often give vibrancy to the life of the school, particularly around fund-raising, effective school governance, and promoting community ownership of the school. Where parents are not recognized and empowered as primary caregivers or where their participation is not facilitated and encouraged, effective learning and teaching are threatened or hindered and learning breakdown occurs (Department of Education, 1997b; Prinsloo, 2005).

There is some controversy over the participation of parents in schools (Department of Education, 1997b; McKenzie & Loebenstein, 2007; Stofile et al., 2011). Parents sometimes feel that the school does not recognize them as having a role to play, while educators, on the other hand often complain that parents are unresponsive to their calls for them to become involved (McKenzie & Loebenstein, 2007). It has also been found that, although some parents try very hard to be involved in school activities, they face enormous challenges, most of which are related to poverty (McKenzie & Loebenstein, 2007; Stofile et al., 2011). This is an issue which needs to be thoroughly researched and addressed, particularly regarding the nature of parental involvement in schools.

2.3.5 Disabilities and learning difficulties that require specific support

Inclusion means that all learners, including disabled learners, must have access to quality education (Department of Education, 1997b; Oswald, 20007). In practice, however, this is not a reality for many, due to the lack of the necessary equipment and training of educators to lend effective support in meeting the diverse needs of all learners.

Disabled learners are often unable to perform or behave in expected ways due to some (physical/neurological/emotional) condition which may act as a barrier to their learning and development (Botha, 2005). For example, a learner who experiences cognitive or intellectual dysfunction or impairment will not easily be able to cope with solving science or maths problems and so will need more specialized support. Many learners with disabilities are placed in mainstream classes, but the educators are left to fend for themselves in supporting these learners. This places both the educators and learners at a disadvantage. Inclusive education should therefore be implemented with care and responsibility, and not for the sake of convenience, in the form of mainstream dumping (Dednam, 2005).

Certain disabilities, such as Autistic Spectrum Disorders (ASD) and those resulting from neurological damage or dysfunction (such as epilepsy, cerebral palsy, learning impairment, etc.), also contribute to the prevalence of language and communication as a barrier to learning and development (Botha, 2005; Kapp, 2005; Koudstaal, 2005). Mainstream educators need to be trained to cater for learners with such disabilities if inclusive education is to be realized in our schools.

In order to overcome barriers to learning and development in our schools, the NCSNET/NCESS report (Department of Education, 1997b) argued for the need not merely to identify and analyse challenges, but also to identify those mechanisms already existing in the South African education system, as well as those that need to be developed, which will enable diversity to be accommodated in an integrated system of education. This study hopes to contribute towards the latter goal by identifying some of 'those mechanisms that need to be developed to accommodate diversity in an integrated system of education.'

2.4 LANGUAGE AND COMMUNICATION AS A BARRIER TO LEARNING AND DEVELOPMENT

2.4.1 Introduction

Further barriers arising from the curriculum, are those which result from the language of teaching and learning (LOLT) (Department of Education, 1997b). For many learners, teaching and learning takes place through a language that is not their first language or mother tongue (Prinsloo, 2005). This situation not only puts these learners at a disadvantage, but also leads to linguistic difficulties which contribute to learning breakdown. The situation is exacerbated by cultural differences (which are closely associated with language). Second-language learners are often subjected to low performance expectations and discrimination. Additionally, educators often experience difficulties in developing appropriate support mechanisms for second-language learners.

This study pays particular attention to language and communication as a barrier to learning and development, as will be seen in the paragraphs below. In Chapter 1 it was pointed out that when there is a mismatch between the language of teaching and the language known by the learner, teaching and learning can be adversely affected (Alexander, 1989; Brock-Utne, 2000; Mazrui, 2002; Nomlomo, 2007; Obanya, 1980; October, 2002). Equally, if the teacher is not competent in the LOLT, the teaching and learning process may be hampered. This suggests that for the learner's academic development, including learning, to be optimal, an effort should be made to reconcile the LOLT and the learner's home language.

Lockheed and Verspoor (in Brock-Utne, 2000: 158) note that:

> Children who speak a language other than the language of instruction (which here refers to the European languages) confront a substantial barrier to learning. In the crucial, early grades when children are trying to acquire basic literacy as well as adjust to the demands of the school setting, not speaking the language of instruction can make the difference between succeeding and failing in school, between remaining in school and dropping out.

Marsh (2006) notes that when we look at the overall educational achievement in any country, it is necessary to consider if the medium of instruction acts as a barrier to learning. This is particularly important when fluency in the 'adopted' teaching language is low among the learners, and possibly even among the teachers.

The next section discusses language in the context of barriers to learning and development. It looks at how both the language of learning and teaching (LOLT) and the special language used in science (the 'language of science') can act as barriers to accessing of knowledge by the learners.

2.4.2 Language of learning and teaching (LOLT) as a barrier to learning

As pointed out in Chapter 1, language plays a crucial and central role in learning and teaching. It was also pointed out that while language can serve as a means of effective teaching and learning, it can also be a barrier to learning. Obanya (1980) notes that:

> It has always been felt by African educationists that the African child's major learning problem is linguistic. Instruction is given in a language that is not normally used in his immediate environment, a language which neither the learner nor the teacher understands and uses well enough (Obanya, 1980: 88, cited by Brock-Utne, 2000:141).

Language is associated with cognitive development (Piaget, 1980; Vygotsky, 1962). Home language is the first language through which the learner expresses him/herself and his/her thoughts (Piaget, 1980; Vygotsky in Kozulin, 1986). It is also the means by which the learner's early concepts and thinking are formed (Nomlomo, 2007). Teaching in the home language, therefore, not only makes it easier for the learner to understand what is taught but also provides continuity in his/her life and development. Learning in the home language gives confidence to the learner (Walsh, 1984) and encourages him/her to communicate and participate actively in learning activities.

A good foundation in, and knowledge of one's home language benefits the second language of learning and teaching (LOLT). Linguists agree that the best way to learn a foreign language is through the best possible command of one's own language achieved by using it as a language of instruction up to a high level of schooling (Brock-Utne, 2000: 165). This argument is supported by research done in Nigerian schools, with Yoruba as the medium of instruction (Brock-Utne, 2000). Evaluation studies have repeatedly shown that pupils educated through the medium of Yoruba are more proficient in school subjects, including English, than those educated through the medium of English (ILEA, 1990, cited by Brock-Utne, 2000: 151).

In "Assessing Student Learning Achievement" [in Africa] the UNESCO/UNICEF 1999 MLA (Monitoring Learner Achievement) Project report notes that "Countries where the mother tongue/lingua-franca is the same as the medium of instruction, out-performed others in most learning areas" (UNESCO/UNICEF, 2000: vi). This is further evidence that learners who are taught in their home language perform better than their peers who are taught in a second/third/foreign language.

Teaching a learner in a second/foreign language, on the other hand, makes understanding more difficult, as the learner cannot make connections with previous experiences in his/her development. Paulo Freire (in Brock-Utne, 2000: 151) described the practice of imposing a foreign language upon a learner when studying another subject as "a violation of the structure of thinking." A learner's thoughts are expressed in a language, and the mother tongue is often the language in which one best expresses him-/herself. If a learner is restricted to expressing him-/herself in a second or third or foreign language, that self-expression becomes limited, and, the language therefore serves as a barrier to effective communication and learning.

A research study by Yip and Tsang (2006) highlighted that self-concept plays a major part in building self-confidence, which is essential for positive behaviour and higher academic performance and achievement. A learner who has a positive self-concept is more likely to perform better than one who has a negative self-concept, as revealed by Yip and Tsang's study, which shows a positive correlation between self-concept and academic performance. Language, therefore, can either build self-confidence and facilitate learning, or can lead to lack of self-confidence and be a barrier to learning.

There seems, therefore, to be no argument against the use of a home language to teach learners to the highest level possible. However, for economic and political reasons, as well as expediency, governments fail to implement the call to home language instruction and children continue to be taught in a second/third/foreign language (Brock-Utne, 2000; Nomlomo, 2007). Rather than being merely critical though, it is important to find ways in which learners and educators who are caught up in this situation can best be supported. Hence the decision to embark on this research study, as motivated and explained in Chapter 1 above.

2.4.3 Language of Science as a barrier to learning

The argument for the importance of language in science education is premised on three basic assumptions, namely that:

- Learning the language of science is a major part of science education. Every science lesson is a language lesson.
- Language is a major barrier (if not *the* major barrier) to most pupils in learning science.
- There are many practical strategies which can help to overcome these barriers (Wellington & Osborne, 2001).

Language, which is an essential instrument for conveying science knowledge and scientific processes, can become the very barrier to learners' understanding of science (Ogunniyi, 1986). Wellington and Osborne (2001:5) point out that learning science presents more difficulties in that,

> ... many of the hard, conceptual words of science – such as energy, work, power – have a precise meaning in science and sometimes an exact definition, but a different meaning in every-day life ... This is made worse because many of the terms of science are metaphors: for example, a field in science is not really a field.

Learners for whom English is not a home language are more likely to take a literal meaning of such scientific terms as 'energy', 'work' and 'power'. Similarly, such learners are likely to miss the metaphoric meaning of the 'field' concept and construe it to mean a field as in a 'soccer or rugby field'.

Research has shown that learners taught science through their home language perform better than those taught through a second/third/foreign (English) language (Nomlomo, 2007; Bamgbose, 1984, cited in Brock-Utne, 2000). Arguments in favour of the simplification of science language in the classroom have been presented by some writers (e.g. Ogunniyi, 2005; Villanueva, 2010). However, while sympathizing with this approach to the teaching of science, Wellington and Osborne (2001:6) point out that:

> … learning to use the language of science is fundamental to learning science. As Vygotsky (1962) pointed out, when a child uses words he or she is helped to develop concepts. Language development and conceptual development are inextricably linked. Thought requires language, language requires thought. Viewed from a negative angle, 'difficulty with language causes difficulty with reasoning'...

Wellington and Osborne (2001) emphasize that we can only learn and teach a new language by providing opportunities to practice its use. In identifying the difficulty of using 'the language of science', they focus on the meanings of the words used in science education (semantics), rather than on the way they are put together and structured (syntax), as well as the problems posed by logical connectives such as *and*, *or, but*, and *although*.

Villlanueva (2010: 37) notes that there is an imbalance between "science orientation and orientation on the students' needs, interests, ideas and learning processes", and argues for the scaffolding of scientific understanding through (functional) scientific literacy in the classrooms. The concept of scientific literacy is more fully discussed in Chapter 3, which deals with the theoretical framework of this study.

In a research study on the possible effect of English-Medium Instruction (EMI) and Chinese-Medium Instruction (CMI) on students' self-concept in science, as measured by the students' responses to a questionnaire (Yip & Tsang, 2006), it was found that, compared to their CMI peers, the EMI students showed a higher self-concept in Chinese, English and Mathematics, but a lower self-concept in science. This finding suggests that the EMI students might have experienced greater learning problems in science than in other subjects, probably because science learning involves abstract thinking and the mastery of scientific terminology which make a higher demand on language proficiency. The study by Yip and Tsang (2006) thus touches on the issue of the language of science. It highlights the difficulties or barriers presented by the language of science to the learning of the subject.

Researchers in science education have found that writing and discussion help learners to generate verbal representations of their thinking and construction of scientific understanding (Ha & Song, 2009), particularly those learners who write their own explanations in learning science. This highlights the fact that the composition of scientific explanation is an important factor in facilitating learners' conceptual understanding of science (Keys, in Ha & Song, 2009). For learners to be able to give their own explanations of scientific phenomena (and thus develop science concepts) they need to possess the language (words) to do so. In other words, if they are lacking in language, their understanding of scientific concepts will suffer.

2.5 SUMMARY AND CONCLUSION

This chapter commenced by identifying and describing the three conceptual approaches or models for discussing or investigating learning difficulties, namely the medical model, the social model, and the ecosystems model. The defining characteristics, assumptions and criticisms levelled at each of these models were highlighted. This was followed by a discussion of the range of key barriers to learning and development, as identified by the NCSNET/NCESS (Department of Education, 1997b) and in other literature. The effects of the various barriers to learning were contextualized, with reference being made to the prominent writers in the field.

As language and communication is the key area of focus in this study, this aspect was then discussed more extensively, citing the latest available research to highlight how language can act as a barrier to learning and development.

The next chapter will discuss the theoretical framework underpinning the study.

CHAPTER 3

PERSPECTIVES ON LANGUAGE AND SCIENCE LEARNING

3.1 INTRODUCTION

This chapter establishes and discusses the theoretical framework that underpins the study. More specifically, it examines the impact of the LOLT on science learning. It also explores science learning within the constructivist framework in order to gain a better insight into how learners make meaning of science phenomena and how they construct science knowledge.

As a point of departure, the constructivist paradigm, which underpins this study, is discussed, with specific reference to how scientific knowledge is constructed. Secondly, the chapter looks broadly at learning in the context of globalization, focusing on current debates as well as current trends and practices, in order to gain an international, cross-national and cross-cultural perspective on the subject. As South Africa strives towards socio-economic development and international or global competitiveness, this country, like every other country in the modern world, has been susceptible to the influences and impact of globalization (Holmarsdottir, 2009; Napier, 2011; Schaffer, 2010). South Africa has, for example, taken part in international comparisons of student achievements in English, Mathematics and Science, which are taken as indicators of educational effectiveness and priorities linked to economic development (Martin, Mullis, Gonzalez & Chrostowski, 2004; Mullis, Martin, Kennedy & Foy, 2007; Napier, 2011; Van Staden & Howie, 2008). Because these global influences have permeated the very fabric of our modern society, including education, this study finds it critical to examine and discuss globalization as one of the primary factors that impact on our education system in general and on science education in particular.

Thirdly, the chapter focuses on science education and the role played by language in developing learners' science literacy skills. As a next step, the theories of learning relevant to the study are discussed in relation to the learners' scientific knowledge construction, that is, how they make meaning of science in their learning. Finally, the theoretical and conceptual framework of the thesis is presented, explaining how the key concepts of the study link with one another, as well as how the theories relevant to the study are linked. The theoretical and conceptual framework seeks to depict and explain the processes and difficulties encountered in learning science by second-language learners (including isiXhosa-speaking learners) in the context of the ex-Model C (English-medium) classroom.

3.2 THE CONSTRUCTIVIST PARADIGM

This study follows a *constructivist* theoretical frame or paradigm. Constructivism is the theoretical perspective which holds or propounds the idea that knowledge is not passively received but is actively and continuously constructed and reconstructed by the individual learner, group or society (Anderson & Krathwohl, 2001; Donald et al., 2010; Schunk, 2008). People can invent, record, accumulate, and pass on organized bodies of knowledge that help them understand, shape, exploit, and ornament their environment (Donovan & Bransford, 2005). The constructivist view stands in opposition to the positivist theory, which views knowledge as having an objective existence, only needing to be discovered and proved. Some constructivists have argued that "knowledge is situated in the activity of the learner and is a product of that activity and the context and culture in which it occurs" (Tobias & Duffy, 2009: 3). Vygotsky's emphasis on the role of social mediation of knowledge construction is central in much of the constructivist view of learning (Schunk, 2008; Vygotsky, 1962).

One of the central concepts in constructivist thinking is *active agency* (Anderson & Krathwohl, 2001; Bruner, 1964; Bruner et al., 1966; Donald et al., 2010). In essence, this means that people actively and continuously construct their view of the world, on the basis of their prior knowledge and experience, instead of regurgitating some pre-packaged information, based on someone else's version of the correct answers (Donald et al., 2010; Pedriana, 2010). Piaget and Vygotsky have helped to clarify the idea of active agency operating in the acquisition of knowledge (Donald et al., 2010). While Piaget adopted an individualistic view of the child's learning, Vygotsky adopted a socio-cultural view of the same learning (Hong et al., 2000). In other words, Piaget perceived the child as actively adapting to his/her environment 'from the inside out', while Vygotsky saw the child as active, but mediated (by society or culture) 'from the outside in' (Donald et al., 2010: 81). Brunner, on the other hand, saw the child as an active explorer and strategist, but also saw the child's social context and the mediation that he/she experienced as shaping the form and effectiveness of his/her cognitive strategies, a process that is directed both from 'the inside out and the outside in' (Donald et al., 2010: 81). In essence, the above theories on how the child learns point to the importance of both the mediation and the constructivist/interpretivist elements in the learning process. This is, perhaps, where drawing from the learners' indigenous knowledge system becomes most relevant and pertinent in the teaching and learning process. As the learner from a traditional background encounters western (school) science, he/she interacts with it via his/her indigenous knowledge (IKS) lenses through the process of 'Border Crossing' (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunniyi, 2002). The Border Crossing process, would then involve both the 'outside in' (accessing the new/scientific knowledge) and the 'inside out' (interpreting and constructing through Border Crossing/Contiguity-/Collateral Learning), resulting in the learner's own knowledge construction. It is assumed in this study that the Border Crossing process may be involved in the learning of science by many Grade 6 isiXhosa-speaking learners. Indigenous knowledge (IKS) and the Border Crossing hypotheses are discussed in more detail in paragraphs 3.3 and 3.4 below.

In the course of their development, children gradually acquire tools of cognition for representing the world (Donald et al., 2010). Symbolic representation, especially language, is a tool that 'shapes, augments and even takes over the child's earlier modes of processing information' (Donald et al., 2010: 83). Constructivism is, therefore, a very important perspective which applies to all aspects of teaching and learning and is central to the outcomes-based approach to education (Donald et al., 2010), particularly in the South African multicultural and multilingual context. In so far as the South African curriculum is intended to be learner-based and learner-paced, it provides fertile ground and an opportunity for learners to engage in the learning process, express themselves, and thus construct their own understanding of scientific knowledge (Department of Education, 2002).

The constructivist approach, however, has its own shortcomings. Its critics point to the inability of its proponents to come up with theory-based, testable instructional principles or specific guidance (Schunk, 2008; Tobias & Duffy, 2009). For this reason, constructivism is considered to be more of a "philosophical" framework or explanation about the nature of learning, than a theory that enables one either to precisely describe instruction or prescribe instructional design strategies (Schunk, 2008: 236; Tobias & Duffy, 2009: 4). However, despite this apparent shortcoming, I have found it the most suitable model for this study, as will be explained in the following paragraph.

3.2.1 Relevance of the constructivist paradigm to the study

Despite the above criticism levelled against the constructivist perspective, this study uses the constructivist approach because it focuses on how learners perceive and experience difficulties in learning science. Such difficulties are experienced in the process of learning science, that is, when the learner is constructing his/her understanding (making meaning) of science and/or scientific phenomena. In this study, the view is held that, in the case of second or third language learners, the shaping and augmenting of the child's earlier modes of processing information, mentioned above, may be negatively affected or, at best delayed to the extent that the learner has or does not have good or full command of the language used in teaching and learning Natural Science. In the ex-Model C scenario many second- and third-language learners are negatively affected in that up to the end of Grade 3 or 4 the learner develops skills and proficiency in the home language, but has to switch to an unfamiliar (LOLT) language (Langenhoven, 2006; Taylor & Vinjevold, 1999). It seems reasonable to presume that such a learner will not be able to use the new language symbols at the same level as his/her English speaking peers, when English is used as LOLT. In the course of development, people find progressively more effective ways of organizing and representing the world. Learning to represent the world internally is a crucial tool which makes it possible for people to think, remember, imagine, solve problems, and perform other cognitive activities. After this, the logical patterns of thinking that a child develops in the concrete and formal operational stages become key tools (Donald et al., 2010). This study, therefore, seeks to find out what impedes a learner's construction of scientific knowledge. Because it does not just speculate about the learner and the learning process, but takes the learner's views and experience of the learning process, the constructivist approach was deemed to be best suited for the purpose of the study.

In this study, an eclectic approach is adopted and applied, within the constructivist framework, to explain the support given to learners in the process of learning science. The approach is eclectic in the sense that it explains how Krashen's Meaningful Input relates to Vygotsky's Zone of Proximal Development (ZPD), Bruner's 'Scaffolding', Cummins' 4 Quadrant Model, Aikenhead's Cultural Border Crossing, and Jegede's Collateral Learning theories, jointly and simultaneously. It explains the mechanism whereby (the educator's) input can be converted into 'meaningful input' in the process of science learning. This eclectic process is graphically represented in Figure 3.2 (paragraph 3.6) below.

3.2.2 How knowledge is constructed

Constructivists view knowledge as the construction of the individual person, based on his/her beliefs and experiences in situations, rather than as having an objective existence or being the absolute truth (Schunk, 2008). In other words, knowledge is subjective and is not imposed from outside the person, but is formed from within. The implication for science learning is that the learner must interpret and reconstruct scientific information according to his or her own understanding. In this process, the learner has to use his/her (contextual or background) cultural experience and language. He/she must use language to explain or communicate this subjective scientific experience. The argument presented in this study is that if the learner lacks the symbolic or psychological tools (Kozulin, 1998), not only to access (e.g. through reading, writing, and mediation) the scientific information but also to communicate his/her subjective experience thereof, he/she may fall short of the task of constructing the required scientific knowledge. Proficient use of the LOLT, taking into consideration the learners' cultural or indigenous backgrounds, is one of the major psychological tools that the learner needs in order to be able to perform the task of effective scientific knowledge construction.

Kozulin (1998: 1) defines psychological tools as:

> ...those symbolic artefacts – signs, symbols, texts, formulae, graphic-symbolic devices – that help individuals master their own "natural" psychological functions of perception, memory, attention, and so on. Psychological tools serve as a bridge between individual acts of cognition and the symbolic sociocultural prerequisites of these acts.

Lack of proficiency in the language of learning and teaching, therefore, implies lack of mastery of the psychological tools of science knowledge construction, as the learner cannot bridge the gap between cognition and the symbolic socio-cultural prerequisites of effective learning.

3.3 SCIENCE LEARNING IN THE CONTEXT OF GLOBALIZATION

As the focus of this study is on the difficulties experienced (by Grade 6 isiXhosa-speaking learners) in learning Natural Science, it has been thought prudent to start off by discussing science learning, bearing in mind that science is often associated with technology. Science learning, however, takes place in both a local and a global context. These contexts have an impact on both what is taught (the content) and the language that is used in science (scientific literacy).

3.3.1 Science learning and teaching

Ogunniyi (1998: 40) defines science as "an attempt to organize our sense data or experience into meaningful systems of description, explanation and prediction." Although there are diverse ways in which science is defined, Ogunniyi points out that there is a general consensus that science attempts to describe, explain and predict natural phenomena in a precise manner. It is argued in this study that when learners are taught through a language that is not their home language (that is, if they are taught through L2/L3), this precise description and explanation of experience may be extremely difficult or even impossible to attain (Cleghorn, 2005; NEPI, 1992a; Nomlomo, 2007; Ogunniyi, 1986; Ogunniyi, 2005). However, when they are taught in their home language, the learners are able to explain scientific ideas in their own words and have a rich understanding of science and technology (Nomlomo, 2007; O-saki, 2005).

Weaver (1948: 8-9) states that the essence of science is to be found in its inner spirit, and notes that "That austere but exciting technique of inquiry known as the scientific method is what is important about science." In other words, science places particular emphasis on the method by which information or scientific knowledge is arrived at. My view is that the emphasis in science learning and teaching should be placed on developing the scientific method and the understanding of science, rather than on content knowledge. Science is essentially about continuing to dig, revise, build, and reconfigure scientific knowledge (Saul, 2004). In relation to the above, the South African Curriculum for the Natural Sciences Learning Area (Grades R-9) enshrines the following values (Learning Outcomes) that learners must be able to achieve, in its Revised National Curriculum Statement (RNCS)[8] (Department of Education, 2002):

(1) Learning Outcome 1: (Conduct) Scientific Investigations

(2) Learning Outcome 2: Constructing Science Knowledge

(3) Learning Outcome 3: (An understanding of the interrelationships between) Science, Society and the Environment (Department of Education, 2002: 6).

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[8] It must be noted that the RNCS is due to be replaced with the Curriculum and Assessement Policy Statements (CAPS). However, the phased introduction of the CAPS is intended to be effective from January 2012 in Grades R-3 and Grade 10, January 2013 in Grades 4-6 and Grade 11, and January 2014 in Grades 7-9 and Grade 12 (Department of Education, 2011). The RNCS was, therefore, still effective in the Intermediate Phase (Grades 4-6) at the time of writing of this thesis.

Language plays an important role in achieving the above Learning Outcomes. Learning Outcome 1: conducting Scientific Investigations, for example, requires that the learners should describe and explain both the processes that they followed in an investigation, as well as their observations and interpretation of the results of that investigation. To do this, the learners need to have good language and communication skills, so as to be able to accurately depict their learning experiences (Baker, 1993; Cummins & Swain, 1986; Nomlomo, 2007). My argument in this thesis is that the appropriate use and understanding of the language of instruction, as well as the language of science, is essential for the development of such *process skills* (Department of Education, 2002; Nomlomo, 2007) as are required of the learners. Those with limited English proficiency (LEP), as is the case with the isiXhosa-speaking learners in this study, are most likely to fall short in developing such essential skills. Science process skills may be defined as "ways of thinking, measuring, and solving problems in science" (Nomlomo, 2007: 123). They can be categorized into *basic skills* (which include observation, classification, communication, measurement, estimation, prediction, and the drawing of inferences) and *integrated skills* (which include the ability to identify and control variables, form hypotheses, perform experiments and interpret data) (Nomlomo, 2007). Basic skills enable learners to broaden their knowledge through experience, while integrated skills facilitate higher-order or abstract thinking in the learners, thus enabling them to conduct scientific investigations in order to discover new knowledge. One of the key questions is, what can be done to assist these learners to develop the necessary proficiency in both the language of learning and teaching (LOLT) and the Language of Science, without compromising their home language and culture (Ogunniyi, 2005; Roy-Cambell, 2001).

Learning Outcome 2, Constructing Science Knowledge, also requires learners to have good language or communication skills in order to access information, interpret or give meaning to it, and construct their own understanding of such information (scientific knowledge). Finally, Learning Outcome 3, understanding the interrelationships between Science, Society and the Environment, presupposes that the learners will possess the (process) skills to interact, observe, interpret, and communicate their understanding of such interrelationships through language. When learners are taught through a second language (L2) in which they are not proficient, it is more likely that they will lack the required understanding to successfully achieve the above learning outcomes (Nomlomo, 2007; October, 2002). Similarly, if the educators are not sufficiently proficient in the language of instruction, they may convey the wrong information to the learners (Nomlomo, 2007).Cummins' model, which explains the dimensions of communicative proficiency and is therefore applicable to the above discussion, is discussed in paragraph 3.5.2 below.

Many studies have shown the importance of the language of instruction to learner achievement in school science (Cleghorn, 2005; Ogunniyi, 1986; Ogunniyi, 2005; Po, 2006; Rollnick, 1998; Sutherland, 2002). When there is a mismatch between the learner's home language or mother tongue and the language of instruction, learning is impaired (Brock-Utne, 2000; Nomlomo, 2007; October, 2002). This situation breeds or leads to underachievement. When the language of instruction is the home language, it becomes an instrument for the cultural and scientific empowerment of the learners, as it allows them to be more creative and innovative (applying both their basic skills and process skills), thus facilitating their scientific knowledge construction (Department of Education, 2002; Prah, 2003; Nomlomo, 2007).

An analysis of the findings of the International Association for the Evaluation of Educational Achievement (IEA's) Trends in International Mathematics and Science Study (TIMSS, 2004) and the Progress in International Reading Literacy Study (PIRLS, 2006) reports on science, mathematics, and reading literacy revealed that South African learners do not meet international standards of performance at the fourth and eighth grade in the fields of Mathematics, Science and (English) Literacy (Martin et al., 2004; Mullis et al., 2007; Taylor & Vinjevold, 1999; van Staden & Howie, 2008; Villanueva, 2010). As the majority of the learner population of South Africa is African, it is reasonable to assume that the language used in these assessments could have been a major factor. As a case in point, Taylor and Vinjevold (1999: 152) note that a study found that "many learners had difficulty in reading and understanding the language and information provided in the TIMSS items and their efforts to engage with the test questions were severely hampered by their low reading levels and inadequate *second language* skills" (my emphasis). The development of programmes such as the Literacy and Numeracy (LIT/NUM) Strategy and the Curriculum and Assessment Policy Statements (CAPS), which is slated to replace the current RNCS, could be seen as South Africa's response to addressing the above learner shortcomings.

Central to the learning of science is the concept of Scientific Literacy (Rollnick, 1998; Jenkins, 1998). Scientific Literacy may be defined as a multifaceted concept which embeds extrinsic and intrinsic values (Rollnick, 1998). It impinges on the interaction of content with both context and the affective dimension. In other words, it is concerned with the interaction of science and society (context), as well as the attitudes of society towards science (affective dimension). In the school context, scientific literacy refers in the first place to how learners perceive, interpret and reconstruct science and scientific phenomena (scientific knowledge). In the second place, it refers to how learners access and treat scientific information – their inquisitive and investigative acumen (i.e. access to scientific and technological knowledge) – and whether they are active or passive recipients of scientific knowledge (Nomlomo, 2007). This has relevance to how learners *construct* their own understanding of scientific knowledge.

A narrower interpretation of scientific literacy is commonly taken to include some knowledge of scientific content, an understanding of scientific methodology, and an attitude towards the scientific endeavour (Jenkins, 1998). The view held in this study is that learners who come from indigenous knowledge backgrounds are presumed to have few or none of these attributes (Quigley, 2009) and will probably lack the 'right attitude' towards science needed to learn the subject effectively. Because of their low literacy level in English, such learners struggle to get good grades in science and need special, culturally sensitive learning support to develop their scientific literacy.

Socio-economic indicators play an important role in the scientific and technological literacy (STL) levels of people or countries. The more favourable the economic status of the person, the higher the STL level (Rollnick, 1998). This is particularly relevant in South Africa because of its apartheid legacy. The White and Black communities economically belong to 'two nations', and the difference in the educational levels of the race groups, as well as the quality of the education they receive, contributes enormously towards the differences in the STL scores (Rollnick, 1998).

Scientific literacy on the part of learners facilitates the learning process (Po, 2006). Teaching learners who are scientifically literate (that is, who are able to understand, interpret, and reconstruct scientific knowledge), makes it easier for educators to concentrate or focus on explaining scientific principles, rather than explaining concepts and the meaning of words. This will, in turn, improve both the level of understanding or abstraction of the learners, as well as the quality and level of class discussions.

Scientific literacy is fundamental to quality teaching and learning in science, and is of national importance in the promotion of public acceptance of scientific and technological change, flexibility, and competition in the global market (Carter, 2005; Po, 2006). The South

African curriculum for Natural Sciences has as its purpose the promotion of scientific literacy through the development and use of science process skills in a variety of settings; the development and application of scientific knowledge and understanding; and the appreciation of relationships and responsibilities between science, society and the environment (Department of Education, 2002: 4). Science process skills entail the ability by the learner to investigate, reflect, analyse, synthesize, and communicate.

The RNCS (Department of Education, 2002) document notes that learners should develop the ability to think objectively and use a variety of forms of reasoning, while they use process skills to investigate, reflect, analyse, synthesize and communicate. My view is that these (process) activities require not only scientific literacy but also proficiency in the language of learning and teaching (LOLT). Grappling with LOLT undermines the learner's ability to accurately interpret scientific information or to analyse, synthesize and communicate it. Consequently, lack of proficiency in the LOLT ultimately undermines the learner's science knowledge construction.

In her paper, Rollnick (1998) explores what she regards as 'a more specific form of literacy', namely, that of scientific and technological literacy (STL), in the context of Southern Africa. According to her, one of the important aspects of STL is that it is not necessarily gained by formal education but can also be required through social interaction. Among its important extrinsic values are awareness of scientific and technological careers and possession of the skills of industry (Rollnick, 1998). Its important intrinsic values include the ability to participate in debates on scientific issues, which may affect one as a citizen, and the ability to use scientific knowledge to manipulate one's environment (Po, 2006; Rollnick, 1998). All these activities presuppose and underline the importance of language proficiency and an understanding of the language of science, which may be lacking with persons or learners for whom the language that is used in science (namely English) is not a home language.

Another important aspect of scientific literacy is what is called 'rational thinking', which involves 'the ability to solve scientific problems in context'. The National Education Policy Initiative (NEPI, 1992c: 2) Science Curriculum Group defines scientific literacy as "an awareness of the processes of science, possession of science-based skills," and "the ability to make decisions involving everyday science matters." In other words, in the context of this study, scientifically literate learners should not only solve hypothetical problems in class but also be able to use their scientific knowledge to solve problems in their immediate environment (that is, both at school and in their everyday living in the community).

Learning Science in a Second Language (L2)

English is seen as the language of globalization and domination (Bgoya, 2001; Brock-Utne, 2000; Phillipson, 1988; Prah, 2003). It is also perceived as the language of science and technology (Rubagumya, 2003). This means that to be globally or internationally competitive in science, learners must be proficient in English, which has become "the target language in South African schools" (Holmarsdottir, 2006: 204). As South Africa seeks to be globally competitive in science and technology (for economic development), this focus translates to the use of English as the medium of instruction, despite the fact that for the majority of learners in its schools English is a second or third language (Napier, 2011; Schaffer, 2010; van Staden & Howie, 2008).

Science happens to be taught through English as the medium of instruction in many countries, including South Africa (Napier, 2011; Schaffer, 2010; van Staden & Howie, 2008). It is also a second or third language for the majority of learners in South African schools (Probyn, 2001). It may be for this reason that many learners in South African schools underachieve in science (Cleghorn, 2005; Ogunniyi, 2005; October, 2002; Probyn, 2001). What complicates the matter further is that language is closely linked to culture, and, as mentioned above, science is a cultural activity, associated with western culture.

3.3.2 Science worldviews

The above definitions of science reflect what may be called western notions of science and the scientific endeavour. However, there is another school of thought that espouses and propounds a cultural view or Indigenous Knowledge System (IKS) as an alternative to the western definitions of the scientific endeavour (Aikenhead & Jegede, 1999; Breidlid, 2004; Fakudze, 2004; Le Grange, 2007; Ogunniyi, 2002; Quigley, 2009; Semali & Kincheloe, 1999). The alternative to western science arose in response to the apparent difficulty experienced by learners who come from traditional or indigenous knowledge (IK) backgrounds in understanding school science, which conflicts with their traditional worldview (Aikenhead & Jegede, 1999; Le Grange, 2007; Ogunniyi, 2002; Semali & Kincheloe, 1999). This alternative is also due to the fact that western science does not seem to take the traditional or indigenous knowledge perspectives into consideration in its 'laws'

(Aikenhead & Jegede, 1999; Le Grange, 2007; Ogunniyi, 2002; Quigley, 2009; Semali & Kincheloe, 1999). A distinction is often made between western modern science (WMS) or worldview and the traditional worldview (Aikenhead & Jegede, 1999; Ogunniyi, 1988; Quigley, 2009; Semali & Kincheloe, 1999). Modern science is perceived largely as a product of western culture while the traditional worldview uses and follows various Indigenous Knowledge Systems (Ogunniyi, 1988; Semali & Kincheloe, 1999; Sutherland, 2002). Science, as such, may not be readily amenable to the traditional (indigenous) worldview because of its different cultural approaches (Ogunniyi, 1988). For example, studies have shown that traditional students – those who have a high level of belief in traditional cosmology – achieve significantly lower scores in tests or assessments involving tasks which conflict with their traditional worldview (Sutherland, 2002). However, both the scientific worldview and the traditional (IKS) are (culturally influenced) explanatory models of how the world functions (Ogunniyi, 1988). Modern science is based on a "mechanistic" explanatory model, while the traditional (IKS) worldview is based on an "anthropomorphic" explanatory model (Ogunniyi, 1988: 6).

Reveles, Cordova and Kelly (2004: 1112) note that:

> Learning science entails participating and communicating in socially appropriate ways within a particular community of practice ... Students take action and interact with others to construct the contextual knowledge of the classroom. Their learning of and about science is therefore inseparable from the surrounding environment in which it takes place.

Science is a cultural enterprise and "has evolved to become part of the cultural heritage of all nations" (Department of Education, 2002: 4). Science teaching and learning should, therefore, take the learners' socio-cultural background into consideration, including the indigenous knowledge background of those learners who come from such a background (Carter, 2007). Indeed, post-colonial studies argue for "a more diverse and inclusive view of science that sees it as any systematic attempt to produce knowledge about the natural world including local knowledge systems, ethnosciences, and science as a local cultural practice" (Carter, 2007: 168)

Studies have shown that there is a close relationship between culture and achievement in science (Cleghorn, 2005; Kim & Wai, 2007; Po, 2006; Sutherland, 2002). It is, therefore, more likely that, learners who learn science through English (a second language) as medium of instruction will underachieve. Culture plays a very important part in influencing the worldview of people, and science is closely associated with the western worldview (Cleghorn, 2005; Ogunniyi, 1988). Culture may be defined as referring to a system of meaning and symbols, including ways of thinking and views of the nature of phenomena (Cleghorn, 2005). Worldview, on the other hand, refers to the taken-for-granted understanding that each cultural group holds about the natural world (ibid.).

Whether or not there is a link between learners' performance in science and their cultural background or context is the subject of much debate (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004; Ogunniyi, 2005; Sutherland, 2002). The challenge, especially for educators, is to find areas of common ground between the two explanatory models, and ways in which the two models can complement one another in order to enhance the learning of science by second-language (L2) learners in our schools.

In this study, the debate on the influence that culture has on science learning is of interest and is considered as highly pertinent, given that the participants of the study consisted of learners who came from a different cultural background to that of English speakers, and that English was the language of instruction for Natural Science at their school. This situation could explain South Africa's poor performance with respect to international comparisons of achievement in maths, science and English literacy (van Staden & Howie, 2008). Indigenous Knowledge Systems are discussed in more detail in paragraph 3.4 below.

In the South African context, the above values are reiterated in the Learning Outcomes for Natural Science, as specified in the RNCS curriculum (Department of Education, 2002; Nomlomo, 2007: 120). Natural Science learners in the South African context are required to demonstrate the acquisition of (and mastery of) the above values in their learning. It is interesting to observe to what extent these values have been influenced or dictated by globalization. For example, Schaffer (2010: 3) notes that *"The White Paper on Science and Technology* and all subsequent government reports – most notably, *South Africa's National Research and Development Strategy* ... highlighted a number of scientific fields in which the government would continue to strive for international excellence." This statement underlines the high premium that is placed by the South African government on being internationally competitive, thus conceding to the influence of globalization on the affairs of the country.

3.3.3 Globalization and Science Education

Our world is increasingly shaped and directed by science, in that the growing demands being placed on individuals and communities in the form of rapidly developing technologies and sustainable development practices call for them to be scientifically aware (Murcia, 2005). This situation demands that individuals the world over be scientifically literate in order to survive and to achieve a meaningful social participation. Increased globalization has meant a dramatic increase in contact between previously geographically isolated groups, resulting in traditional knowledge systems being assimilated or in some cases disappearing altogether (Quigley, 2009). In other words, the phenomenon of globalization in a sense dictates the agenda (i.e. the direction and form that they should take) for science and science education. These are considered to be crucial elements for the economic development of any country (Murcia, 2005; Napier, 2011).

Most of the debate on globalization in the last few decades is found in the social sciences (Guillen, 2001; Jones, 1998; Quigley, 2009; Sklair, 1999; Wedikkarage, 2006), probably because of the field's historical concern with the study of society and human relationships: i.e. the study of social life, social groups and societies (Hughes, 2010; Scott & Marshall, 2004). The rapid increase in cross-border economic, social, technological and cultural exchange has raised much debate among observers and theorists of globalization (Guillen, 2001; Quigley, 2009). Much of this debate revolves around what globalization entails, as well as its impact on the political, economic and cultural wellbeing of people all over the globe, as various countries strive to develop themselves and find a place in the sun by participating in and influencing developments in world affairs. The process of globalization is largely dominated (and driven) by conglomerates or transnational corporations (TNCs) which own mass-media and control the world economy across national boundaries (Sklair, 1999). Through their aid to developing countries and their control of the mass media, the TNCs have directly and indirectly influenced education in these countries. South Africa, as a developing country, is engaged in the global enterprise of education, knowledge economy, international competitiveness, and other priorities linked to economic development (Napier, 2011: 59). These ventures translate to an emphasis on the importance of learning mathematics, science, technology, and English (ibid). South Africa has, therefore, targeted these subjects as priority areas, both for economic development and world competitiveness. In education, for example, this is done through Outcomes Based Education's New Curriculum Statements (NCS).

Further programmes, such as National Curriculum Assessment Policy Statements (CAPS) and the Literacy and Numeracy (LIT/NUM) Strategy in the Western Cape, have been devised to augment the new (RNCS/NCS) curriculum, with a view to preparing South African citizens for a globalized world (Department of Education, 2011; Foulds, 2002; Western Cape Department, 2006). The Literacy and Numeracy (LIT/NUM) Strategy in the Western Cape, for example, is specifically intended to improve learner performance (or skills) in the targeted areas of literacy and numeracy (WCED, 2006).

In broad terms, *globalization* refers and relates to the phenomenon whereby recent reforms in the economic, political and social spheres have, like a tidal wave, swept across national boundaries, bringing about changes which have a universal and homogeneous effect on a broad range of practices in global society (Carter, 2005; Wedikkarage, 2006). In brief, globalization may be defined as 'the integration and organizing of economic, political and social activity resulting in transformations at levels which transcend national boundaries and jurisdictions' (Jones, 1998; Sklair, 1999). The concept of globalization refers not only to a series of economic changes but also to technological changes that have altered the way the world operates and transfers information (Quigley, 2009).

Sklair (1999: 145) makes a distinction between the 'inter-state' or 'international' and the 'global' conceptions of social relations between countries, noting that in the phenomenon of globalization, the 'global' signifies "the emergence of processes and system of social relations not founded on the system of nation-states." In other words, globalization involves more than the 'traditional' bilateral relationships (e.g. long-standing trade between any two countries) or the kind of agreement between any two countries which we are accustomed to. Indeed, the process of globalization defies both bilateral agreements and national boundaries, as its processes influence developments across national boundaries all over the globe. It is also often the means by which the economically dominant and powerful first-world countries tend to impose their economic, political, and cultural agendas on the poorer (third-world) countries. This is done mainly through the conditions that these powerful countries (or their agents) set as prerequisites for economic and development aid or loans, including the World Bank and IMF economic structural adjustment programmes (ESAPs), and restrictions (through the global market) on both the funding and language of instruction used in education (Brock-Utne, 2000; Carter, 2005; Holmarsdottir, 2009; Wedikkarage, 2006; Punchi, 2001).

Indeed, Brock-Utne (2000: 22) notes that "The ESAP medicine led to a starvation of the social sectors, including the education sector, in most developing countries."

The political debate on globalization can, perhaps, be best explained in terms of the 'core' versus 'peripheral' structural or hierarchical power relationship between countries or regions in the world-system (Pennycook, 1994; Phillipson, 1988; Wedikkarage, 2006). In this system, the powerful and wealthy core countries, which are rich in capital, dominate and exploit the weak and poor peripheral ones, which, although poor, are labour-intensive. The core and peripheral countries are geographically and culturally different but are interdependent. Technology, which is often associated with science and development, is considered to be a central factor in positioning countries in either the core or peripheral categories (Pennycook, 1994; Phillipson, 1988). The powerful core countries possess the technological know-how which is needed by the poor peripheral countries for their economic development, and they use this advantage to spread their tentacles. Through the technological (scientific) language, essential for the use or operation of such know-how (including technological gadgets such as computers), the core countries are able to impose their 'linguistic imperialism' on the (often unsuspecting) recipient peripheral countries (Pennycook, 1994; Phillipson, 1988). Phillipson (1988: 339) defines linguistic imperialism as an essential constituent of imperialism, and as "a global phenomenon involving structural relations between rich and poor countries in a world characterized by inequality and injustice." Language (including the language used in science and technology) thus becomes embroiled in and part of this complex powerplay between the powerful core and the weak, poor peripheral countries. The use of foreign languages (mainly English) in science education, the latter being associated with economic development, is a feature of both globalization and science teaching and learning in developing African countries, including South Africa (Napier, 2011; Phillipson, 1988).

At the political level, it is argued that globalization has, through its neoliberal approach and policies, undermined the authority and influence of the nation state (Carter, 2005; Wedikkarage, 2006). Nation states have come to rely on development aid, mainly from their former colonial masters, that have often suggested reforms in the form of set conditions and development programmes, the so-called economic structural adjustment programmes (ESAP) which largely favour the donor country. This has, by and large, extended into the field of education (Brock-Utne, 2000; Gray, 1999; Napier, 2011).

Political rather than educational imperatives have often driven the process of development aid. Carter (2005: 565) argues that "Applied to education, the powerful ideologies restructuring the global economy, in concert with supranational institutions like the World Bank, both discursively and structurally determine the ways in which education can exist worldwide." The argument presented here is that the reform imperatives set by the first-world donor corporations for development aid to second-world countries (through the structural adjustment programmes) has led to the globalization of education. The upshot is that this structural adjustment requirement places restrictions on poor countries in both the funding and language of instruction used in science education (Holmarsdottir, 2009; Wedikkarage, 2006). Since science and technology are considered to be crucial for the development of (industrial) skills, and thus in stimulating the economy of a country, this often places science (and technology) education at the top of the agenda in many countries, including South Africa. However, the language through which science is learned, mainly English (Kim & Wai, 2007; Quigley, 2009), coupled with the language of science itself, with its unfamiliar terms and concepts, places many third-world countries, in which English is not the learners' home language, at a huge disadvantage. It is, therefore, extremely difficult for these countries to compete equally and keep abreast, both in scientific invention and (economic) development, with English home language first world countries. The poor performance of South Africa in the TIMSS, discussed in paragraph 3.3.1 above, is a case in point.

The 'Global Culture' approach to globalisation focuses on the problems caused by the 'mass media-based culture' for national identities (Sklair, 1999: 151). Due to the revolutionary transformations of Trans-national Corporations (TNCs) which own the mass media, especially television channels, and their presentation of western programmes worldwide through satellites, nation-states elsewhere are facing problems in maintaining their identities (Wedikkarage, 2006). Instead, a global culture, characterized by consumerism and the use of technological gadgets such as the television and the cell phone, which has an influence across national boundaries, has emerged. This has also to do with communication, whereby the language of the dominant (mostly English) culture is used above the languages of local or indigenous communities (linguistic imperialism). The development of science, technology, and industry in the developed world, which has drastically improved communication globally, has also led to an open economy. The advancement of information and communications technology (ICT) has paved the way for people across the globe to watch or listen to what is happening in other parts of the world instantaneously. Thus, during the past century, major scientific developments, combined with new economic activities, have brought together the entire globe, resulting in a global society. Griffiths (1998: 90) characterizes this phenomenon as "an explosion in information technology and international communication and migration, leading to globalisation and the diverse, plural, fast changing society we inhabit today." This drastic change has put more pressure on developing countries to adopt the 'global language' of technology and ICT communication, giving rise to a greater emphasis on the importance of mathematics, science and technology.

The global culture has also been an important feature of postcolonial education (including science education) through curriculum development which is highly influenced by western countries (Quigley, 2009). Countries which want to "succeed" in the global world are forced to learn western modern science (WMS), which follows a curriculum based on those of European or American countries (Quigley, 2009: 78). These countries do this in order to be competitive in the economic global markets (Holmardottir, 2009).

Carter (2005) identifies two salient aspects of globalization. The first entails the increasingly universalized homogenizing process which is embodied in the structural and economic reforms, the expansion of Western culture, and the growth of supranational regulation. The second aspect entails the social and cultural theorizations which promote creative and innovative ways of adapting or responding to larger global forces. Viewed in this way, globalization can be thought of as "a complex dialectic of both political- economic and socio-cultural transformations," which enhance the local as well as the universal or global competences (Carter, 2005: 562). The impact of western culture, mainly presented through the advancement of ICT, is seen to have a greater impact on the countries in the south than in European or developed countries, probably because of their colonial history (Carter, 2005; Quigley, 2009). This has occurred, not only in terms of borrowing or imitating a particular pattern of life (mainly from Britain and the US) which includes entertainment, fashions and eating habits (consumerism), but also in education. For example, in its outcomes-based education curriculum, South Africa borrowed heavily from America (Napier, 2011; Holmarsdottir, 2009).

The process of globalization has also been aided and abetted by the process of post-colonialism, as delineated by Quigley (2009). The author uses the concept of colonialism, as it persists beyond the time when colonization occurred, "to describe a complexity and hybridity of culture, language, history, politics, and education due to colonization, which are also relevant to the process of globalization" (Quigley, 2009: 78). As mentioned above, even after independence, most African countries have continued to use the language of the erstwhile colonial masters as the language of learning and teaching in their schools (Brock-Utne, 2000). For example, English continues to be the dominant language of learning and teaching in most schools in South Africa (Desai, 2012; Prah, 2003; Probyn, 2005). In similar fashion, the cultural practices of the indigenous people of these countries have been influenced by western culture.

Globalization and the LOLT

In tandem with the cultural debate, is the issue of the choice of the language of instruction, particularly in learning science (Ogunniyi, 1988). In the wake of the increases in linguistic diversity of many countries, the issue of language choice for education in this era of globalization has become more pronounced (Brock-Utne, 2000; Napier, 2011; Prah, 2003; Prah, 2005; Quigley, 2009; Roy-Cambell, 2001). It was pointed out in Chapter 1 of this study, that many Black parents in South Africa prefer their children to be taught through the medium of English, in order to give them a competitive advantage in both the local and global job markets (Mazrui, 2002; Nomlomo, 2007; Taylor & Vinjevold, 1999). Many have sent, and continue to send their children to former White (ex-Model C) schools to give them a competitive edge over their peers who are taught through the home language (in Black schools), in the quest for better employment opportunities. Being conversant in English is perceived as giving them this competitive edge for future employment.

Globalization plays a crucial part in the education process, in that the 'new knowledge' and skills required for the economic development of the recipient country are mainly acquired through education (Quigley, 2009; Wedikkarage, 2006). Education is, of course, often carried out in the language of the aid-providing country, and thus helps to promote the spread of its language and dominance. With regard to the spread and dominance of English through technology, Phillipson (1988: 341) notes that "Western products still come wrapped in a Western language and in Western thought." Skutnabb-Kangas defines this use of language to maintain dominance and political power by one country over another as *linguicism*[9].

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[9] Skutnabb-Kangas (1988: 13) defines linguicism as "ideologies and structures which are used to legitimate, effectuate and reproduce an unequal division of power and resources (both material and non-material) between groups which are defined on the basis of language (on the basis of their mother tongues)."

Language, in turn, goes hand-in-hand with culture, meaning that through education in the language of the aid-providing country (e.g. the US, which is predominantly English speaking), its culture is also spread or globalized.

As noted in the section above, globalization is a major factor that affects and influences current trends in the provision of education in modern society, especially urban society in industrialized countries, including South Africa. The globalized language used especially in science and technology leaves little choice for the learner but to learn it, if he/she is to keep abreast with the latest developments and innovations in the field. Inevitably, the impact of globalization has permeated the teaching and learning of science in our (South African) schools, as we strive to be globally competitive (Schaffer, 2010). The global spread of English has been one of the main drivers of globalization. Wedikkarage (2006: 45), in the quest to gain a theoretical understanding of the driving forces behind the rapid spread of English as the medium of instruction in Sri Lanka, especially in science education, asserts that "In addition to the Internet and rapid communication systems that enhance and accelerate globalization, English is thought to be the most unrivalled and unmatched tool of globalization." The point being made here is that globalization has added impetus to the perception (mainly by parents) of English as the language of (economic) access, power and mobility (Nomlomo, 2007), notwithstanding the difficulties that English presents to learners for whom it is not their home language.

Given that education operates within the larger historical, social, and political context to which it must respond, it becomes crucial to realize that contemporary education, including science education, has to be seen in close alliance with globalization as the dominant forces in transforming our world. Globalisation and education work hand-in-hand, that is, they are closely linked, with knowledge globalization as the fundamental resource and education as a major player in its production, rationalization, distribution, and transmission (Wedikkarage, 2006). Carter (2005) argues that globalization is implicated in the discourses of science education, even if it remains under-acknowledged and under-theorized. Globalization has precipitated reformed relationships between the nation-state, capital, and the individual, leading to greater co-operation and educational funding.

The influence of globalization on education, particularly science education, is the interest of this study, as globalization (indirectly) dictates what curriculum must be followed or taught in the classroom, both in terms of subject content and 'global convention' (e.g. technical language or terms that go with the new knowledge or technology). Globalization also has great influence with respect to the two worldviews on science mentioned earlier, namely, western science versus Indigenous Knowledge Systems (IKS), or the integration of the two, which has implications as to what syllabus is followed and what is taught in the classroom. This study, therefore, is particularly interested in the advocacy for "equitable instruction and assessment practices for diverse students" in science, in the light of the transformation of education in democratic South Africa (Quigley, 2009: 77). This interest arose from a desire to promote achievement and equity in favour of those learners who come from traditional or indigenous backgrounds, in the context of cross-cultural classrooms which have come to characterize the situation in ex-Model C (and ex-HOR) schools in the democratic South Africa. Quigley (2009: 77) notes that "Equitable instruction and assessment practices for diverse students involve consideration of their cultural and linguistic experiences, which should enable them to connect to science and maintain their identities." In other words, equitable instruction and assessment practices seek to contextualize western modern science education with the learner's local and cultural experience. Language is central to making both instruction and assessment equitable, as it is critical to the access, construction, and communication of scientific knowledge (Po, 2006). The learners can only understand instruction and give meaning to it through understanding the language by which that instruction is mediated. Language, however, is embedded in culture and, as noted above, for effective science learning to take place, teaching must take the learners' cultural background into consideration (Cleghorn, 2005; NEPI, 1992c; Ogunniyi, 1988).

3.4 INDIGENOUS KNOWLEDGE SYSTEMS (IKS) IN RELATION TO WESTERN SCIENCE

There is a raging debate concerning the efficacy of teaching purely western science in our schools, since it ignores the learners' indigenous knowledge background (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunleye, 2009; Ogunniyi, 2002; Quigley, 2009). A major influence on science education identified by students in developing countries is their feeling that school science is like a foreign culture to them, a feeling stemming from the fundamental differences between the culture of western science and their indigenous cultures (Adler, 2002; Aikenhead & Jegede, 1999; Le Grange, 2007). It was pointed out above that, in order to explain the cognitive conflict experienced by non-western learners, emanating from learning western science, some writers developed theories that take the IKS into consideration. The theories of Border Crossing and Collateral Learning, developed by Aikenhead and Jegede (1999), as well as the Contiguity Learning Hypothesis, developed by Ogunniyi (2002), sought to provide alternative explanations to conventional or western culture, on how learning in the context of IKS takes place (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunleye, 2009; Ogunniyi, 2002).

In order both to make sense of and to understand the globalized western science taught at school, learners who come from traditional cultural backgrounds have to make linguistic, cultural, and cognitive adjustments. Research on indigenous knowledge systems (IKS) attaches significance to the transition that learners have to make between their traditional cultural life-world and western culture in learning school science, as well as how such learners deal with the resultant cognitive conflict between these two worlds (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004; Sutherland, 2002). Aikenhead and Jegede (1999) developed the theories of Border Crossing and Collateral Learning, while Ogunniyi (2002) developed the Contiguity Learning Hypothesis (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunniyi, 2002; Ogunleye, 2009). The concepts of cultural border crossing and collateral learning seem to capture the essence of the learning adjustments or shifts that second- or third-language learners (e.g. the isiXhosa-speaking learners in this study) have to make in learning science in a second language (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004; Po, 2006). The concepts of ***Border Crossing***, ***Collateral Learning***, and ***Contiguity Learning*** are discussed in more detail below.

Border crossing refers to the transition between a learner's traditional worldview and school science, while collateral learning comes about as a result of (the attempt to resolve) the cognitive conflict arising from cultural differences between the learner's indigenous worldview and school science (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004).

In science teaching and learning situations involving second (L2) or third (L3) languages, it becomes necessary for the learner to cross linguistic, cultural and cognitive borders in order to understand what is taught (Cleghorn, 2005). In other words, in learning Natural Science through English, second- or third-language learners have to make this transition, not only in terms of language but also in terms of their indigenous cultural knowledge (IKS) base, in order to access scientific knowledge. They also have to make a cognitive transition with regard to foreign scientific concepts in an unfamiliar language, and to adopt a western cultural worldview. When learners cannot successfully do border crossing, they may sometimes resort to collateral learning. This process involves keeping knowledge from their indigenous background in a separate compartment, but alongside that of school science knowledge, in order to use the knowledge 'appropriately' when the situation (either in school or at home) demands it (Aikenhead & Jegede, 1999; Cleghorn, 2005). Collateral learning thus refers to the extent to which learners may compartmentalize new (school) knowledge alongside knowledge that emanates from their prior experience, instead of integrating the new with prior knowledge (Cleghorn, 2005). This situation may arise due to the difference between either the home language and the (English) language of learning and teaching (LOLT), or the learner's indigenous knowledge (IK) worldview and the western (school) science worldview (Aikenhead & Jegede, 1999; Cleghorn, 2005).

My view is that collateral learning is merely a coping strategy that learners use when they cannot reconcile (or deal with the contradiction or conflict between) a western worldview and their traditional worldview. Learning school science (which has become increasingly globalized) is more likely to produce this kind of (superficial) learning/effect on learners who come from a traditional cultural background if that learning does not integrate or take these learners' indigenous knowledge (IKS) into account (Cleghorn, 2005; Holmarsdottir, 2006; Le Grange, 2007; Sutherland, 2005). Given that the Grade 6 science educators in this study could not use the code switching teaching strategy to assist isiXhosa-speaking learners, the implication is that they may have had very little, if any, knowledge of those learners' traditional/cultural backgrounds. In such a case, the collateral learning option for isiXhosa-speaking learners in learning science might have been strengthened.

Fakudze (2004) investigated the learning of science concepts within a traditional socio-cultural environment. Although her study corroborated the three theories/hypotheses of 'border crossing', 'collaterality', and 'contiguity', it also revealed that "each of the three theoretical models did not seem to fully capture the phenomenon of border crossing" (Fakudze, 2004: 270). In other words, each of the above theories/hypotheses did not, on its own, cover all the aspects or contexts of border crossing. As a consequence, Fakudze (2004) proposed the 'Cognitive Border Crossing Learning Model' (CBCLM) which, by combining the three theoretical models, shows when, how, and in what contexts the various types of border crossing (namely, *smooth*, *hazardous*, and *impossible*) occurred in the minds of the learners. As stated above, border crossing involves the learner crossing a linguistic border from his/her traditional (home) language (L1) into English (L2), in order to understand scientific concepts.

According to Aikenhead and Jegede (1999), the transition from indigenous to western culture that the learner has to make in learning science is relative to the extent and level of the differences between the two cultures involved, namely western culture and indigenous culture. Aikenhead and Jegede (1999: 70) note that:

> Success in science courses depends on (a) the degree of cultural difference that students perceive between their life-world and their science classroom, (b) how effectively students move between their life-world culture and the culture of science or school science, and (c) the assistance students receive in making those transitions easier.

As many of the learners in my study came from Khayelitsha, home mainly to people from the (rural) Eastern Cape, the above transition from the traditional worldview to science may include the rural-urban divide, making it even more complex and difficult to manage.

Ogunniyi's Contiguity Learning hypothesis argues that the dominant worldview in a given context is likely to affect the type of border crossing from one worldview to another (Fakudze, 2004; Ogunniyi, 2002). With regard to my study, I found Fakudze's (2004) exemplars of the applicability of the three theoretical constructs most useful and pertinent in explaining how they are used (by the learners) in practice. The model not only defines the theoretical constructs but, based on investigation, gives practical examples and spells out the context and conditions under which learners manifested smooth, hazardous, or impossible border crossing and collateral learning. The model can, therefore, be put into practice or replicated under particular contexts and circumstances.

Hong, Morris, Chiu, and Benet-Martinez (2000) use the concept of 'frame switching' among bicultural individuals, which is similar to Aikenhead and Jegede's (1999) concept of border crossing and collateral learning. In the process of frame switching, "the individual shifts between interpretive frames rooted in different cultures in response to cues in the social environment" (Hong et al., 2000: 709). Bicultural individuals are defined as "people who have internalized two cultures to the extent that both cultures are alive inside of them" (Hong et al., 2000: 710).

The most obvious challenge faced by Limited English Proficiency (LEP) students in learning science is having to learn a new language (namely English) at the same time that they are required to acquire new subject matter (Holmarsdottir, 2006; Kim & Wai, 2007; Langenhoven, 2006). It is not surprising, therefore, that LEP students often experience difficulties in attaining higher levels of abstraction in learning science. The ease with which students make the transition between their home or family and school *subcultures* determines their success in learning science at school (Aikenhead & Jegede, 1999: 270; Murcia, 2005). However, for the vast majority of learners the movement between the micro-culture of their family and the micro-culture of school science, presented in a second language LOLT, is not smooth and often limits their success in school science. This is particularly the case with learners from indigenous cultural backgrounds. This situation defines an emerging priority for educators in the 21st century, that of developing culturally sensitive curricula and teaching methods that reduce the foreignness felt by students (Le Grange, 2007; Murcia, 2005).

In this study, it is contended that teaching (and learning) science by using contextualized (place-based) life experiences (e.g. investigations, projects, and examples based on the immediate or local environment) should deepen and strengthen the learners' understanding of the nature of science, as this approach emphasizes and highlights its contextual usefulness (Quigley, 2009). This also provides an opportunity to integrate the learners' indigenous knowledge (IK) and western science. Le Grange (2007: 577) argues for "a (dis)position that moves the debate beyond the binary of Western science/indigenous knowledge" to finding ways in which western science and indigenous knowledge could be integrated. I would argue that the integrated approach to teaching science (Kim & Wai, 2007; Murcia, 2005; Villanueva, 2010) should not be narrowly defined or confined to 'content-based language instruction' and 'language-sensitive content instruction' (Villanueva, 2010: 47), but should include the conscious integration of western science and indigenous knowledge. This approach could be the key to solving some of the language problems associated with learning science. Le Grange (2007: 582) sees the integration of indigenous and western worldviews as "the basis for effective science learning in South Africa."

According to Le Grange (2007) research has revealed further aspects of how learners from an indigenous knowledge background approach the learning of science: their socio-cultural background has a greater effect on their learning than subject content; their indigenous worldview inhibits their initial adoption of western science; and they are involuntarily selective when making observations in science classrooms. They may explain natural phenomena in ways which appear as non-rational in the perception of western science, but experience no contradiction in their conceptual system, compartmentalizing knowledge about school science and that learned through traditional ways.

The two important implications of the above observations are that any science curriculum which ignores the indigenous worldview of the learner risks destroying the framework through which the learner is likely to interpret scientific concepts, and an indigenous learner can perform excellently in a western classroom without assimilating the associated values (Le Grange, 2010). This scenario is similar to the superficial basic interpersonal communication skills (BICS) manifested by some second-language (L2) learners who cannot cope with cognitive academic performance in the classroom (Abriam-Yago, Yoder, & Kataoka-Yahiro, 1999; Cummins & Swain, 1986). Cummins' 4 Quadrant Model, which elucidates this situation, will be discussed in more detail (paragraph 3.5.2) below.

3.5 THE ROLE OF LANGUAGE IN SCIENCE LEARNING

Language is the primary vehicle of communication, and is the key, therefore, to accessing information (Desai, 2012; NEPI, 1992; Nomlomo, 2007). Language plays a central role in the thought and learning processes and most science educators have recognized this (Cleghorn, 2005; Ogunniyi, 1986; Po, 2006). Since it is a well-established fact that language plays a crucial role in learning, it is very important that the simplest and easiest language that is understood by the learner should be used in the teaching and learning process, in order for the learner to derive maximum benefit (NEPI, 1992c). Central to the issue of language of instruction (i.e. instruction in the L1, L2, or L3) is the question of access to information by the learner (Cleghorn, 2005; Nomlomo, 2007; Prah, 2003; Sutherland, 2002). With regard to the above, the NEPI (1992c: 24) recognizes the language issue in the learning of science as twofold, namely "how to improve the learner's language proficiency whilst teaching science" and "the need to make science understandable to second-language learners through a suitable medium of instruction."

As science uses specialized and highly coded language, the most important role of the teacher is to translate this highly coded language of science into a personal, creative language (comprehensible input) that his/her learners can understand (Ogunniyi, 1986; 1998; Po, 2006; Wellington & Osborne, 2001). Similarly, the science teacher is faced with the important task of helping his/her learners to use scientific language as he/she uses it (Ogunniyi, 1986). In other words, the teacher must 'model' the use of scientific language to his/her learners. This means that the teacher's actions and language use should, at all times, be purposeful, and the teacher must be fully conscious of the implications of such actions for the learning process.

3.5.1 Learning through first/home language (L1)

Learning through the first language (L1) or home language instruction makes learning meaningful for the learner, and when this happens the motivation to stay in school and learn more is fostered (Cleghorn, 2005; Prah, 2003). Cleghorn, 2005: 102) notes that:

> ... schooling takes on added meaning if the learner's own language (L1) is not only used at school but is an important part of the curriculum from the earliest primary grades, in a climate that promotes literacy in the L1 and L2. It is via the use of the local (L1) as well as the official instructional language (L1/L2) that access to both local and global knowledge may be provided.

When learners are taught through their first language or home language (L1), the process of learning becomes a natural extension or continuation of their life activities (O-saki, 2005; Sutherland, 2002). In other words, there is no break or disjuncture between their natural development and their formal or school learning. They learn more effectively when their home language is used as the language of instruction (Nomlomo, 2007; Po, 2006; Prah, 2003). It has also been reported that, in the wake of the Jomtien Conference of 1990, in some African countries, where instruction has been based on the home language in the formative years of basic education, this has resulted in a faster and improved capacity for the acquisition of knowledge by learners (O-saki, 2005; Prah, 2003).

In learning through the home language, the subject content becomes easily accessible to the learners. In a number of education systems, where children learn first in the home language and later (when they mature) switch to national or international/global (second/third) language, they remember vividly their first experience of science concepts and are able to explain the concepts in many languages (O-saki, 2005). Perhaps even more importantly, learning through the home language makes the learners' own science knowledge construction easier, as they do not struggle with (understanding) language. They are able to explain scientific ideas in their own words (constructivist principle), and have a rich understanding of science and technology (O-saki, 2005).

When learners are taught in their home language, they are able to draw on their natural developmental experience in the home, in society, and in their culture and use that (knowledge) as a stepping stone for further learning and development. This manifests itself in learner confidence, active participation, and a better understanding of concepts in science. In other words, they are able to use their prior learning experience to enhance their new learning. When they learn through their home language, the chances of a mismatch between the LOLT and the language of the learner are minimized (Nomlomo, 2007) and communication between educator and learner is enhanced.

3.5.2 Learning through First Additional/Second language (L2)

In terms of the new Language-in-Education Policy, the South African Curriculum distinguishes between First/Home Language and Second/Additional Languages (Department of Education, 1997a; Holmarsdottir, 2006; Holmarsdottir, 2009; Nomlomo, 2007; Taylor & Vinjevold, 1999). The policy states that "From Grade 3 (Std 1) onwards, all learners shall offer their language of learning and teaching and at least one additional approved language as subjects" (Department of Education, 1997a: 2). It is assumed here that the First or Home Language is the learner's home language. The implication of the above policy statement is that in the ex-Model C context, where English is used as the medium of instruction and no African language is offered, African learners are forced to take English as their First Language and Afrikaans as an Additional Language. The policy further states that "The following promotion requirements apply to language subjects: ... From Grade 5 (Std 3) onwards, one language must be passed" (Department of Education, 1997a: 2). The implication is that for an African learner in the above ex-Model C context, in order to proceed to the next grade, he/she must pass either English or Afrikaans. This situation constitutes a double disadvantage for the African learner. In the majority of South African schools, teaching and learning in the Intermediate Phase are done through English as the medium of instruction, which is a second or third language for the majority of learners (Probyn, 2005; Taylor & Vinjevold, 1999).

The above pass requirement situation remains even with the new National Curriculum Statement (NCS) Grades R-12: Curriculum and Assessment Policy Statements (CAPS), with which it is planned to replace the current RNCS. Where language[10] is concerned, in terms of the CAPS policy document, paragraph 14 (of the document): Promotion Requirements for Grades 4-6, states as follows:

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[10] Although this discussion refers to language with respect to Promotion Requirements, and not Natural Science per se, it highlights how language acts as a barrier to academic progression of the learners in the above context.

> The following are guidelines for determining a learner's promotion from Grade 4 to 6 in the Intermediate Phase:
>
> (a) Adequate Achievement (Level 4) in one official language at Home Language level as contemplated in paragraph 12(1);
>
> (b) Moderate Achievement (Level 3) in the second required official language at First Additional Language level as contemplated in paragraph 12(1); ... (Department of Education, 2011: 17).

The above mentioned paragraph 12(1) (of the CAPS policy document): Programme Requirements for Grades 4-6, states as follows:

> A learner must offer and complete six (6) subjects for each of Grades 4-6 as contemplated in paragraphs (1) to (5) and listed in Tables 6-8:
>
> (1) Two (2) official languages selected from Table 6, provided that one of the two official languages is offered on the Home Language level, and the other official language on at least First Additional Language level, and provided further that one of the two languages offered is the language of learning and teaching; ... (Department of Education, 2011: 16).

In terms of paragraph 41(of the CAPS policy document): Short Title and Commencement of the above NCS (Grades R-12) document, the implementation programme is stated as follows:

> This Policy may be cited as *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R-12* and will commence on the day of its promulgation in the *Government Gazette* and becomes effective from January 2012 in Grades R-3 and Grade 10, January 2013 in Grades 4-6 and Grade 11 and January 2014 in Grades 7-9 and Grade12 (Department of Education, 2011: 58).

In virtually all such schools in the Western Cape, African learners choose English as their First language and Afrikaans as their Additional language. The irony of the situation is that one of the stated "main aims" of the Ministry of Education's policy for language in education is "to counter disadvantages resulting from different kinds of mismatches between home languages and languages of learning and teaching" (Department of Education, 1997a: 1-2). However, the opposite seems to be the case in the above ex-Model C scenario (at least in many such schools in the Western Cape). The selection of English as the LOLT is by choice of the parents (Department of Education, 1997a), who see learning through English as presenting their children with better commercial and employment opportunities (Mazrui, 2002; Nomlommo, 2007; Taylor & Vinjevold, 1999). However, this choice has negative implications for the learners who experience difficulties in learning through a language that is not their home language or mother tongue (Desai, 2012; Holmarsdottir, 2009; Nomlomo, 2007).

The report of the Project for the Study of Alternative Education in South Africa (PRAESA) (Vinjevold, 1999: 217) notes that "Indications are that the increasing use of English as the language of learning and teaching (LOLT) in the Foundation Phase at the expense of learners' primary languages negatively affects teaching and learning in many township schools," in that the learners concerned do not get a solid knowledge foundation and this becomes a backlog in their further learning (Alexander, 1989; Nomlomo, 2007; Taylor & Vinjevold, 1999). Vinjevold (1999: 217-221) attributes "the decrease in primary language instruction in the first years of schooling" to three main reasons: first, the rapidly and constantly shifting demography of learners; second, many learners do not have an obvious primary language; third, many parents want English language instruction from as early as possible. As many parents send their children to historically well-resourced or privileged ex-Model C schools in pursuit of better education (Nomlomo, 2007), the backlog that these learners carry multiplies, as they are now also faced with a new language accent and a new cultural environment. This situation has its roots in South Africa's colonial and apartheid history, where policy on language of instruction was always a very emotive and contentious issue (Hartshorne, 1992; Hartshorne, 1995; Holmarsdottir, 2009; Napier, 2011; Vinjevold, 1999), as was discussed in Chapter 1 of this study.

The South African Curriculum for the Intermediate Phase, for example, requires the learner to pass at least two official languages in order to move to the next grade (Department of Education, 1997a). The second-language isiXhosa-speaking learner in the ex-Model C context is hardest hit, in the sense that, although IsiXhosa is one of the official languages in the province, it is not offered in most schools (Vinjevold, 1999). The learner is thus compelled to 'choose' English and Afrikaans (as first and second languages) to fulfil the pass requirement, both being second languages, of which one of them (generally English) is the language of instruction (LOLT). The NEPI (1992: 7) notes that:

> If the medium of instruction is not the home language, at least up to a certain stage, children's other learning may be affected in serious ways. There is a great deal of evidence that basic concepts in the early years of schooling are learned best through the home language.

Learning through a second or third (L2/L3) language breaks the natural flow of learning, as the learner must first acquire and understand the new language before learning content knowledge. In other words, if we use Cummins' model, in learning through the second language, the natural flow of input (from the educator to the learner) is disturbed, as the learner has consciously to figure out the meaning of the input to make sense of what is being said. Learning thus becomes complicated and difficult for the learner.

As language is both the product and reflection of culture, the use of an additional language (L2/L3) as a medium of instruction alienates the learners' prior knowledge that they bring from their cultural backgrounds to the classroom, especially in the context of subtractive bilingualism at the school (Heugh, 1995; Mgqwashu, 2007). Just as language is embedded in culture, so also are the concepts and knowledge (ways of thinking and knowing) associated with a particular society. Whorf's linguistic relativity hypothesis asserts that "*thought is shaped by the form of the language used for thinking*" (Farnham-Diggory, 1972: 389). Learning through a second language, therefore, means that the learner has to alter his/her thought processes (to fit in the new way of thinking) and this may interfere with, or delay, the learning process. According to Vygotsky children learn to talk about problems and finding solutions in a social context (Farnham-Diggory, 1972). They then internalize the habit of using language to solve problems and manifest it in the form of *egocentric speech* (i.e., talking to themselves loudly in problem-solving situations). This egocentric speech later develops into *inner speech* in older children (Piaget, in Kozulin, 1986: 26; Farnham, 1972). The significance of this is that, as learning involves finding suitable or better ways to address or solve problems in the environment, using one's home language facilitates the thought processes and therefore makes the process of problem solving easier (Kozulin, 1986). In contrast, learning through a second language obfuscates and obstructs the use of inner speech (self-talk) and therefore hinders problem solving (i.e. learning/scientific knowledge construction).

Despite the concerns raised above, learning through English without doubt has its merits in the South African context. For example, excluding English, South Africa has ten other official languages, none of which is used as a common language through all the provinces (Republic of South Africa, 1996). English, then, has the potential to play a unifying role in the South African educational scene, as it is used and probably learned as a subject in most schools in all the provinces of the country (Hartshorne, 1995; Holmarsdottir, 2009; NEPI, 1992a). Secondly, English is an international language and is also perceived to be the language of science (Rubagumya, 2003). In the context of the globalization of science and technology, learning science in English is advantageous. Indeed, since the democratic election of 1994 in South Africa, "English has expanded its position as the language of access and power" (Probyn, 2005: 1855). In the same vein, Roy-Cambell (2001: 275) notes that:

> In many African societies, English has been viewed as a "neutral language" and therefore a reasonable choice as the language of education in countries where choice of one indigenous language would have been a contentious issue. As one of the dominant world languages, it is an important source of knowledge, particularly of science and technology. However, valuing English as an important language need not be coterminous with devaluing African languages.

For the majority of learners in South African schools, English is only a second (or third) language, one which is not spoken out of school or in their homes or their community. In fact, African languages have been reduced to the status of being "effectively confined to functions of 'home and hearth'" (Probyn, 2005: 1855).

The view held in this study is that English should be used together with African languages to clarify or elucidate knowledge for the learner, as it seems that there is a positive correlation between the use of the learner's home language as a medium of instruction and learners' understanding and academic performance in science (Nomlomo, 2007: 302; Po, 2006). In other words, my view is that English and African languages should complement one another in scaffolding the learning process in science. In her comparative study of language and education (in the context of globalization) between the United States and Tanzania, Roy-Cambell (2001: 276) shares a similar view, and recommends that Tanzanian researchers find a context-based model of bilingual education that would enable students to use Kiswahili while learning English. Research also "suggests that the recognition of concepts in Western science taught in English to (some) non-western populations is more accessible than when taught in their mother tongue, especially when there are no linguistic correlates to the scientific concept in the indigenous language" (Sutherland, 2002: 5).

Learning in a second language implies the crossing of cultural boundaries (Aikenhead & Jegede, 1999), from the culture of the learner's home language (indigenous knowledge) to the culture of the (dominant) language of instruction. According to Vygotsky, cognitive processes and development are the result of social and cultural interactions, such that all psychological processes are initially social and only later become individual (Lunt, 1993: 146). In other words, the child's intellectual (and language) development starts in social interaction, first with people at home and later in the community. In the process of early development, the child also learns by imitating the actions (and thinking) of significant others in his/her cultural environment before he/she can act and think independently. The child, therefore, is first a social being before he/she becomes an individual being. This also means that when the child goes to school, he/she brings this culture-embedded knowledge (including language) with him/her (i.e. knowledge is also culture-bound). Learning through a second language means that the child must abandon his/her previous cultural experiences (i.e. prior knowledge) in favour of the new (also culturally bound) school knowledge. This could mean a total breakdown in the child's learning if the child's (culturally-embedded) prior knowledge is not taken into consideration or integrated in the new teaching and learning situation.

Impact of learning science through L2

Learning science through the second language means that the learner must not only grapple with understanding the language of instruction (LOLT) but also the language of science. The problem is compounded by the fact that scientific concepts, which are difficult even for first-language speakers, are explained through the second language, which the learner does not understand. The end result is that the second-language learner's performance in science is negatively affected. Such a learner will not only struggle to explain him-/herself but will also be unable to take his/her arguments or discussion to a higher level, due to a superficial level of abstraction of scientific knowledge. Bridging the gap between home language or mother tongue and LOLT, and acquiring not only proficiency in English but also the kind of cognitive language proficiency (CALP) required for academic learning and meaningful engagement with the curriculum, is difficult for such a learner (Dempster & Zuma, 2010; Probyn, 2005). Under such circumstances it is also doubtful whether such a learner would be able to bring or take his/her indigenous knowledge experience in the 'new' learning into account. The learner's own construction of scientific knowledge will be adversely affected.

The challenge for educators and curriculum developers (particularly for science) is to develop culturally sensitive curricula and teaching methods that take the learners' social context into consideration, so as to reduce the feeling among learners, especially in developing countries, that science is 'foreign' to their social or cultural context (Aikenhead & Jegede, 1999). Saul (2004: 11) suggests that, "To help students to acquire academic language, teachers need to remain cognizant of and sensitive to the various languages (discourses) and dispositions and cultural suppositions (discourses) that students bring to school." Adler (2002: 2) argues that:

> It is a significant challenge for all in education to come to grips with how policies, visions, and goals are themselves a function of how and where they are formed. They [i.e. the policies, visions, and goals] will not travel in even ways across different regions and different schooling cultures.

In other words, educational strategies and practices that work in some school contexts will not necessarily work in others, as their success is determined by the environmental context of the learning. Policy developers and practitioners, therefore, need to find ways to understand and promote diverse practices to meet the different contextual needs of learners. Indeed, one of the stated aims of the Language in Education Policy of South Africa is "to counter disadvantages resulting from different kinds of mismatches between home languages and languages of learning and teaching" (Department of Education, 1997a: 2). Jegede's collateral learning, then, should be viewed in this context, as a model against which science learning can be understood in a socio-cultural framework (Le Grange, 2007).

The use of English as a (globalized) language of instruction (LOLT) has particularly affected the learning of science by second-language learners in South African schools, as English has increasingly become the dominant global language (Probyn, 2005; Quigley, 2009). In order to explain the interrelationships between the English language proficiency of learners and their academic performance, reference is now made to Cummins' 4 Quadrant Model.

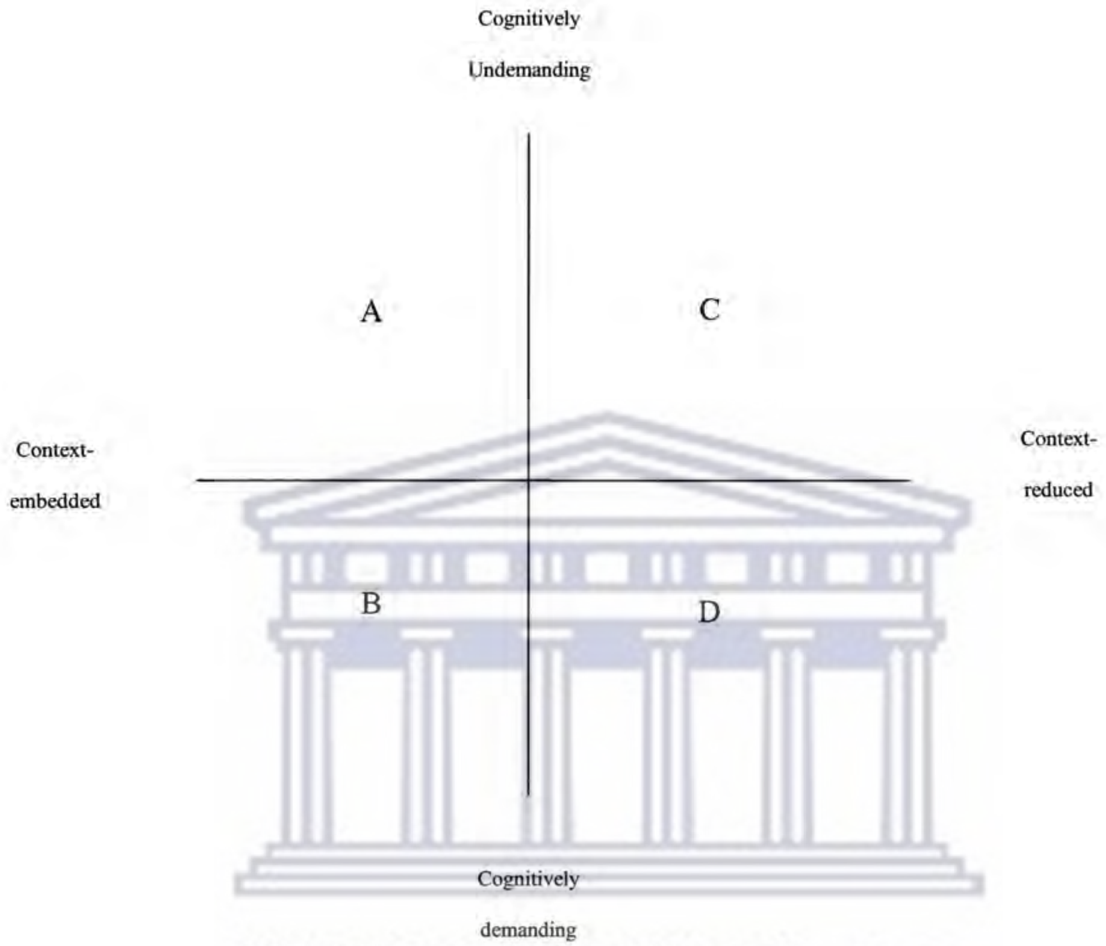

Figure 3.1: Cummins' 4 Quadrant Model: Range of contextual support and degree of cognitive involvement in communicative activities (adopted from Cummins & Swain, 1986: 153).

Cummins' model offers a framework for conceptualizing 'linguistic proficiency' in a way which considers the development interrelationships between academic performance and language proficiency in both first- and second-language (L1 and L2) learners (Abriam-Yago et al., 1999; Cummins & Swain, 1986).

In the 1970s a distinction developed between surface fluency and the more evolved language skills required for the learner to benefit from the educational process (Baker, 1993). Simple communication skills (for example, being able to hold a simple conversation with a shopkeeper) may hide a child's relative poverty of the language proficiency necessary to meet the cognitive and academic demands of the classroom. This realization led to a distinction between basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP) (Baker, 1993; Cummins & Swain, 1986).

The distinction between BICS and CALP helps to explain the relative failure of many minority language children in the educational system. This can be attributed to the fact that their cognitive academic language proficiency is not developed enough to cope with the demands of the curriculum. Cummins regards it as essential in the bilingual education of children that the 'common underlying proficiency' (CUP) be well developed. This means that a child's language-cognitive abilities need to be sufficiently well developed to cope with the curriculum processes of the classroom. This underlying language ability (proficiency) could be developed in the first or second language, but also in both languages simultaneously. In the context of this study, this common underlying proficiency could be developed by finding the common denominator between western science and the learners' indigenous knowledge. For example, this could be done by including and integrating examples of concepts and understanding of scientific phenomena drawn from the learners' own cultural context or social background (IKS) into the lessons and classroom activities.

A further development of Cummins' model proposes two dimensions, with both dimensions concerning communicative proficiency (Baker, 1993; Cummins & Swain, 1986). The *first (horizontal) dimension*, the *context-embedded communication*, refers to the amount of contextual support available to a learner, particularly via body language. For example, by pointing to objects, using the eyes, head nods, hand gestures and intonation, people give and receive plenty of clues and cues to help understand the content of a message. It is very common, for example, to see two young children of different language groups playing together without difficulty (as they use context-embedded communication in their play). In *context-reduced communication*, on the other hand, there are very few cues provided to the meaning that is being transmitted. Context-reduced communication is often found in the classroom where the meaning is restricted to words, with the subtlety and precision of meanings situated in the vocabulary of the teacher or the book. This latter fact is highly pertinent in the field of Natural Science where even ordinary words like 'salt', or (magnetic) 'field' are accorded specialized meanings. The context- reduced nature of the language of science marks the height of the difficulties faced by isiXhosa-speaking learners, and is therefore highly relevant to this study.

The *second (vertical) dimension* refers to the level of cognitive demands required in communication. Cognitively demanding communication may occur in a classroom where much information at a challenging level needs processing quickly. Cognitively undemanding communication is where a person has a mastery of language skills sufficient to enable easy communication. An example would be having a conversation in the street, at the shop, or at the stadium, where the processing of information is relatively simple and straightforward (Baker, 1993).

Surface fluency or basic interpersonal communication skills will fit into the first quadrant, where BICS is context-embedded and there is a cognitively undemanding use of a language. Language which is cognitively and academically more advanced fits into the fourth quadrant, where CALP is context- reduced, with a cognitively demanding use of language. (Baker, 1993: 161) highlights that:

> It should be noted that the letters A, B, C, and D are used solely for labelling purposes and do not imply an overall developmental sequence or order of difficulty. Thus as far as *cognitive* demands are concerned, by definition, tasks in quadrants A and C will have become cognitively undemanding more rapidly than those that remain in quadrants B and D; however, nothing is implied about the comparative difficulty of tasks in quadrants A and B versus those in quadrants C and D.

Cummins' model suggests that second-language competency in the first quadrant, referred to as surface fluency, develops relatively independently of first-language surface fluency (Baker, 1993; Cummins & Swain, 1986). In comparison, context-reduced, cognitively demanding communication develops inter-dependently and can be promoted either by one language or by both languages in an interactive way. Thus the model suggests that bilingual education will be successful when children have enough first- or second-language proficiency to work in the context-reduced, cognitively demanding situation of the classroom. For Cummins, it often takes one or two years for a child to acquire context-embedded second-language fluency, but five to seven years or more to acquire context-reduced fluency (Baker, 1993).

The important point to make with regard to Cummins' model is that children with some conversational ability in their second language may falsely appear ready to be taught through the second language in the classroom. Cummins' theory suggests that children operating at the context-embedded level in the language of the classroom may not understand the content of the curriculum and fail to engage in the higher order cognitive processes required in the classroom, such as synthesis, discussion, analysis, evaluation and interpretation (Baker, 1993).

Baker (1993) cites instances, where the two-dimensional model helps to explain various research findings. In the United States, for example, minority-language children may, on the basis of their BICS, be transferred from transitional bilingual programmes to English-only schooling, when their conversational ability in English seems sufficient (Baker, 1993; Cummins & Swain, 1986). Cummins and Swain (1986: 140) state that, "Language minority students are frequently transferred from bilingual to English-only classrooms when they have developed superficially fluent English communicative skills." However, such pupils frequently perform poorly in mainstream schooling. In terms of Cummins' model, this suggests that this poor performance is attributable to the children not having developed the more evolved language skills required for them to benefit from the educational process (Baker, 1993).

Cummins' model has implications for the learners' capacity for scientific knowledge construction, as well as the educators' role in helping these learners to achieve academic success. At the horizontal dimensional level, the educators need to provide as much contextual support as possible, to enable the learners to develop those communicative skills which will enable them to meet the linguistic demands of the classroom and (progressively) move towards quadrant C (the context-reduced level of operation) along the continuum. In this regard, there needs to be closer co-operation and joint planning between language and science teachers. At the vertical dimensional level, educators need to provide the learners with the necessary communication tools (or information processing skills) that would increase their active cognitive involvement at quadrant D level, thus capacitating them to master their academic activity or task performance (e.g. science knowledge construction) and move or 'automatize' their performance from the bottom toward the top of the vertical continuum (Cummins & Swain, 1986). This would facilitate the learners' science knowledge construction.

3.5.3 Language of Science

Learning science is, in many respects, like learning a new language as the learners must master the special language (terms and concepts) used in science (that is, the *language of science*) (Halliday & Martin, 1993; Ogunniyi, 1986; O-saki, 2005; Po, 2006; Wellington &

Osborne, 2001). However, learning science presents a further difficulty, in that many of the conceptual words of science (for example, *energy*, *work*, and *power*) have a precise meaning and sometimes an exact definition which gives them different meanings to those used in every-day life. This situation is further aggravated by the fact that many of the terms of science are metaphors. For example, a (magnetic) field in science is not really a field as we know it in everyday or ordinary language (Wellington & Osborne, 2001), as in a sports field, for instance.

Wellington and Osborne (2001) point out that research over the past 30 years has shown that one of the major difficulties in learning science is learning the language of science. They assert that "paying more attention to language is one of the most important acts that can be done to improve the quality of science education" (Wellington & Osborne, 2001:1). This seems to suggest that, if the learner were to receive sufficient exposure to the target language (TL) of input (i.e. the LOLT) as well as comprehensible input in the target language, he/she could produce meaningful (language) output in science (Cummins & Swain, 1986; Nomlomo, 2007). The duty of the science teacher is to translate the highly codified language of science into a language that his/her learners can understand (Ogunniyi, 1986).

The argument for the importance of language in science education is premised on three basic starting points:

1. Learning the language of science is a major part (if not *the* major part) of science education. Every science lesson is a language lesson. This relates to *language across the curriculum* whereby, in the process of teaching science, the educator also integrates and lays emphasis on the TL development of the learners (working in close co-operation with the English teacher).
2. Language is a major barrier (if not *the* major barrier) to most pupils in learning science. This includes both the language of instruction (LOLT) and the *language of science*.
3. There are many practical strategies which can help to overcome these barriers. These depend largely on the creativity of the teacher and could, for example, include (but not be limited to) exposing learners to the world of science through films, videos, etc.; integrating western science with indigenous knowledge based on the learners' social context, and organizing science 'expos', excursions and 'science camps', to name but a few. (Wellington & Osborne, 2001).

Arguments in favour of the simplification of science language in the classroom have been presented by some writers (e.g. Ogunniyi, 2005; Saul, 2004). However, while sympathizing with this approach to the teaching of science, Wellington and Osborne (2001:6) point out that:

> … learning to use the language of science is fundamental to learning science. As Vygotsky (1962) pointed out, when a child uses words he or she is helped to develop concepts. Language development and conceptual development are inextricably linked. Thought requires language, language requires thought. Viewed from a negative angle, 'difficulty with language causes difficulty with reasoning'.

In other words, when the learner understands the language through which science knowledge is mediated (meaningful input), it is easier for him/her to conceptualize such knowledge and to give or construct meaningful scientific output. Lack of understanding of both the LOLT and the language of science interferes with the learner's thought processes. A learner who is not familiar with the concepts of science will not only fail to understand the language but will also struggle to conceptualize what is being taught. To a learner for whom English LOLT is a second language this amounts to double jeopardy, as such a learner will not only struggle with scientific concepts but also with the language that is used to explain the concepts. The task of grasping science knowledge abstraction, as well as science knowledge construction, becomes virtually impossible for such a learner.

Wellington and Osborne (2001) emphasize that we can only learn and teach a new language by providing opportunities to practice its use. In identifying difficulty with the use of 'the language of science' they focus on the meanings of the words used in science education (semantics), rather than on the way they are put together and structured (syntax), as well as the problems posed by logical connectives such as *or, but,* and *although*.

The study by Yip and Tsang (2006) also indirectly touches on the issue of the language of science, in that they interpret the findings to suggest that English Medium Instruction (EMI) students might experience greater learning problems in science than in other subjects, probably because science learning involves abstract thinking and *the mastery of scientific terminology which make a higher demand on language proficiency* (Yip & Tsang, 2006: 406; O-saki, 2005). This argument further highlights the difficulty presented by the language of science to the learning of the subject. Firstly, science demands cognitive language proficiency (CALP). Scientific terms have precise or specific and specialized meanings (or definitions) which go beyond the normal every day use of words. For example, the word 'solution' in science stands for a chemical fluid in which some 'salt(s)' have been dissolved, and has nothing to do with the 'answer to a particular problem', as in ordinary speech. A learner using a scientific term, therefore, must know its precise meaning and keep this in mind when discussing, describing, or explaining phenomena. This is what is meant by the learner's *mastery of scientific terminology*. Secondly, science language demands a high level of abstraction or abstract thinking. For example, if a learner is required to calculate the distance a car will travel in 30 minutes at a speed of 20 km/h, it is expected that he/she will not only use his/her imagination but will also be able to use the appropriate scientific formula (using *special symbols*) to work out the answer. A learner who lacks proficiency in the language of science will fall short in meeting both the above demands. In this regard, Gee (2004: 13) asserts that:

> No domain represents academic sorts of language better than science. Science makes demands on students to use language – oral and printed – as well as other symbol systems that epitomize the types of representational systems and practices that students need to master for higher levels of school success. In addition, these languages and representational systems are at the heart of living in and thinking critically about modern society.

3.5.4 Science learning linked to theory

In this study, it is acknowledged that learning (including science learning) does not occur in a vacuum, but in the context of society and its cultural environment. This approach to learning is in keeping with the Eco-systemic Model (discussed in Chapter 2, paragraph 2.2.3), which locates the learning difficulties experienced by the learner in the interaction between the child and the (ecological) environment. The theories and models below are discussed in relation to the above understanding.

3.5.4.1 The Zone of Proximal Development

Vygotsky's Socio-Cultural Theory, in particular, *The Zone of Proximal Development* (ZPD), emphasizes the importance of the socio-cultural context by which learning is mediated (Cleghorn, 2005; Davey, 1996; Kuzolin, 1998). In this mediation and the support or 'scaffolding' process, language plays a central and critical role (Bruner, 1964; Pea, 2004; Vygotsky, 1962).

Vygotsky acknowledged that the child's intellectual ability necessarily passes through developmental phases (as Piaget hypothesizes), but that these stages are not where true learning takes place (Davey, 1996). Learning only takes place in what he called the Zone of Potential (or proximal) Development (ZPD). The ZPD represents those intellectual functions which have not yet matured and are still in the process of developing. Vygotsky calls these functions "buds" or "flowers" of development rather than the "fruits" of development. "The *actual (current) developmental level* (the one that Piaget identified) is indicative of mental development that has been accomplished, while the *zone of proximal development* characterizes mental development that is *possible"* (Davey, 1996: 12). In terms of the above definition of learning, the ZPD can be seen as the area where the expected change in learner behaviour is more likely to take place. The maturation of intellectual functions in the child includes the ability to master the use of symbols (including language) as the tools of thought and communication. According to Vygotsky, the Zone of Proximal Development represents the distance between the *actual* developmental level, determined by *independent* problem-solving by the child, and the level of *potential* development, determined through problem-solving under adult guidance or in *collaboration* with the child's more capable peers (Davey, 1996). What Vygotsky is saying, in effect, is that the state of a child's mental development can be determined only by clarifying the two levels previously mentioned: the actual developmental level and the zone of proximal development. The actual developmental level is the level of development of a child's mental functions that has been established as a result of certain biological cycles (the ones that Piaget identified). When one determines the child's intellectual ability by using tests (without the assistance of others, i.e. without demonstration, clues, or guiding questions), one is almost dealing with the *actual* developmental level. These tests presume that only those things that children can do on their own are indicative of their mental abilities. A child's actual developmental level, therefore, tells us about functions that have already matured, i.e. the end products of development (Davey, 1996).

If an educator offers clues to the learner, helps the learner with guiding (leading) questions, or shows how the problem is to be solved and the learner then solves it, or the learner solves the problem in collaboration with his/her peers, how the learner arrives at a solution is regarded as indicative of the child's mental *potential.* The learner's ZPD, therefore, tells us about how his/her intellectual functions are maturing, that is, in the process of development. The potential developmental level becomes the next actual developmental level, which presupposes a specific social nature and a process by which the child grows into the intellectual life of those around him/her.

What Vygotsky is saying, therefore, is that learning is a cognitive function that occurs in a social or cultural context. It is something that happens in association with other people and does not occur naturally. In this relationship, language plays a crucial role in that it is through language that meaningful communication and understanding are facilitated. It is therefore critical that the child understands the language that is used in the guiding or mediation process. In other words, by using L1 or language that the learner understands in teaching science, the learner's potential development is maximized and he/she is likely to learn more. In this way, the learner's own science knowledge construction potential is maximized. The teaching and learning process thus links social interaction with cognition (Cleghorn, 2005). The primary task of teaching, then, is to provide a learning environment in which learners from diverse social backgrounds can engage collaboratively in productive purposeful activities which develop them. However, this theory is challenged "when education comes via an L2 and the content of the curriculum represents a culture that is foreign to the learner" (Cleghorn, 2005: 107).

Davey (1996) notes that the notion of Vygotsky's *proximal development* enables us to propound a new formula, namely that the only "good learning" is that which is in advance of a child's natural cognitive development and occurs in a social context (involving language). Language, therefore, releases the learner from dependency on immediate and concrete experiences and allows for thinking about people, objects and events that are not immediately present. The implication for this study is that one needs to look at how language can be used, taking the learner's cultural background or context into consideration, to facilitate learning. The next paragraph looks at Krashen's Input Hypothesis with a view to integrating it with the theories of Vygotsky, Aikenhead and Jegede, and with Cummins' Model.

3.5.4.2 Krashen's Input Hypothesis

Much as Krashen's Input Hypothesis relates to language acquisition and not to learning per se, I have found its principles applicable in the context of the Constructivist paradigm. I have found the hypothesis useful in explaining the processes by which learners (with guidance and through the use of language) construct their own (scientific) knowledge.

Krashen's Input Hypothesis explains the role played by language in learning. It seeks to explain the relationship between what the learner is exposed to in a language (the input) and the learning process (Davey, 1996). According to this hypothesis people acquire language best by understanding input which is slightly beyond their current level of competence. An *acquirer* can "move" from a stage *i* (where *i* is the acquirer's level of competence) to stage (*i*

+ 1), where ($i + 1$) is the stage immediately following i along some natural order, by understanding language containing ($i + 1$). Clues based on the situation and the context, extra-linguistic information, and knowledge of the world make comprehension possible. In this respect the concept is similar to Vygotsky's ZPD process. The ability to speak fluently cannot be taught directly; rather, it "emerges" independently in time, after the acquirer has built up linguistic competence by understanding input. If there is a sufficient quantity of comprehensible input, ($i + 1$) will usually be provided automatically (Davey, 1996: 17 – 18).

Comprehensible input refers to utterances that the learner understands, based on the context in which they are used, as well as the language in which they are phrased. When a speaker uses language so that the acquirer understands the message, the speaker "casts a net" (in line with Vygotsky's concept of "scaffolding" and providing "clues") of structure around the acquirer's current level of competence, and this will include many instances of ($i + 1$). This suggests that, in addition to being relevant and/or interesting, the input must approximate to the learner's ($i + 1$). It must be comprehensible, in that it is near the learner's actual level of development (i), but must then stretch beyond that to include concepts and structures that the student has not yet acquired, to ($i + 1$). The input need not be finely tuned to the learner's current level of linguistic competence: in fact it cannot be all that finely tuned in a language class, since many of the learners will be at different levels of competence. According to Krashen, acquirers of a second language need to be provided with "adapted speech" which is rough-tuned to their present level of understanding (Davey, 1996: 18). In this way, the learner is provided with simple codes that facilitate second-language comprehension, which emerges and develops as growing competence in the second language.

This adapted speech is characterized by exaggeration of pronunciation and facial expression; a slower speech rate and increasing or alternating volume; frequent use of pauses, gestures, graphic illustrations, questions and dramatization; sentence expansion; rephrasing, repetition, restatement and simplification; prompting; completing utterances made by the student; use of Yes/No instead of Why- questions, and other changes that make messages more comprehensible to those of limited language proficiency. By these methods, the input is automatically adjusted to ensure understanding. In this way, a second language is acquired through the natural process of communication.

Vygotsky's ZPD and Krashen's Input Hypothesis use the same principle, whereby the learner must be taken or assisted to an immediate 'higher level' of functioning in order to learn effectively. Both theories also imply and depend on the use of language that is understood by the learner in 'assisting' the learner. If there is a mismatch between the language of the learner and the language used by the educator, both the ZPD and the Input Hypothesis may not be applicable. In terms of Krashen's (affective filter) hypothesis, learners "acquire best under non-threatening conditions, and large scale, formative evaluation might be likely to raise the filter" (Alderson & Beretta, 1992: 144).

Jegede (in Semali & Kincheloe, 1999) talks about what he terms 'situated cognition' (i.e. understanding that takes the context or situation into consideration), and notes that:

> A key factor in problem-solving ability is the learner's resources – the informal or intuitive knowledge an individual is capable of bringing to bear on his or her relevant competencies. Schema theory and related research indicate that as in the case of expert practitioners, children's previous knowledge and experience are a major determining factor in how new tasks are interpreted, what is understood and what they can go on to learn. The organized, abstracted bodies of information which learners bring to learning determine whether new materials will make sense (Semali & Kincheloe, 1999: 121).

Semali and Kincheloe (1999) also state that the way students represent the information given in a mathematics or science problem, or in a text they have read, depends upon the structure of their existing knowledge. These structures enable them to build a representation or mental model that guides problem-solving and further learning. Atwater (1994) holds the view that a student's prior knowledge, expectations, and preconceptions serve as filters for information. This suggests that a learner who comes from an indigenous background will probably have a different knowledge structure and will be likely to interpret, present or solve the problem differently. Therefore, "in science classes the ideal way for students to understand science concepts includes students challenging the new concept, grappling with it, attempting to make meaning of it, and eventually integrating it with what they already know"(Semali & Kincheloe, 1999:121). This is in line with the constructivist approach used in this study.

3.5.4.3 Alignment of theories with constructivism

The above theories are congruent with the constructivist approach in that they facilitate and support the learner in the process of knowledge construction. Through meaningful (language) input the learner is able to understand what is taught and to access the ZPD; this enables the learner to construct his/her own scientific knowledge, based on an understanding of the input. In the case of a learner from an indigenous knowledge background, Aikenhead and Jegede's

Border Crossing helps to manage or clarify the input so as to make it more meaningful. If the Border Crossing is not successful the learner may resort to Collateral Learning by holding the (less meaningful) input alongside his/her indigenous knowledge.

How the theories link with constructivism

Learning with understanding affects our ability to apply what we have learned (Donovan & Bransford, 2005). The above theories of learning (including science learning) have one common denominator, namely that teaching must be aimed at making it easy for the learner to understand the subject to be learned. If the learner understands the subject, he/she should be able to construct his/her own knowledge of the subject, based on personal experience (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004; Ogunniyi, 1986).

The concept of learning with understanding occurs at two levels: (1) factual knowledge (e.g., about characteristics of different species) must be placed in a conceptual framework of the learner (e.g., about adaptation) to be well understood; and (2) concepts are given meaning by multiple representations that are rich in factual detail (Donovan & Bransford, 2005). The construction of new knowledge, therefore, means that the learner incorporates such new knowledge into his/her frame of reference (including indigenous knowledge) to form a more complex cognitive structure (schema). By using a language that he/she understands, the learner is propelled to cross the linguistic/cultural/cognitive border into constructing his/her own scientific knowledge (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004; Ogunniyi, 1986). As Ogunniyi (1988: 8) points out, "It seems that if the scientific world view is to succeed in Africa and perhaps other traditional societies, the aim should be geared towards accommodation rather than assimilation."

3.5.4.4 Implications of the theories for scientific knowledge construction

Both Vygotsky's ZPD and Krashen's Input hypothesis give an indication of, or suggest how, learners should be assisted to construct knowledge rather than knowledge (information) being stored or banked in their minds. Awareness of, and effective implementation of, Krashen's Input Hypothesis can assist educators in applying Vygotsky's ZPD or, alternatively, Aikenhead and Jegede's Border Crossing and Collateral Learning principles to guide their learners in the process of science knowledge construction and in promoting the teaching and learning of science in their classrooms. Equally, knowledge of Cummins' 4 Quadrant Model will enable the educator, on the basis of his/her awareness of the learner's CALP, to decide what strategies to use to 'scaffold' the learner to the required cognitive skills (from 3rd to 4th quadrant). In so doing, the learner's scientific knowledge construction will be enhanced.

Donovan and Bransford (2005: 1-2) highlight three "fundamental and well-established principles of learning" that they consider particularly important for teachers to understand and be able to incorporate in their teaching:

> 1. Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
>
> 2. To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
>
> 3. A "metacognitive" approach to instruction can help students to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

The above principles are in line with the notion of learners constructing their own (scientific) knowledge that is propounded by the constructivist approach.

3.6 THEORETICAL AND CONCEPTUAL FRAMEWORK

The following diagram (Figure 3.2) is a graphic summary of the theoretical and conceptual framework of the study in the context of globalization and the Constructivist paradigm. It shows how globalization impacts on scientific knowledge (both western science and indigenous knowledge) through language (input), which ultimately determines the knowledge construction (i.e. language output) of the learner.

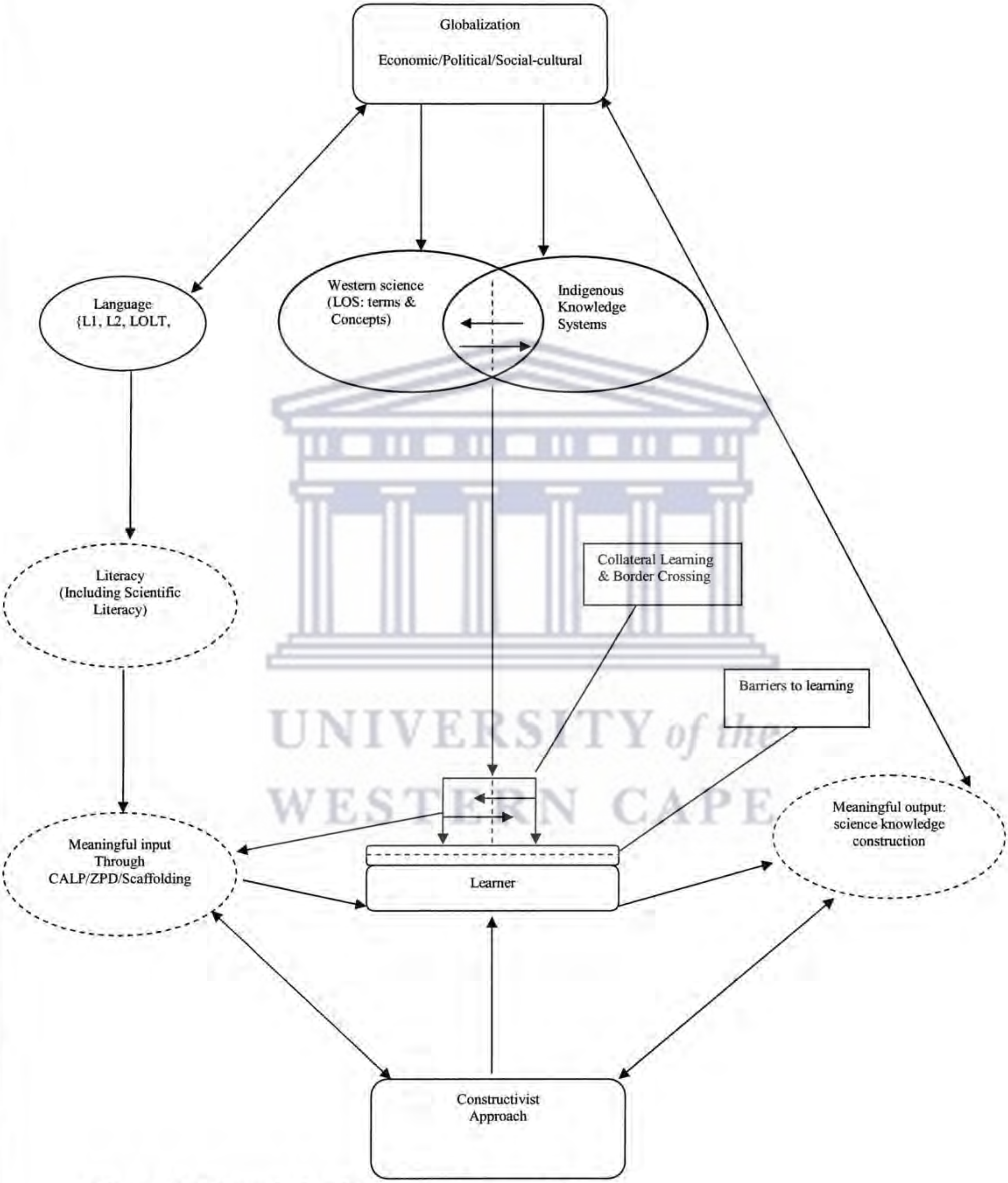

Figure 3.2: Theoretical and Conceptual frame of the study

Figure 3.2 shows the relationship between the various aspects involved in learning (including the learning of science) in the context of globalization, within the constructivist theoretical framework. The first three downward arrows indicate the impact of globalization, through the English language that is used in the classroom, in teaching western science. To the indigenous/African learner, however, western science is learned 'collaterally' with indigenous knowledge systems (IKS) (Aikenhead & Jegede, 1999). Thus, Language, Western Science, and Indigenous Knowledge Systems, are denoted by circles in the diagram. The 'collateral learning' is facilitated by a successful 'border crossing' by the learner (denoted by the dotted vertical line at the intersection between the Western Science and IKS circles) (Aikenhead & Jegede, 1999).

The language used in the science classroom is here examined or seen at two levels, namely, First Language (L1) or Second Language (L2) as Language of instruction (LOLT), on the one hand, and Language of science, on the other. A good understanding of language, both LOLT and language of science, by the learner, leads to scientific literacy (denoted by the first dotted circle). Using both the LOLT and the language of science with a scientifically literate learner enables the teacher to transmit a 'meaningful input' to the learner (denoted by the second dotted circle on the left side of the diagram). The 'meaningful input' from the teacher is further assisted and achieved by use of CALP, ZPD and scaffolding. However before the 'input' of the teacher becomes meaningful, the (indigenous) learner sometimes experiences barriers (including a language barrier) to learning (denoted by the block with a dotted line between the learner block and the 'Cultural Border Crossing' indication at the bottom middle of the diagram). If, however, the learner overcomes the barrier(s) to learning, the 'meaningful input' of the teacher leads to a 'meaningful output' and successful science knowledge construction by the learner (denoted by the dotted circle on the right hand side of the diagram).

The arrows from the bottom block of the diagram show how the Constructivist Approach influences the teacher's 'meaningful input', the learner's thinking (or cognition) and the 'meaningful output' (science knowledge construction) of the learner.

In a nutshell, Figure 3.2 shows how science language, which is influenced by the western science tradition or indigenous knowledge systems (IKS), is used by the teacher to overcome barriers to learning, using techniques (such as the ZPD, scaffolding and facilitation of CALP) to create meaningful input. Successful or meaningful input enables the learner to understand science (phenomena) better. Thus the learner is able to construct his or her own scientific knowledge.

3.7 SUMMARY AND CONCLUSION

In this chapter, it has been argued that globalization has used science (and technology) to drive and advance its mission of universalizing and homogenizing economic, political and socio-cultural activity. The globalization of science education has impacted on the nature and agenda of the science curriculum in many countries (including South Africa), particularly with respect to science learning, the role and place of IKS, scientific literacy, and the role played by the LOLT.

In the context of the constructivist paradigm, this study used an eclectic approach to discussing some of the cognitive theories of learning that are considered to be relevant to its purpose. Because the constructivist paradigm sees the individual or learner as an active agent in constructing (scientific) knowledge, this study utilizes the cognitive theories of Vygotsky, Krashen, Cummins, Aikenhead and Jegede, Fakudzde, and Ogunniyi to explain how this knowledge construction takes place, using both the Western and Indigenous Knowledge perspectives. The chapter also made suggestions as to how the chosen cognitive theories can be used in tandem, within the constructivist framework, to deepen the learner's understanding of science and facilitate his or her scientific knowledge construction. The need to address the barriers to learning, discussed in Chapter 2, was used as a framework for discussing the learning theories.

The next chapter discusses the research methodology that was followed in the study.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter discusses the methodology that was used in investigating the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science through English as the LOLT. It describes the research process and the methodology that was followed in collecting data from the participants involved in the research, and from the documents or records available at the school.

In the paragraphs that follow, details are provided under the headings: Research Objectives; Research Approach and Design; Research Participants and Context; Research Procedure; Data Collection and Analysis; Trustworthiness of the data; Limitations of the study; and, Ethical considerations. Tabular representations of both the research design and the research process followed are presented for clarity. The chapter ends with a Summary and Conclusion.

4.2 RESEARCH OBJECTIVES

The specific objectives of the research were:

- To determine the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science in an English-medium teaching and learning context.
- To understand the role of language in the context of these difficulties.
- To understand the dynamics within the teaching and learning process which contribute to the learning difficulties.
- To understand how the learners and educators are currently coping with the challenges/difficulties.
- To make recommendations to address the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science in an English-medium context.

With the above aims and objectives in mind, the research methodology sought to answer the following (research) questions:

1. What are the difficulties experienced by isiXhosa-speaking learners in learning science through the medium of English?

2. What role does language play in the context of these difficulties?

3. What factors within the teaching and learning situation contribute to these difficulties?

4. How are the learners and educators currently coping with all these challenges?

5. What can be done to assist both learners and educators in overcoming the difficulties?

4.3 RESEARCH APPROACH AND DESIGN

The study used a *mixed-methods* design based on both qualitative and quantitative methodologies (Bergman, 2008; Tashakkori & Teddlie, 2010; Teddlie, 2009). The main body of the research is qualitative in nature, but quantitative data are also used to highlight or show the validity of some of the observations or claims made. According to Abbas and Teddlie (2010):

> Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.

Some of the characteristics of the mixed-method approach which made it suitable for this research are: (1) its "focus on the research question (or research problem) in determining the methods employed within any given study" (Tashakkori & Teddlie, 2010: 10); and (2) its "reliance on visual representations (e.g., figures, diagrams) and a common notational system ... which can simplify the complex interrelationships among elements inherent in those processes" (Tashakkori & Teddlie, 2010: 11). However, one of the limitations of mixed-methods research is that there is no "agreed-upon language for discussing mixed methods studies" (Bergman, 2008: 88).

As a first step in the research process, the quantitative method was used to collect demographic information about both the learners and the educators involved in the learning and teaching of Natural Science in Grade 6 at the school of interest. A qualitative approach was then used to conduct a document analysis, classroom observation, and the learner and educator interviews.

The emphasis of a qualitative research approach is on studying human action in its natural setting and as seen through the eyes of the actors themselves (Babbie & Mouton, 2001). Babbie and Mouton (2001: 278-9) note the following features as shared by qualitative research designs:

- A detailed engagement/encounter with the object of study;
- Selection of a small number of cases to be studied;
- An openness to multiple sources of data (multi-method approach); and
- Flexible design features that allow the researcher to adapt and make changes to the study where and when necessary.

All the above features were present in this study. As its aim was to describe and understand the difficulties experienced by isiXhosa-speaking learners, the researcher found the qualitative approach (characterized by the above features) best suited for the task.

As suggested above, in some cases it became necessary to obtain quantitative statistical information to support (or quantify) a qualitative statement or argument. For example, in analysing the learner responses to an interview question it was necessary to indicate (i.e. quantify) what percentage of learners felt or responded in a particular way. Leedy and Omrod (2005: 180) state that in quantitative research,

> Typically, the focus is on a *particular* aspect of behavior. Furthermore, the behavior is quantified in some way. In some situations, each occurrence of the behavior is counted to determine its overall frequency. In other situations, the behavior is rated for accuracy, intensity, maturity, or some other dimension. But regardless of approach, the researcher strives to be *as objective as possible* in assessing the behavior being studied.

This study, therefore, used the quantitative approach to support particular aspects of the qualitative observations or claims that it made.

Within the qualitative research approach, a *case study design* was used. Merriam (1998: 19) states the following with regard to a case study design:

> A case study design is employed to gain an in-depth understanding of the situation and meaning for those involved. The interest is in the process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation. Insights gleaned from case studies can directly influence policy, practice, and future research.

A single-site *embedded case study design* (Yin, 2003b) was followed in doing the research. An embedded case study design is applicable when the case study involves more than one unit of analysis, that is, when, within a single case, attention is also paid to a subunit or subunits. The embedded case study design is used to collect as much convergent evidence or data as possible around the research question (i.e. to focus the case inquiry), and thus to enhance the validity and reliability of the study. Yin (2003b: 46) notes that, "The subunits can often add significant opportunities for extensive analysis, enhancing the insights into the single case."

According to Bless and Higson-Smith (2000: 64):

> The unit of analysis is the person or object from whom the social researcher collects data. The data from such a unit can only describe that unit, but when combined with similar data collected from a group of similar units, provides an accurate picture of the group to which that unit belongs.

In this particular case study, the units of analysis included Grade 6 *learners*, Grade 6 *Natural Science educators*, (a sample of) *parents* of Grade 6 isiXhosa-speaking learners, the *School Management Team* (SMT), and the available *documents* on the Grade 6 learners participating in the study. The methods or techniques used to collect the data included learner and educator questionnaires, classroom observation, document analysis, and learner and educator (semi-structured) interviews. Through these methods and techniques the study focused on barriers to learning; on the medium of instruction used in teaching and learning Natural Science; on teaching and learning strategies (including coping strategies) employed by the educators and learners respectively to reinforce the learning of Natural Science; and on understanding the Language of Science and the general learning environment of the school. The following diagram (Table 4.1) represents the research design in 'step' form, showing how one step followed and linked with another.

Research Design		
Research Phase	**Method**	**Source**
Phase 1: Developing a picture	Questionnaires, classroom observation, interviews	Learners, educators
Phase 2: Focusing on language	Analysis of questionnaires and documents; interviews	Learner Portfolios; Educator Portfolios; Mark Schedules and Assessment records; learners; educators
Phase 3: Conceptual analysis of language challenges	Review of literature; Data analysis	Literature; Chapters 2 and 3; collected data.

Table 4.1 Research design

4.4 RESEARCH PARTICIPANTS AND CONTEXT

The research was conducted with Grade 6 English-medium Natural Science classes that had isiXhosa-speaking learners. It was carried out over a period of four months, spread over two years (August to September 2008 and October to November 2009), at an ex-Model C[11] primary school (named Tableside Primary School in this text) situated in an urban area of the Western Cape. All three Grade 6 classes had a diverse group of African, coloured and white learners. Some of the learners were immigrants from Anglophone and francophone Africa. Although learning and teaching in Natural Science was done through the medium of English, the composition of the classes provided a multilingual and multicultural environment. However, other than the isiXhosa-speaking learners, the other second-language learners did not speak isiXhosa as their home language, except for one (in 2009) who had a coloured father and an isiXhosa-speaking mother. As this learner was not fully isiXhosa-speaking, she was not included among the 26 focused on over the two years of research.

Because of the small number of Grade 6 isiXhosa-speaking learners, distributed in all three Grade 6 classes at the school in 2008, it was decided to involve all three classes in the research. In that year, there were a total of thirteen (13) isiXhosa-speaking learners in the three Grade 6 classes. Furthermore, because of the small sample size (N =13 isiXhosa-speaking learners), it was decided to extend and replicate the research with a second cohort of learners in 2009, so as to increase the scope and enhance the validity of the study. Babbie and

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[11] During the apartheid era, schools designated for White children were classified by law as Model C Schools.

Mouton (2001: 397) note that "Replication can be a general solution to problems of validity in social research." As before, there were 13 isiXhosa-speaking learners distributed over three Grade 6 classes at the school. The total number of isiXhosa-speaking learners involved in this study was thus 26.

Tableside Primary School is situated in an urban suburb in the Metropole Central Education District. This school was chosen because it typifies the post-1994 situation, with an influx of African learners from the local townships in the Western Cape, from the Eastern Cape, as well as from other parts of Africa, into previously Coloured (ex-HOR) and previously White (ex-Model C) schools. An ex-Model C school was chosen because this type of school embodies the shift to a totally new cultural environment that learners from black townships have had to make in post-apartheid (democratic) South African education. Secondly, the primary school level of the study was chosen because of the importance attached to the early years in language acquisition as a foundation for further education (Alexander, 1990; Taylor & Vinjevold, 1999).

Except for the three learners whose parents did not give consent, all the Grade 6 learners allowed to complete the questionnaire part of the research process. This was done to determine the kind of cultural and linguistic environment the main interest group of the study (the isi-Xhosa-speaking learners) was exposed to in their Natural Science classrooms.

Although the focus was on the isiXhosa-speaking learners, all learners in the Grade 6 class at the school participated in the research, except in the interview phase. Only isiXhosa-speaking learners were interviewed in 2008. However, in 2009, in addition to the isiXhosa-speaking learners, a randomly selected comparative group of 10 English-speaking learners was interviewed in order to obtain a balanced view of how 'normal' English-speaking peers responded to the same interview questions as were posed to the isiXhosa-speaking learners. All three Grade 6 Natural Science educators who taught these particular classes were involved in the entire research process, including the interviews. In addition, the SMT (composed of the principal, the deputy principal and Heads of Department) and some isi-Xhosa-speaking parents were also interviewed.

In summary, the following table (Table 4.2) shows the research participants:

Year	**Data collection technique**	**Class participants**	**IsiXhosa-speaking learners**	**Educators**	**SMT**[12] **members**	**IsiXhosa-speaking parents**
2008	Questionnaires	90	13	3		
2008	Interviews	0	13	3	3	2
2009	Questionnaires	89	13	3		
2009	Interviews	10	13	3	4	2
		N = 179	N = 26	N = 4[13]	N = 4	N = 4

Table 4.2: Research participants

Sampling

Bergman (2008: 74) notes that "Different sample sizes are common in mixed methods designs because quantitative and qualitative data are usually collected for different purposes." The participants in this research were selected through *purposive sampling*. "This type of sample is based entirely on the judgement of the researcher, in that a sample is composed of elements that contain the most characteristic, representative or typical attributes of the population" (de Vos, Strydom, Fouche & Delport, 2005: 202). De Vos et al. (2005: 328) state that "In purposive sampling a particular case is chosen because it illustrates some feature or process that is of interest for a particular study," and that "In the case of purposive sampling researchers purposely seek typical and divergent data" (de Vos et al., 2005: 329).

Purposive sampling was thus used in selecting the learner participants, namely Grade 6 isiXhosa-speaking learners (N = 26) and some English-speaking learners (N = 5). IsiXhosa-speaking learners were selected from each Grade 6 class because they constituted the focus of the study, while the English-speaking learners were selected specifically for the purpose of determining whether there would be a different pattern in their responses to the interview

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[12] Two of the three Grade 6 Natural Science educators were Heads of Department (HODs) and, therefore, members of the SMT.

[13] At the time of the researcher's visit in 2008, one of the Grade 6 Natural Science educator HODs had been on leave and was substituted by an ordinary Natural Science teacher (i.e. the teacher was not a HOD). The former returned to his post in 2009, hence the "N = 4" educators interviewed over the two years. This also explains why there were only 3 SMT members interview in 2008 instead of 4 as in 2009.

questions posed to their isiXhosa-speaking classmates. IsiXhosa-speaking learners are defined as those whose mother tongue is isiXhosa and who speak the language at home (as reflected in the Demographic Information Questionnaire administered to all the participating learners at the beginning of the research study). Similarly, English-speaking learners are defined as those whose mother tongue is English and who speak the language at home (again, on the basis of the learners' responses to the Demographic Information Questionnaire). All Grade 6 Natural Science teachers participated both in answering the questionnaires and in the interviews.

4.5 RESEARCH PROCEDURE

The research was conducted from 1 August to 30 September 2008 for Cohort 1, and from 1 October to 30 November 2009 for Cohort 2. The Cohort 2 process was initially scheduled to start on 1 August and end on 30 September but was delayed due to the Swine Flu epidemic which broke out in the Western Cape and resulted in many learners staying away from school, either because they were infected with the flu or out of panic or fear that they might be contaminated. Thirteen isiXhosa-speaking learners and three Natural Science educators (each year) took part in the research for each period of the research process. In 2009, one female (substitute) educator left the school and was replaced by the male educator for whom she had substituted in the post. This meant in effect that four different educators, three female and one male, took part in the research.

The difference in the period of research between Cohort 1 and Cohort 2 had the potential to impact (positively or negatively) on the outcomes, as the latter part of the research with Cohort 2 was done on the eve of the final or end-of-year examinations. However, this slight shift in the time frame had the advantage that the topic that was being dealt with in Natural Science at the time differed from that of the previous year, creating an opportunity for more variety in the lessons that were observed and, consequently, greater diversity in the input made by the participants in the research.

The research was conducted in the following three phases:

4.5.1 Phase 1: Developing a picture

This phase of the study focused on identifying and understanding the difficulties and barriers to learning (and teaching) experienced by isiXhosa-speaking learners in learning Natural Science through English as LOLT.

The first step in the data gathering process was to develop a 'picture' of the Grade 6 class concerned by using *questionnaires*, *observation* and *interviews*. The purpose of this step was:

1. To obtain relevant demographic information on the learners in all Grade 6 classes, as well as their Natural Science educators;
2. To obtain a sense of the general class atmosphere, including the nature of relationships among the learners, and between learners and educators (i.e., the classroom dynamics);
3. To identify and understand the learning and teaching strategies used by learners and educators during science lessons; and
4. To understand the difficulties and barriers to learning experienced, as well as the coping strategies employed, by learners and educators in learning and teaching science.

This initial phase of the study *did not focus on language specifically*. The theoretical framework used as a background and as an analytical framework for this phase was 'barriers to learning'.

4.5.2 Phase 2: Focusing on language

Phase two of the research was a more in-depth exploration of the difficulties and barriers experienced by the learners around 'language' – using two frames as a basis, namely: the *LOLT* aspect and the *Language of science* aspect.

The questionnaires and interviews used for Phase 1 were used here too. The questionnaires and documents (Learner Portfolios, Educator Portfolios, and Mark Schedules/Assessment Records) were analysed or used to establish to what extent the learners were exposed to or used English (the LOLT) in their daily lives, at home and at school (in class or outside the classroom). During this phase, interviews were also conducted with both learners and the educators, individually and in focus groups. The interviews were used to obtain an in-depth understanding of the learning and teaching strategies used by learners and the educators during science lessons to assess the difficulties experienced in learning and teaching science through the medium of English, and to identify ways in which these difficulties could be addressed. Information obtained from the interviews was used to triangulate the data collected during the document analysis, classroom observation, and questionnaire phases of the research process. In the interviews, the focus was mostly on the Language of Science, including scientific terms and concepts, as used in the classroom and in their textbooks or other learning materials.

As a next step, the teachers' as well as the learners' *proficiency in using English and the language of science* during the lesson activities was *observed* and noted. This observation was guided by the criteria set out in the observation checklist and by an analysis of the learners' workbooks. With regard to the coping strategies used by isiXhosa-speaking learners (relating to language specifically) in the classroom, particular attention was paid to *code switching* (both among the learners, and between the learners and the educators). Holmarsdottir (in Brock-Utne, Desai & Qorro, 2006) notes that *code alternation* (including code-mixing, code-switching and translation) is a major coping strategy used in black/township schools: "In the townships the use of the mother tongue is not only recognised, but also valued as a tool to assist both learners and teachers alike" (Brock-Utne et al., 2006: 211). Code alternation is used in black/township (ex-DET) schools to give learners access to the curriculum, to assist with classroom management, to elicit the response of learners, and to promote interpersonal communication. However, Holmarsdottir (2006) notes that this coping strategy seems not to be used in multicultural (i.e. ex-Model C and ex-HOR) schools in the Western Cape (Holmarsdottir, 2006). It was interesting to find out what coping strategies were used by isiXhosa-speaking learners and their Natural Science teachers in these schools. The classroom observation process was tape-recorded to facilitate further analysis and ease of reference. The observation checklist is attached as an Appendix to this study.

The next step was to determine the learners' proficiency in English and the Language of Science by examining and analysing their class work, assignments and assessment/test performance (through document analysis). This was done with reference to the requirements of the Grade 6 Natural Science curriculum, as prescribed by the National Curriculum Statement (NCS), and those key concepts in their prescribed science textbooks which were included in the lessons covered both before and during the research period. This *document analysis* was guided by the research questions.

4.5.3 Phase 3: Conceptual analysis of language challenges

This phase, which was conducted once all the primary data had been collected, was linked to the conceptual/theoretical framework (Chapter 2 and Chapter 3, paragraph 3.6). Phase 3 was an analytical phase which involved looking at all the collected data through the lens of the constructivist approach. It also focused on analysing the language challenges within the context of the overall barriers to learning and teaching. This was intended to help the researcher understand the language challenges within a broader constructivist framework, and to identify 'key levers' on which to focus when addressing the barriers or challenges, within the context of an eco-systemic analysis.

The analysis focused on how the learners communicated with each other (i.e. among themselves, both formally and informally), with the teachers (formally and informally), and how the school issued general instructions and communiqués to the learners. Extra-curricular and cultural activities which enhanced (bilingual) linguistic and scientific development in the school were also examined. The performance of the school in the Grade 6 Departmental Systemic Evaluation (WCED, 2006), conducted in 2007, was also examined as part of the document analysis. This was done to obtain an overall impression or picture of how the school was performing in the systemic Literacy and Numeracy (Lit/Num) tests, with particular focus on the literacy aspect, in order to assess how far ahead or behind the school was in relation to the national standard or benchmark. An attempt was also made to find out whether there was a correlation between the number of African/isiXhosa-speaking learner participants in the systemic evaluation tests and the quality of the results that the school achieved or obtained in a particular year. The Lit/Num tests were limited, however, in that they did not distinguish the performance of the various (racial) groups in the school's results, but instead only gave an overall performance percentage for the entire grade.

4.6 DATA COLLECTION AND ANALYSIS

The data were collected by using various instruments prepared beforehand for the specific purpose of accessing demographic information and the socio-economic conditions of the learners, and by carrying out classroom observation, document analysis, and interviews. The data collection instruments are attached as appendices (Appendix D to Appendix L).

The following table shows how each research method in the study was used to pursue its objectives.

Data collection method	**Instrument**	**Source (who)**	**Analysis method**	**Research objective/ question**
Questionnaires	Questionnaires	Learners and educators	Content analysis	To obtain demographic information; learn about socio-economic conditions
Document analysis	Checklist	Learner profiles; educator profiles; assessment records	Content analysis	Learner performance; language usage
Classroom observation	Observation checklist	Learners and educators	Participation; language usage	Learning difficulties; participation; language usage; coping strategies
Interviews (semi-structured)	Interview questions	Learners; educators; SMT; parents	Content analysis	Triangulation; learning difficulties; understanding of science; coping strategies

Table 4.3: Research methods used

4.6.1 Orientation

The first day at the school (both in 2008 and 2009) was spent introducing the researcher, explaining the research process, and sending consent letters to the parents and educators. Copies of the consent letters are attached as appendices (Appendix A to Appendix C – pages 272 to 277).

4.6.2 Questionnaires

Questionnaires entail "a strategy in which participants use self-report to express their attitudes, beliefs, and feelings toward a topic of interest" (Teddlie & Tashakkori, 2009: 232). They differ from interviews in that:

- They involve a self-report by the respondent that does not require contact with researchers;
- They use closed-ended formats more often;
- Studies using questionnaires typically involve more participants, but attrition (i.e. low return rate) can be problematic;
- Questionnaires are typically less expensive to conduct (Leedy & Omrod, 2005; Teddlie & Tashakkori, 2009).

The strength of questionnaires is that they offer a very efficient strategy for data collection. A major advantage is that the researcher can send them over long distances to the respondents at minimal cost, through mail or email (Leedy & Omrod, 2005; Teddlie & Tashakkori, 2009). In particular, questionnaire items with closed-ended responses can be more efficiently collected and analysed. The limitations of questionnaires include attrition, where participants fail to respond. They also call for a level of reading ability which the population under study may not have (Teddlie & Tashakkori, 2009).

In this study, the consent letters from both the learners' parents and the educators were received on the second day of the researcher's visit to the school. Questionnaires were then fielded to all the learners in all three Grade 6 classes at the school on the third day (after verifying the consent of the parents). The aim of the questionnaires was to obtain demographic information about the learners, as well as information relating to their home socio-economic and cultural backgrounds, including the languages they could speak. On the same day that the learners completed their questionnaires, the educators were asked to complete similar questionnaires prepared for them.

4.6.3 Classroom observation

Observation in natural settings may be characterized as "descriptions either through open-ended narrative or through the use of published checklists or field guides" (Angrosino & Mays de Perez, 2000: 674). Vinjevold and Taylor (1999: 91) point out that:

> Classroom observations can provide an enormously rich source of data about general conditions in schools, teaching methods, the quality of learning taking place, the use of equipment and materials, and the relationship between the forms of teaching and learning behaviours and their outcomes.

Observation also plays a very important role in the triangulation of data, where it is one among a number data collection methods used. Merriam (1998: 96) notes that "Observations are also conducted to triangulate emerging findings; that is, they are used in conjuction with interviewing and document analysis to substantiate the findings." In this study, classroom observation visits were paid during Natural Science periods in all three Grade 6 classes, both in 2008 and 2009. A Classroom Observation Checklist was developed and used in order to focus the visits. The Checklist is attached as Appendix J. Extensive field notes on the observed classroom activities were also made (in a journal).

During the classroom observation, the focus was on the following aspects of the teaching and learning situation in each Natural Science class:

1. The interaction between the teacher and the learners, focusing particularly on how language was used;
2. The interaction between the learners themselves, focusing particularly on how language was used;
3. The classroom environment;
4. Whether the educators' teaching styles were adapted to the learners' learning styles; and
5. The coping strategies used by both learners and educators to address the teaching and learning challenges encountered in Natural Science.

The (main) potential limitation of the observation technique of data collection is "observer bias" (Angrosino & Mays de Perez, 2000: 697).

4.6.4 Document analysis

The term *document* is used as an "umbrella term to refer to a wide range of written, visual, and physical material relevant to the study at hand" (Merriam, 1998: 112). Documents constitute "a ready-made source of data" that is "easily accessible" to the investigator or researcher (Ibid.). The strength of documents as a source of data or unit of analysis lies in the fact that their presence does not interfere with the research setting and that they do not depend on the attitudes of the participants in the research. Merriam (1998: 126) notes the following strengths of document analysis:

> The data found in documents can be used in the same manner as data from interviews or observations. The data can furnish descriptive information, verify emerging hypotheses, advance new categories and hypotheses, offer historical understanding, track change and development, and so on. ... document data are particularly good sources for *qualitative* case studies because they can ground an investigation in the context of the problem being investigated.

The limitations of document analysis lie in the fact that locating public records depends on the imagination and industriousness of the researcher, and that in using documents "the researcher has to rely on someone else's description and interpretation of data rather than use the raw data as a basis for analysis" (Merriam, 1998: 114).

In this study, during the document analysis the following documents were perused in order to assess the quality of the learners' work:

1. The Learner Portfolios – these contained samples of the learners' work, including their class work, assignments or projects and assessment scores for all the various subjects prescribed in terms of the Grade 6 curriculum. The focus of the researcher, however, was on Natural Science, in line with the focus of this research study.

2. The Educators' Portfolios – these contained details of the educators' lesson plans for the various subjects that they taught, as well as records of work given to the learners, class tests and memoranda, and records of the learners' assessment scores for the class work, assignments/projects and class tests (including Quarterly Mark Schedules). As was the case with the learners, the focus was on records pertaining to Natural Science. All the Tables used in the statistical analysis of the research (i.e. Table 5.1 to Table 5.13) were drawn using information or records from the Educator Portfolios and Learner Portfolios. The themes that emerged from the statistical analysis (using

analytic categories that were based on the research questions) were integrated with those that emerged from the questionnaires, classroom observation and interviews (as part of the data triangulation process).

Bloom's Taxonomy was the preferred tool used in this study for adjudging the level of cognitive functioning at which the learners performed a given task because this tool has stood the test of time with respect to its reliability (Anderson & Krathwohl, 2001; Bloom, 1957; Po, 2006). In brief, 'Bloom's Taxonomy of Educational Objectives' categorises performance into six levels of increasing complexity, namely:

Level 1 – Knowledge: remembering of previously learned material; recall (facts or theories).

Level 2 – Comprehension: grasping the meaning of material; interpreting; predicting outcome and effects.

Level 3 – Application: ability to use learned material in a new situation; apply rules, laws, methods, theories.

Level 4 – Analysis: breaking down into parts; understanding organization, clarifying, concluding.

Level 5 – Synthesis: ability to put parts together to form a new whole; unique communication; set of abstract relations.

Level 6 – Evaluation: ability to judge value for purpose; base on criteria; support judgement with reason.

The current practice, however, seems to be to use the four levels of questions from the PIRLS (Mullis et al., 2007). The Annual National Assessment (ANA) tests have also included these four levels of questions (Department of Education, 2012). These are:

1. Retrieve explicitly stated information;
2. Make straightforward inferences;
3. Interpret and integrate ideas and information; and
4. Examine and evaluate content, language, and textual elements.

At the start of this research in 2008, the ANA was still being implemented on a trial basis and there was no certainty about its future application, hence the reliance on Bloom's Taxonomy in the study.

4.6.5 Interviews

The most common form of interview is the person-to-person encounter, in which one person elicits information from another (Merriam, 1998: 71). Group or collective interviews are also used to obtain data. The interview is regarded as "the best technique to use when conducting intensive case studies of a few selected individuals" (Merriam, 1998: 72).

In this study, *semistructured* interviews were conducted with all the isiXhosa-speaking learners in all three Grade 6 classes, the three Grade 6 Natural Science teachers, four members of the SMT and, finally, with four parents (two in 2008 and two in 2009). A semistructured interview contains a "mix of more- and less- structured questions" (Merriam, 1998: 73). In this study, the interviews were less structured in the sense that, although determined before hand, most of the questions were open-ended. Secondly, as the learner respondents were second-language English speakers, it sometimes became necessary to rephrase the questions or even translate them into isiXhosa. The interviews were recorded (with the consent of the interview participants) and intensive or 'thick description' field notes taken to include the researcher's observation of the non-verbal content (including 'body language) of the participants' responses. The tape recorded interviews were later transcribed and the responses were grouped into themes or categories (using codes for the emerging themes and the intensive field notes). After concluding the educator interview in 2008, the researcher realized that the learner and educator data did not complete the picture, and that parent input was needed to give a systemic environmental perspective. In collaboration with the SMT, parent interviews were therefore arranged. In the event, many of the isiXhosa-speaking parents did not appear for the interviews, either in 2008 or 2009. However, because parent interviews were not the main focus of this study, four were considered as sufficient and were included (and related to the four science educators interviewed).

The strength of the *semistructured* interview technique is that it "allows the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic" (Merriam, 1998: 74).

4.6.6 Triangulation of data

Data based on the above questionnaires, document analysis, classroom observation, and interviews were collected, collated and analysed. This information was used to identify key challenges and to make recommendations for addressing the learning challenges.

Qualitative content analysis (Henning, van Rensburg & Smit, 2004: 102) of the data texts, namely, the questionnaires and the interviews (with the learners, educators, SMT and parents), was used to derive meaning from, and interpret the data. This was triangulated with data collected from document analysis and classroom observation. The steps followed in this process were: first, with each research method used, the *key themes* that emerged were identified; second, the key themes that emerged with each research method were compared in order to identify the *common threads between themes* among the various research methods; third, the common themes were used as headings for presentation (Chapter 5) and discussion (Chapter 6) of the research findings. Thus the findings made through the various methods used in the research were integrated.

Henning et al. (2004: 102) note that the content analysis method is, unfortunately, "also the method of analysis that may lead to superficial and *naively realistic* findings because it captures what is presumed to be the 'real world' (through the eyes of the research participants) in a straight-forward way." However, as noted above, the content analysis was supplemented and balanced out by document analysis and classroom observation instruments (checklists, field notes and journal entries).

The data and findings of the research were also shared with the author's supervisors and Ph.D support group, who made critical comments and suggestions on them.

4.7 TRUSTWORTHINESS OF DATA

The research questionnaire items and interview questions for both learners and educators were tested through piloting at a primary school in the Metropole South Education District for:

1. Suitability and simplicity of language, that is, whether the language was simple and easily understood by the respondents; and

2. Whether the items or questions elicited the anticipated (same or similar) responses from the participants.

Cohen, Manion and Morrison (2000: 260) highlight that "the wording of questionnaires is of paramount importance and ... pretesting is crucial to its success. A pilot has several functions, principally to increase the reliability, validity and practicability of the questionnaire ..." Questionnaire items and interview questions that did not fulfil the above requirements were either altered accordingly or replaced with suitable ones. The instruments that were used in the research were also scrutinized and discussed beforehand with my supervisors.

To strengthen its validity and limit subjectivity or bias in this study, the following measures were taken:

1. Transcription of data from the interview audio-tape recordings was double-checked with an independent research assistant.

2. The coding of the emergent themes from the data was also tested via the independent helper.

3. Triangulation of the data and findings was done through the various research methods used in the study, namely the questionnaires, classroom observation, document analysis, and interviews. Cohen et al. (2000: 112) note that "Triangulation is a powerful way of demonstrating concurrent validity, particularly in qualitative research."

4. Peer debriefing on the methodology and process of the research was done with the researcher's Ph.D Support Group at the University of the Western Cape. This group gave critical comments and advice on the process and methods of the research study.

5. The preliminary data and research findings were shared with the educators and SMT at the school where the research was conducted by way of feedback. This was done to correct errors and to check for the accuracy of both the data and its interpretation. Angrosino and Mays de Perez (2000: 676) note that:

    > True objectivity has been held to be the result of agreement between participants and observers as to what is really going on in a given situation. Such agreement has been thought to be attained through the elicitation of feedback from those whose behaviors were being reported.

4.8 LIMITATIONS

This study sought to find out the learning difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science through the medium of English at a particular primary school in the Western Cape. Its findings, therefore, cannot be extrapolated to other schools. Indeed, the findings in this study may not be applicable to all Grade 6 isiXhosa-speaking learners. It is hoped, however, that the findings will be used as a stepping stone to inform further studies and debate on the same subject.

As the research method of the study was predominantly qualitative in nature, the quantitative aspects were only used to highlight or qualify particular observations made. The quantitative elements were, therefore, not the main focus, nor were they meant to be deep or intensive.

As stated previously (in paragraph 4.4), purposive sampling was used to select the participants in this study. With regard to such sampling, Cohen et al. (2000: 104) state that: "Whilst it may satisfy the researcher's needs to take this type of sample, it does not pretend to represent the wider population; it is deliberately and unashamedly selective and biased."

Because two groups or cohorts of Grade 6 learners were involved in the research process (13 learners in 2008 and 13 in 2009), the class assessment exercises perused during document analysis were not necessarily identical in content. However, the curriculum remained the same, and the trends and patterns of the exercises given to the learners that were analysed were similar.

In the study, the communicative literacy skills of the learners (i.e. reading, writing, and speaking) were not assessed or tested in depth (Langenhoven, 2006). Any comment or opinion on such skills in the study was based solely on evidence in the Learner Portfolios and assessment records contained in the Educator Portfolios reviewed during the document analysis, as well as during the learner and educator interviews.

As a person who is no longer an active classroom practitioner, there was a potential risk that the researcher might miss or misinterpret some of the current and broader practical realities of teaching Natural Science in Grade 6 on the ground, other than those presented by the educator respondents in the research. Furthermore, having been an isiXhosa-speaking learner under the apartheid education system, taught through the English (and Afrikaans) medium of instruction, there was also a potential risk that the author might overstate the case of the difficulties experienced by the learners in this study.

However, because of his conscious awareness of these potential risks, the researcher tried as much as possible to stick to the issues and rigorously (and critically) followed the research methods and procedures in a disciplined way.

4.9 ETHICAL CONSIDERATIONS

The following ethical statement is based on the Faculty of Education's (2006) *Ethical Guidelines for Students*, University of Western Cape.

Consent

Every person participating in this research was asked to do so voluntarily. Detailed information about the aims, importance, methodology and duration of the research was provided to ensure that a participant's consent was informed.

Right to withdraw

Participants were informed that they could withdraw from participating in the research at any time without having to give an explanation. The researcher respected this right to withdraw, whether it was indicated verbally or in writing.

Vulnerable participants

The researcher took special care to ensure the protection of vulnerable participants, in particular the children. He also took care not to cause emotional or any other harm and so avoided asking questions that were judgemental, insensitive to cultural values, or which might expose the respondents to humiliation. Sensitive topics were, therefore, carefully scrutinized for their possible impact upon the participants.

Privacy and confidentiality

The participants' right to privacy, confidentiality and anonymity was respected and assured. However, if they wished to be identified, this too was recognized, provided they expressed such a wish in writing.

Recording

Permission was obtained from all the participants for the tape-recordings. Any discomfort with the audio recording was taken into account, and the process was terminated if discomfort was expressed. All tape recordings will be erased after completion of the research.

Storage and security

The data collected and used in the research have been organized, stored and managed in such a way as to prevent loss, unauthorized access or divulgence of confidential information.

Disclosure

All participants in the research were informed of their right of refusal and of the degree of confidentiality with which the material that they provided would be handled.

Reporting

Key respondents will be provided with copies of any reports or publications arising from their participation in this research, if they so wish.

Integrity

The researcher has tried to protect the integrity and reputation of this research by ensuring that it was conducted to the highest standards. He took care to ensure that there was no discrimination involved in choosing participants to interview on the basis of sex, race, age, religion, status, educational background, or physical disability.

4.10 SUMMARY AND CONCLUSION

This chapter discussed the research methodology that was used in the study. As a starting point, it gave details of the research objectives, the research approach and design. It then gave details of the participants and of the context, sampling, the research procedure, data collection and analysis. Finally, it discussed ethical issues pertaining to trustworthiness of the research, the challenges encountered in the research, and other ethical considerations of the study.

The Research Objectives section specified the aims of the study and the research questions that the study sought to answer. Under Research Approach and Design, the research methods used and processes followed were described, with reference to the relevant literature. The strengths and limitations of each method were also highlighted. The Research Participants and Context section provided details on the participants in the research, as well as the sampling process that was followed. The Research Procedure section gave the time frame and specified the period in which the research took place. It also described the various stages of the process, as well as the focus of each stage. The Data Collection and Analysis section gave details on the methods used in collecting the data and how the data were analysed and triangulated. The Trustworthiness of Data section discussed how issues of validity and reliability were addressed, while the Limitations section highlighted the scope, applicability, and transferability of the study's findings. Finally, the Ethical Considerations section specified the measures taken to ensure that good ethical standards were met.

The next chapter will present the research findings of the study.

CHAPTER 5

DATA ANALYSIS AND RESEARCH FINDINGS

5.1 INTRODUCTION

This chapter presents the data analysis and findings of the research study. The findings are presented under headings that are based on the research questions the study sought to answer. For each research question, the data and findings are given under the following sub-headings: questionnaires, classroom observation, document analysis, and interviews, which were the research methods used in the study. Patterns and themes emerging from the analysis across methods will be highlighted under each research question.

The research sought to answer the following questions:

1. What are the difficulties experienced by isiXhosa-speaking learners in learning Natural Science through the medium of English?
2. What role does the language of learning and teaching play in the context of these difficulties?
3. What factors within the teaching and learning situation contribute to these difficulties?
4. How are the learners and educators currently coping with all these challenges?
5. What can be done to assist both learners and educators in overcoming the difficulties?

This study adopted a mixed method approach, in that some quantitative research data were used to explain or highlight particular aspects or arguments of the qualitative research process. The research was conducted over a period of two years (2008 and 2009) with twenty-six Grade 6 learners, four Grade 6 Natural Science educators, four SMT members, and four isiXhosa-speaking parents at one ex-Model C primary school in the Western Cape.

The following is a presentation of the findings relating to the various research methods applied to each research question.

5.2 DIFFICULTIES EXPERIENCED BY GRADE 6 ISIXHOSA-SPEAKING LEARNERS IN LEARNING NATURAL SCIENCE THROUGH ENGLISH

All four research methods mentioned were used to answer the above question. The question is premised on the view that isiXhosa-speaking learners are faced with unique or peculiar and specific difficulties or barriers in learning Natural Science. The relevant data obtained from the research are presented under the various methods used in the research process.

5.2.1 Questionnaires

In order to obtain demographic information on both the learners and the educators, questionnaires were fielded to both groups on the second day of the researcher's visit. All Grade 6 learners, except three non-isiXhosa-speaking learners in 2009 whose parents did not give permission, participated by completing the questionnaires prepared for them beforehand. All three Grade 6 Natural Science educators participated by completing the questionnaires prepared for them beforehand.

With respect to the above question, the questionnaires administered to both the learners and the educators did not directly apply, as the questionnaires were mainly concerned with obtaining demographic information to provide a contextual background for the study. However, certain inferences can be drawn from such information. For example, information pertaining to the learners' socio-economic home environment, the parents' level of education, and mode of transport to school, has implications for the learner's attitude to learning and the learner's academic performance in science and in general.

The findings based on the questionnaires will now be presented under the following sub-headings: Poor socio-economic home environment; More time spent in (Intermediate) Phase; and Significance of school entry-level.

5.2.1.1 Poor socio-economic home environment

In response to the questionnaire, 84.6% (92.3% in 2008, and 76.9% in 2009) of isiXhosa-speaking learners indicated that they lived in a township or informal settlement. Of these, 80% lived in Khayelitsha, a township which is situated about 30km from the school. Most of these learners also indicated that they travelled to school by public transport. This had implications for the time they had to wake up in the morning, the time they arrived at school, and their state of readiness to receive tuition when they arrived (often late) in the classroom.

Table 5.1 gives a summary of the learners' *demographic* information. This was gathered from the responses of Grade 6 learners to the questionnaires in 2008 and 2009 at Tableside Primary School. To protect the learners' identities, special codes or symbols were assigned and given to them to use when participating in the research process. Thus, on the basis of the class lists, isiXhosa-speaking learners were assigned the first thirteen numbers (L1-L13 in 2008, and L01-L013 in 2009). The remainder of the numbers (L14-L85 in 2008, and L01-L087 in 2009) were assigned to non-isiXhosa-speaking learners. Although the focus of the study was on isiXhosa-speaking learners, it was sometimes necessary to refer to their (mainly English-speaking) counterparts in the class or grade for comparative purposes in order to emphasize a particular point or argument.

GR 6 LEARNERS	**GENDER**		**AGE IN YEARS**				**HOME LANGUAGE**				**TYPE OF RESIDENCE**	
	F	M	11	12	13	14	AFR	ENG	XHO	OTHER	SUBURB	Township/Cape Flats/ Info.setlmt
L1-L13 (2008)	7	6	1	4	6	2			13	Sotho/Xho = 1	1	12
L14-L85 (2008)	39	23	21	36	3	2	6	54		Portuguese/ Fre/Swahili = 1	50	12
L01-L015[14] (2009)	8	5	2	6	4	1			13	Zulu/Xho	3	10
L016-L087 (2009)	45	29	15	48	11	0	8	64		French = 2; Turkish = 1	68	6
N=26												
+N=136												

Table 5.1: Summary of demographic information of all Grade 6 learners taking Natural Science at Tableside Primary in 2008 and 2009

As can be seen from Table 5.1, the majority of isiXhosa-speaking learners (92.3% in 2008, and 76.9% in 2009, that is, 84.6% on aggregate) lived in the township or informal settlement.

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[14] Learners L03 and L07 were African immigrants who were erroneously assumed to be isiXhosa-speaking by the researcher. They were later excluded from the isiXhosa-speaking category of learners but their learner numbers could not be changed as all the Grade 6 participating learners had been allocated numbers to protect their identity.

These learners were most likely to be affected by the poor socio-economic factors mentioned above.

5.2.1.2 More time spent in (Intermediate) Phase

From Table 5.1 it can also be observed that the majority of isiXhosa-speaking learners were in Grade 6, between the ages of 12 and 13 years (76.9% in both 2008 and 2009). The majority of their English-speaking peers, on the other hand, were in the same grade between the ages of 11 and 12 years (91.9% in 2008, and 81.8% in 2009). This suggests that the majority of Grade 6 isiXhosa-speaking learners had spent at least one extra year to reach Grade 6 or in the grade, in comparison to their English-speaking peers. Furthermore, 15.4%, and 7.7% of isiXhosa-speaking learners were in Grade 6 at the age of 14 years in 2008 and 2009 respectively, as opposed to 1.6% in 2008 of their English-speaking peers. This delay of an extra year or more on the part of isiXhosa-speaking learners could be attributed to difficulties associated with learning through a (English) second language. However, more in-depth and conclusive research needs to be done in this regard.

The next tables (Table 5.2 and Table 5.3) provide information pertaining to Grade 6 isiXhosa-speaking learners with regard to home language, type of residence, and mode of transport to school in 2008.

Gr.6 learners	Gender	Current age in years	Home language	Type of residence	Mode of transport to school
L1	M	11	IsiXhosa	Township	Bus
L2	M	14	IsiXhosa	Township	Train
L3	M	12	IsiXhosa	Township	Org/transport
L4	M	13	IsiXhosa	Township	Train
L5	F	13	IsiXhosa	Township	Bus
L6	F	13	IsiXhosa	Township	Bus
L7	M	14	IsiXhosa	Township	Train
L8	M	13	Sotho/Xhosa	Township	Train
L9	F	12	IsiXhosa	Township	Parent car
L10	F	12	isiXhosa/English	Township	Parent car
L11	F	12	IsiXhosa	Township	Bus
L12	F	13	IsiXhosa	Township	Train
L13	F	13	isiXhosa/English	Suburb	Org/transport
N = 13					

Table 5.2: Grade 6 isiXhosa-speaking learners according to home language, type of residence, and mode of transport to school in 2008

In 2008, many isiXhosa-speaking learners travelled to school by public transport, of which 38.5% travelled by train, 30.8% travelled by bus, and 15.4% by organized 'transport', or by their parents' car. In so far as the educators complained about the late coming of learners because of public transport problems (with all its attendant impediments), this means that 11/13 (84.6%) of the Grade 6 isiXhosa-speaking learners in 2008 were affected by transport challenges. Only 15% of the learners travelled to school by their parents' car or by the car of their friend's parents.

Gr. 6 learners	Gender	Current age in years	Home language	Residence	Mode of transport to school
L01	M	12	IsiXhosa	Suburb	Bus
L02	M	12	IsiXhosa	Township	Taxi
L04[15]	F	11	IsiXhosa	Township	Train
L05	F	12	IsiXhosa	Township	Bus
L06	M	12	IsiXhosa	Township	Train/taxi
L08	F	13	IsiXhosa	Township	Bus
L09	F	12	isiXhosa/Eng.	Suburb	Taxi/train/car
L010	F	13	IsiXhosa	Inf. Settlemt	Train
L011	F	12	English	Inf. Settlemt	Bus
L012	M	13	IsiXhosa	Township	Org.transp.
L013	M	13	Zulu/isiXhosa	Township	Org.transp.
L014	F	14	IsiXhosa	Township	Taxi
L015	F	11	IsiXhosa	Township	Train
N = 13					

Table 5.3: Grade 6 isiXhosa-speaking learners according to home language, type of residence, and mode of transport to the school in 2009

Similarly, the majority of Grade 6 isiXhosa-speaking learners (84.6%) in 2009 travelled to school by public transport, i.e. by bus, taxi, or train, while only a few (15.4%) travelled by organized 'transport'. This meant that, as was the case in 2008, in effect 84.6% of the Grade 6 isiXhosa-speaking learners in 2009 were also affected by late coming. Only 15% of the learners travelled to school by private (organized) transport.

5.2.1.3 Significance of school entry-level

Table 5.4 and Table 5.5 below reflect the *entry levels* of the Grade 6 isiXhosa-speaking learners at the school in 2008 and 2009 respectively. These tables were drawn in order to determine whether there was any significant difference in the academic performance of

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[15] L03 and L07 were immigrant African learners who were erroneously assumed to be isiXhosa-speaking by the researcher. They were, therefore, removed from the Table.

learners who joined the school in Grade R or Grade 1 and those who joined the school in Grade 5 or Grade 6. This was done in order to confirm or refute the claim made by the educators, that isiXhosa-speaking learners who joined the school earlier (e.g. Foundation Phase) did better academically than those who came later. The two tables will later be used in relation to Table 5.11 and Table 5.12 (paragraph 5.2.3) in the above regard.

Gr. 6 learners	Gender	Current age in years	No. of Years @ Tableside Primary	Entry level @ Tableside Primary
L1	M	11	2	Gr. 5
L2	M	14	5	Gr. 2
L3	M	12	7	Gr. 1
L4	M	13	4	Gr. 4
L5	F	13	6	Gr. 1
L6	F	13	4	Gr. 4
L7	M	14	4	Gr. 3
L8	M	13	1	Gr. 6
L9	F	12	6	Gr. 1
L10	F	12	6	Gr. 1
L11	F	12	2	Gr. 5
L12	F	13	4	Gr. 3
L13	F	13	7	Gr. R
N = 13				

Table 5.4: Grade 6 isiXhosa-speaking learners according to age, first *entry-level*, and length of time at the school in 2008

Table 5.4 reveals that in 2008 the majority of Grade 6 isiXhosa-speaking learners (76.9%) had been at the school for more than three years. According to the educators' assertion, they should, therefore, have been more familiar with the school's system and should have been in a position to perform better academically. Only 23.1% of isiXhosa-speaking learners had been at the school for less than three years. However, in terms of Table 5.5 only 23.1% had been at the school for more than four years.

Gr. 6 learners	**Gender**	**Current age in years**	**No. of Years @ Tableside Primary**	**1st Gr. @ Tableside Primary**
L01	M	12	1	Gr. 6
L02	M	12	7	Gr. 1
L04[16]	F	11	2	Gr. 5
L05	F	12	7	Gr. R
L06	M	12	1	Gr. 6
L08	F	13	1	Gr. 6
L09	F	12	3	Gr. 4
L010	F	13	2	Gr. 6
L011	F	12	1	Gr. 6
L012	M	13	2	Gr. 5
L013	M	13	1	Gr. 6
L014	F	14	5	Gr. 3
L015	M	11	1	Gr. 6
N = 15				

Table 5.5: Grade 6 isiXhosa-speaking learners according to age, first *entry-level*, and length of time at Tableside Primary School in 2009

Tables 5.4 and 5.5 reveal that 10/13 (i.e., 76.9%) of isiXhosa-speaking learners in 2008 had spent a minimum of four years at the school. They should, therefore, have been familiar with the 'systems' at the school. This is contrary to one educator's assertion that one of the reasons for the poor academic performance of isiXhosa-speaking learners was that *"they are not used to the system"* (educator interviews, 2008 – E1). Only 3 (23.1%) had joined the school after Grade 4 (the critical entry point, according to the educators) and had, therefore, spent less than three years at the school.

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[16] As in Table 5.3, L03 and L07 were immigrant African learners who were erroneously assumed to be isiXhosa-speaking by the researcher. They were, therefore removed from the Table.

In summary, based on the learner and educator questionnaires, the demographic information has revealed that:

1. The majority of isiXhosa-speaking learners lived in a township or informal settlement. These learners were most likely to be affected by the poor socio-economic factors which characterize the township home environments.

2. The majority of isiXhosa-speaking learners did Grade 6 between the ages of 12 and 13 years, while the majority of their English-speaking peers did the same grade between the ages of 11 and 12 years. This suggests that the majority of Grade 6 isiXhosa-speaking learners could have spent at least one extra year to reach Grade 6 or in the grade, in comparison to their English-speaking peers. Furthermore, 15.4%, and 7.7% did Grade 6 at the age of 14 years in 2008 and 2009 respectively, compared to 1.6% in 2008 only, of their English-speaking peers. This delay on the part of isiXhosa-speaking learners could be attributed to difficulties associated with learning through a (English) second language.

3. 76.9% of isiXhosa-speaking learners in 2008 had spent at a minimum of four years at the school. They should, therefore, have been familiar with the 'systems' at the school. Only 23.1% had joined the school after Grade 4 (the critical entry point, according to the educators) and had, therefore, spent less than three years at the school.

4. Contrary to 2008, 46.15% (almost half) of Grade 6 isiXhosa-speaking learners had been at the school less than three years in 2009, and were, therefore, less familiar with the school's system.

5. It would appear that the educators' *entry-level* assertion was applicable to 50% (aggregate) of isiXhosa-speaking learners over the two years, and was, therefore, potentially significant. This issue will be dealt with in more detail under paragraph 5.2.3.1 "*Assessing the academic performance of Grade 6 isiXhosa-speaking learners*". It seemed, however, that the critical entry-level for academic achievement in science was Grade 4. IsiXhosa-speaking learners who entered the school in Grade 4 or earlier seemed to perform better in Grade 6 Natural Science than those learners who entered after Grade 4

5.2.2 Classroom observation

In addition to the demographic factors and broader social context discussed above, the classroom environment plays a very important part in facilitating or inhibiting learning. This is particularly crucial in view of the constructivist theory which underpins the discussion in this research study. The teacher plays a central role in creating and maintaining an enabling environment for learners both to learn and to fulfil their potential in the classroom. Metaphorically speaking, the teacher provides the wind beneath the learners' wings, enabling them to reach the greatest heights they are capable of.

5.2.2.1 The classroom environment

Both in 2008 and 2009, the three Grade 6 classes were visited for observation during the scheduled Natural Science lessons, over a period of three weeks (i.e. from 6/10/08 to 27/10/08 and from 5/11/09 to 26/11/09). The one-month delay in 2009 was due to an outbreak of Swine Flu epidemic in the Western Cape which resulted in many learners staying away from school, either because they were infected with the flu, or out of fear that they might be contaminated. The purpose of the visits was to see the science classes in action and to observe whether isiXhosa-speaking learners encountered any learning difficulties in Natural Science, the nature of such difficulties, how they were addressed, and what coping strategies were employed to deal with them, by both the learners and the educators.

In terms of the school time table, each of the three Grade 6 classes was scheduled to receive six Natural Science lessons per week (i.e., over 5 days). This was in keeping with the 'notional time' allocation, as prescribed by the National Education Department's OBE Curriculum for the Grade 6 Natural Science Learning Area.

The classroom observation visits focused on:

1. The conduciveness of the (science) learning and teaching environment;
2. The extent and level of interaction between learners and educator;
3. The extent and level of interaction among the learners themselves; and
4. The language used in the interactions between learners and educators, as well as among the learners themselves.

5. The attitude of the learners towards learning Natural Science, that is, did they find it challenging and exciting or did they find it frustrating and/or boring?

6. Whether the educators' teaching styles were adapted to the learners' learning styles and addressed their educational needs.

7. The coping strategies used by both learners and educators to address the challenges that confronted them in learning Natural Science.

5.2.2.2 Snapshots of classroom experiences

The following discussion provides snapshots of scenarios that occurred during the visits to observe what was happening in the Grade 6 Natural Science classes. The topic under discussion in the lessons at the time of my classroom observation visits in August, 2008 was 'The Weather'. In November, 2009, the topic of discussion at the time of my visits was 'Electricity'. All the educators presented their lessons in English.

Teaching approach

During my class visits in 2008 (Cohort 1) I observed, firstly, that the three Grade 6 Natural Science educators (E1 – E3) *approached the same lesson differently* and emphasized different aspects of the topic under discussion (the theme: was 'Weather'). For example, E3 started the lesson by focusing on the learners' experience of the weather when they woke up in the morning. E2, on the other hand, started the lesson by focusing on and asking the learners how weather is determined by the weatherman. E1 started the lesson by challenging and testing the learners' understanding of the term 'weather'. E3 emphasized the use of weather symbols, while E2 emphasized how weather is studied and predicted at weather stations and the use of weather satellites (e.g. showing pictures of weather-men working in the South Pole). E1, on the other hand, focused on the seasons of the year and their concomitant weather patterns. E3 made extensive use of group activity and group discussion in her lessons, while E1 and E2 used more narrative and video presentations.

A similar pattern of lesson presentation was observed with educators E1 and E2 during the classroom observation visits in 2009 (Cohort 2). However, E3 was replaced by E3.1 who had returned from leave, having been substituted by E3 in 2008. Similar to his substitute, E3.1 made more extensive use of the (technology) laboratory and applied more learner group activities in his lessons. Educators E1 and E2 preferred to conduct their science lessons in the learners' classrooms, which all three educators used as their base. The lesson theme at the time of the classroom observation visits in 2009 was "Electricity".

Seating arrangements

The seating arrangements in the classrooms (both Cohort 1 and Cohort 2) also reflected the educators' teaching styles. In educator E1's classroom (Grade 6KV), the learners were seated in rows for the duration of all the lessons in their classroom. The only visible learner activity was taking turns to write (mainly working out Maths problems) on the chalk board.

In educator E2's classroom (Grade 6 FS), although the learners were seated in rows most of the time, occasionally they moved into pre-established groups during the group discussion part of the 'Weather' lesson. The group work was based on homework which involved completing a questionnaire frame in their 'Natural Science Reader'. During the Cohort 1 visit there was an incident, where one learner (L3) was at a loss because he had not re-arranged his 'Reader' beforehand, as per instruction the previous day. This resulted in some disorganization of the group and the back-chatting between some learners in the group and the teacher. The learners were more responsive to the teacher's instructions and questions when seated in rows than they were when they were seated in groups.

Although the learners were seated in rows in educator E3's classroom (Grade 6 BT), she used the group activity strategy more often than did the other educators. The learners in this class engaged in group activity in class, first in preparation for a simulation 'Weather Station Report', and then the following day taking turns to give the 'Weather Report'. They also took turns to write weather symbols for the various weather conditions on the chalk board. On two other occasions, the learners in educator E3's classroom were taken to the Technology laboratory to do weather experiments (to construct an air pressure instrument, followed by a weather barometer). Thus educator E3 used a greater variety of strategies in her lesson presentation and involved the learners more in the learning and teaching process.

Class/learner discipline

There was also a *difference of approach to class discipline* and learner freedom between the three educators (in both Cohorts). E3 was very strict and insisted on quietness and focus on what was being done. There was a high rate of learner talk and activity in this class. There were, however, intermittent outbursts of disruptive talk or jokes by one learner (L14), which the teacher kept consistently in check. E1's class was more relaxed, but still focused on the work. There was more learner noise in the class, but the learners responded positively to the teacher's questions, demonstrating that they were focused. E2 struggled to keep control of her class and often had to use a strong voice to keep order, so much so that three learners (L2, L8 and L17) had to be moved to E1's class because of ill-discipline, constantly back-chatting the teacher (E2). Learner L 3 struggled to keep abreast of the class because he had not followed instructions to rearrange his worksheets from the 'reader', as was required of the class the day before.

However, despite the differences in approach between the three educators, there was generally a cordial and caring relationship between the educators and the learners in all the classes (in both Cohort 1 and Cohort 2).

5.2.2.3 Identifying the learning difficulties

The following section gives an overview of the observations made during the science class visits at the school.

Table 5.6 below reflects the difficulties experienced by Grade 6 isiXhosa-speaking learners as observed and perceived by the researcher (and subsequently confirmed in the semi-structured interviews with both learners and educators):

Nature of difficulty	**Coping strategy by learner/educator**	**How it was addressed by educator**	**Remarks (extracts from observation journal)**
Not understanding the language used in teaching Natural Science (LOLT), i.e. English.	Learners asked clarifying questions; some learners spoke their home language (isiXhosa) in their discussion groups.	Educators responded to learners' questions; sometimes asked other learners to respond and clarify or explain; educator encouraged learners to use English LOLT	
Not understanding *weather* concepts (i.e., the 'language of science).	Educators explained further; some learners explained concepts to each other.	Educators explained concepts, e.g. 'satelite', 'weather station'.	Educator opportunistically asks learners to explain to one another in their home language
Educator mediation (lack of code switching).	Educators asked isiXhosa-speaking learners to explain to each other in their home language.	Educators further elaborated in English.	Educators could not use code switching as a strategy to mediate learning as they could not speak isiXhosa, the learners' home language.
Difficulty in participation: group discussion; carrying out experiments.	'Informal' code switching among isiXhosa-speaking learners in their home language.	Educators encouragd learners to actively participate.	Subtractive bilingualism was practiced – learners were not allowed to communicate in isiXhosa but did so secretly among themselves in their group discussions.
Not being able to follow educator's instructions.	Learners asked other learners to explain; educator encouraged learners to explain to each other.	Educator explained instructions to individual learners.	In Cohort 1, some learners tended to ignore E2's instructions or 'back-chat' her. Consequently three learners (two isiXhosa-speaking and one English-speaking) were sent to detention and moved to E1's class due to ill-discipline. One isiXhosa-speaking learner was left behind for failing to organize his reader as previously instructed by the NS educator.
Answering higher order assessment questions: e.g. *explain, describe, discuss.*	Some learners floundered while others guessed or used personal experiences to answer questions.	Educator explained what was expected in each question.	Limited or no evidence of alternative forms of assessment to cater for LEP learners, e.g. more diagrams and less words.

Table 5.6: Learning difficulties experienced by Grade 6 isiXhosa-speaking learners in class during a 'weather' lesson at Tableside Primary in 2008

As shown in Table 5.6, the apparent *learning difficulties* experienced by Grade 6 isiXhosa speaking learners include Language of learning and teaching (LOLT); Language of science (LOS); Classroom interaction and language (LOLT) usage.

Language of learning and teaching (LOLT)

The learning difficulties possibly associated with the LOLT were manifested by the learners' tendency to use their home language in group discussions; some learners asking their isiXhosa-speaking peers to explain what was said; and the educators asked some isiXhosa-speaking learners to explain to their peers who struggled to understand an idea or concept or failed to understand or follow an instruction. The LOLT difficulties were also (further) manifested by (1) Inability to follow the educator's instructions, as manifested by the failure of some learners to do what was required of them because they had not understood either the LOLT or the scientific terms used (e.g. L8 and his group); (2) Educators could not use *code switching* as a strategy to mediate learning as they could not speak isiXhosa, the learners' home language; and (3) *Subtractive bilingualism* was practised in the classrooms – learners were not allowed to communicate in isiXhosa, but did so secretly among themselves and in their group discussions. It should also be noted that learner L13, as the only isiXhosa-speaking learner in Grade 6BT, did not have the opportunity to practice or use code switching as a coping strategy, but was forced to communicate entirely in English both with the other learners and with the educator.

The Language of Science

The learning difficulties associated with the language of science were manifested by the inability of many isiXhosa-speaking learners to understand science 'weather' concepts such as 'satelite', 'temperature', 'full moon'; 'electricity' concepts like electric 'current' or electric 'circuit'; or describe their observation of a science experiment, for example, explaining what happened in their process of constructing a 'weather' barometer; and using a wind-sock to determine the direction in which wind was blowing.

Classroom interaction and language (LOLT) usage

The following table provides a picture of classroom interaction. It shows the kind of interaction in which both the learners and educators in the first cohort engaged, the purpose of the interaction, the language of communication used, and the researcher's observational remarks relating to the conduct and participation of isiXhosa-speaking learners.

Interaction	**Language used**	**Purpose**	**Remarks (extracts from observation journal)**
Teacher-Learner	English	Teaching and giving instructions.	Grade 6FS (Cohort 1) seemed to be the most difficult to handle among the Grade 6's. They tended to be noisy and the teacher often had to use a strong tone of voice or single out particular learners (e.g. L3) for attention. On one occasion L3 struggled to keep up with the class because he had not organized his Learner Guide/Reader as the class had been instructed by the teacher previously.
Learner-Learner	English and isiXhosa (privately)	Participation in lesson and class activities; communication in the home language by some learners among themselves.	Participation of isiXhosa-speaking learners constrained by their limited English language proficiency (LEP).
Learner-in group	English; IsiXhosa	Group discussion; communication in the home language by some isiXhosa-speaking learners among themselves to explain to each other.	More group activity and group discussion teaching strategy used by E3 and E3.1; E1 and E2 used more narrative and video presentations.

Table 5.7: Classroom interaction involving Grade 6 isiXhosa-speaking learners during a Natural Science lesson at Tableside Primary in 2008 and 2009

The interaction of isiXhosa-speaking learners in the Natural Science classroom was observed at three levels, namely teacher-learner; learner-learner; and learner-group. Table 5.8 below reflects these three levels of interaction in the Natural Science classroom.

Interaction	**Yes**	**No**	**Remarks**
Teacher-Learner:			
- Did teacher give clear instructions?	X		
- Did learners respond to teacher's instructions or questions?	X		
- Did learners express their needs?	X	X	L13 expressed needs effectively; L8 did not express needs effectively, possibly due to poor English (LOLT) proficiency.
- Did teacher respond to learners' needs?			Sometimes teacher was not elaborate enough; in Class 6FS teacher E2 experienced some disciplinary problems from L8's group.
	X	X	
Learner-Learner:			
- Did learners co-operate?	X		Not always, as in the case of L8.
- Were learners willing to share ideas?			Not always.
- Were learners willing to lead discussion?	X		
	X	X	
Learners-in group			Participation of some isiXhosa learners limited by lack of English (LOLT) proficiency.
- Did learners co-operate?	X		Xhosa learners willing to report but shy or lacked confidence
- Were learners willing to share ideas?			
- Were learners willing to lead discussion?	X		
- Were learners willing to report or perform task on behalf of the group?	X	X	
	X	X	

Table 5.8: Classroom observation control sheet showing classroom activities (Grade 6 Natural Science) at Tableside Primary in 2008 and 2009

An examination of Table 5.8 shows that, at Teacher-Learner level, while the teacher gave clear instructions and the isiXhosa-speaking learners responded to the instructions, there were some variations between the learners regarding the expression of their needs. Some were able to communicate their needs (e.g. L13), while others (e.g. L8) did not express their needs very clearly. At Learner-Learner level, the isiXhosa-speaking learners were more open on a one-to-one interaction. They co-operated well, and were willing to share ideas. However, they were doubtful and hesitant to lead the discussion, except for learner L13, who was always assertive and full of confidence. At Learners-Group level, the learners cooperated very well with the group, and were willing to share ideas in the group discussion. However, they became diffident when it came to leading the group discussion and reporting on behalf of the group. In 2008, learner L13 was again the exception.

5.2.2.4 Teaching strategies used

Although the educators used similar strategies overall in their teaching, some showed preference for a particular strategy.

The three educators used a variety of teaching methods during their lessons (both Cohort 1 and Cohort 2). E3 and 3.1 were more innovative, used a lot of group work and experiments (the heuristic/discovery method); E2 used more demonstrations, as well as the question and answer method; E1, on the other hand, laid more emphasis on the teaching of scientific concepts and used the telling method more.

The above teaching strategies might have impacted differently on the learners' learning, motivation or discipline. For example, Grade 6 BT, which was regarded by the educators as the highest performing class in the grade, could have been motivated by the creative, challenging and practical strategies used by their teacher (E3/E3.1) during lessons.

5.2.2.5 Resources

As the environment contributes to the quality of teaching and learning, the study looked at how the availability or lack of resources at Tableside Primary affected this process.

Although it does not apply exclusively to second-language learners (including isiXhosa-speaking learners), a conducive and *stimulating learning environment* can contribute towards better learner motivation. As the study revealed that many isiXhosa-speaking learners came from the (less scientifically stimulating environment) townships, they would benefit more from visual display and demonstration of scientific phenomena.

The school does not have a science laboratory where science experiments could be carried out, demonstrated or kept on display for some time for learners to view at their leisure (as a constant reminder of what had transpired during some experiments). This can be of particular disadvantage to learners who come from a less (scientifically) stimulating learning environment such as the township or informal settlement. It can also be seen that there was little or no evidence of science posters (e.g. a spaceship in orbit, or various kinds of monocot/dicot indigenous plants) or display of scientific models, to familiarize or stimulate scientific thought in learners in the classrooms.

In summary, the following *difficulties experienced by Grade 6 isiXhosa-speaking learners* emerged during the classroom observation:

1. ***Class size***: Each of the three Grade 6 classes had a total of 25 learners, boys and girls of between 11years and 12 years, on average. It should be noted that the ex-Model C classrooms were designed for apartheid education and to accommodate about 20 exclusively white learners. So a class of about 25 learners became relatively congested, both physically and compared to what the educators had been used to in the Model C context.

2. ***Educators' teaching and discipline styles***: The three Grade 6 Natural Science educators (E1 – E3) approached the same lesson (on 'weather') differently and emphasized different aspects of the topic under discussion. Furthermore, there was a difference of approach to class discipline and learner freedom across the three educators. Despite the difference in approach, there was generally a cordial and caring relationship between the educators and the learners, as well as among the Grade 6 learners themselves, in all the classes. Some learners showed signs of frustration with their class work through ill-discipline, possibly due to not coping with the work.

3. ***Language usage***: IsiXhosa-speaking learners seemed to manage to speak English (LOLT) at basic interpersonal communication (BICS) level in communicating with other learners. The learners, however, seemed to struggle with 'weather' concepts such as 'satelite' and 'weather station', and 'electricity' concepts such as electric 'current' and electric 'circuit'. There were manifestations of 'informal' or secret code

switching among isiXhosa-speaking learners to their home language in group discussions or in conversation among themselves (a case of *subtractive bilingualism*). The educators could not use this strategy as they did not speak isiXhosa, and this possibly disadvantaged both them and the learners.

4. ***Teaching strategies used by the educators***: These were mainly the question and answer method; telling method (talk and chalk); demonstration; class activity: group planning (radio station weather report); simulation (weather report) presentation; and group experiments (e.g. constructing a weather barometer).

5.2.3 Document analysis

In the document analysis process, the 26 isiXhosa-speaking learners' Assessment records (13 in 2008, and 13 in 2009) were examined. The Assessment records of nine randomly selected English-speaking peers (three from each of the three Grade 6 classes) were also examined for comparison purposes. The Assessment records were accessed through the Learner Portfolios and the Learner Mark Schedules found in the Educator Portfolios. The Learner Portfolios contained documentary evidence of the learners' academic work, including class-work, assignments or projects, and assessments or tests. The Educator Portfolios, on the other hand, contained documentary evidence of the teachers' (daily) lesson preparations, records of academic work given to the learners (e.g. class-work, assignments or projects), assessment or tests, and memoranda showing mark allocation for each of the foregoing tasks, as well as records of the learners' academic performance on all the foregoing tasks. The contents of both the Learner Portfolios and Educator Portfolios are prescribed by the Department of Education and monitored by its officials at District, Provincial and National level.

The findings of the document analysis will now be discussed under the following sub-headings: Ranked academic performance in relation to entry level; and Assessment task analysis.

5.2.3.1 Ranked academic performance in relation to entry level

The following academic performance profile (Table 5.9) was gleaned from the Learner Portfolios of isiXhosa-speaking learners in the three Grade 6 classes, as well as the Educator Portfolios of teachers who taught Natural Science in the same classes. It reflects the performance of Grade 6 isiXhosa-speaking learners in Natural Science at the end of each of the first three terms (T1 – T3) of 2008 (Cohort1).

Learner code	**% in science: Term 1 (March)**	**% in science: Term 2 (June)**	**% in science: Term 3 (September)**	**Average % (T1-T3)**
L1	54	42	58	51
L2	48	38	40	42
L3	64	46	53	54
L4	A	41	50	#DIV/0![17]
L5	64	69	63	65
L6	64	66	63	64
L7	30	56	52	46
L8	0	54	44	33
L9	43	60	63	55
L10	38	63	46	49
L11	61	62	59	61
L12	41	68	53	54
L13	45	76	74	65

Table 5.9: Profile of academic performance of Grade 6 isiXhosa-speaking learners in Science at Tableside Primary in 2008

In terms of the average (overall) percentage performance for Terms 1-3, L8 was the lowest achieving Grade 6 isiXhosa-speaking learner in 2008. It is also significant that L8 scored nil in the first assessment or test, suggesting that at the time the first test was given he did not understand anything in Natural Science, possibly due to language problems and unfamiliarity with the school system. However, with the next two Assessments there was a marked improvement in L8's scores, suggesting an improved understanding of the subject and greater familiarity with the school system. A similar trend can be observed with the performance scores of learners L9-L13.This suggests a correlation between the familiarity of the isiXhosa-

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[17] #DIV/0! Denotes that the learner's scores could not be averaged accurately due to outstanding or incomplete work.

speaking learner(s) with the school system (including familiarity with the LOLT) and academic performance in science. This issue is taken up with the next set of tables (Tables 5.10 and 5.11).

The following table (Table 5.10) reflects the academic performance of isiXhosa-speaking learners, drawn from Table 5.9 above and plotted against the *entry level* of each learner at the school, as well as the number of years each learner spent at the school. The intention was to compare the academic performance of each learner and the length of time he/she had spent at the school to see if there were any correlation between the two.

Ranked average % performance in science in 2008 **(T1 – T3)**	**Learner code**	**Entry grade at Tableside Primary**	**Years spent at Tableside Primary school**
65	L13	R	7
65	L5	1	6
64	L6	4*[18]	4
61	L11	5	2
55	L9	1	6
54	L3	1	7
54	L12	3	4
51	L1	5	2
49	L10	1	6
46	L7	3	4
45.5	L4	4*	4
42	L2	2	5
33	L8	6	1

Table 5.10: Ranked academic performance of Grade 6 isiXhosa-speaking learners in Natural Science in 2008 in relation to their entry level at Tableside Primary

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[18] * denotes the critical entry level in order for the learners to master the Grade 6 curriculum; T1-T3 denotes average Assessment scores for Terms one to three.

Ranked average % performance in science in 2009 (T1-T3)	**Learner code**	**Entry grade at Tableside Primary**	**Years spent at Tableside Primary school**
83	L01	R	7
71	L05	R	7
68	L09	4	3
61	L013	1	6
61	L015	1	6
58.5	L02	1	6
51	L010	6	1
41	L011	6	1
38.5	L06	6	1
38	L08	6	1
37.5	L012	5	2
X[19]	L04	5	2
X	L014	3	4

Table 5.11: Ranked academic performance of Grade 6 isiXhosa-speaking learners in Natural Science in 2009 in relation to their entry level at Tableside Primary

From Table 5.10, the following observations can be made:

Learner L4 had been absent from school when the first term Assessment or test (T1) was done. His/her average % performance was, therefore, based on the last two terms' assessments or tests (T2-T3), hence the symbolization: #DIV/0! (in Table 5.9).

It is interesting to note that L8, the lowest achieving learner in the 2008 term assessments, only entered the school at a late stage, namely Grade 6. This could be significant.

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[19] X denotes that the learner was absent during testing

Learners L13 and L5, the highest achieving learners in the 2008 term assessments, entered the school at an early stage, namely Grade R and Grade 1, respectively. This is also interesting and potentially significant.

Except for learner L10, all the Grade 6 isiXhosa-speaking learners who entered the school in Grade 1 or earlier achieved an average score of 54% and above. This suggests that the longer exposure of the learners concerned to the LOLT and the school system (e.g. how to follow or use the Natural Science learning programmes) could have enhanced the scores. It also seems to support the educators' theory that learners who joined the school at the lower level did better academically than those who joined at the higher level (see paragraph 5.2.1 above). On the other hand, except for L8, all the learners (30% of the isiXhosa-speaking learners) who scored below the 50% mark had entered the school either in Grade 4 (which was regarded by the educators as the critical entry-level) or earlier. This seems to contradict the educators' early entry-level theory. However, this needs to be followed up by more intensive and in-depth research.

Grade 4 was regarded by the Grade 6 Natural Science educators as the *critical entry-level* for mastering the Grade 6 curriculum (Educator interviews).

Learner L13 (Cohort 1) was the only isiXhosa-speaking learner in Grade 6B, which was regarded by the educators as the 'brightest' or best performing among the current group of Grade 6 classes. She had joined the school in Grade R, and had been at the school for seven years.

As can be seen from Table 5.9, all the learners who scored above 50% in the test had started at the school in Grade 4 or before. All those who scored 50% and below in the test had started at the school after Grade 4 (that is, in Grade 5 or Grade 6). A calculation of the average number of years at the school for learners who pass and those who fail shows that, in Cohort 1, the average number of years per passing learner is 4.75 while for the failing learner it is 3.2.

In conclusion, the above evidence seems to suggest that, to a large extent, Grade 6 isiXhosa-speaking learners who started at the school in earlier grades (that is, in Grade 4 or before) performed better academically than those who started in Grades 5 or 6.

5.2.3.2 Assessment task analysis

This section examines the challenges faced by isiXhosa-speaking learners during assessment. It focuses particularly on the type of assessment tasks or questions that the learners struggled with and found difficult to answer.

During the *document analysis* phase of the research (Cohort 1and Cohort 2), a learner assessment task was chosen (as an exemplar or model) in order to examine the nature of the challenges faced by isiXhosa-speaking learners. This assessment task was selected because it contained a variety of assessment questions which the learners had to answer, giving the researcher an opportunity to analyse and understand which *type of assessment activities* the learners found easy or difficult. The score achieved by each learner for each question is reflected in Table 5.10. The purpose of this analysis was to determine which *type of questions of assessment* the learner obtained highest or lowest scores in answering, and by so doing, to ascertain in which areas in Natural Science the learners needed most support on. A comparative group of five peer English-speaking learners was randomly selected from the three Gr. 6 classes: one learner from the class with a single isiXhosa-speaking learner and two learners from each of the other two classes. This was done to compare the isiXhosa-speaking learners' performance with their English-speaking peers. The (Model) Test follows below for ease of reference and further discussion.

The 'Model'Test

ASSESSMENT TASK 1 **DATE: FEBRUARY 2009**

LO 1: Scientific Investigation

LO 2: Constructing Science Knowledge

LO3: Science, Society and the Environment

Forms of Assessment: Research, conducting and experiment

Activity 1:

Read the information below and answer the questions which follow:

What is a solution?

Tea or coffee is sweetened, by adding a spoonful of sugar. When the drink is stirred, the sugar disappears. We say it has dissolved in the liquid. A solution is a liquid in which something is dissolved. To dissolve something in a liquid, it must become part of the liquid. If a solid substance can dissolve in a liquid, we say it is soluble. Substances that do not dissolve are insoluble.

Solid substances that are added to liquids are called solutes. The liquid that a substance dissolves in is called a solvent. When a solute dissolves in a solvent, we get a solution. When we mix two substances that do not dissolve in each other, we get a mixture. Sometimes a stubstance appears to mix with water, but the water remains cloudy with fine particles in it. We call this a suspension.

a) Write a definition for the underlined words in the passage. (7)

b) Use any of the three words in your own sentences to show you understand the meaning. (3)

c) Investigating solutions (experiments)

You will need:

- Sugar
- Sand
- Salt and pepper
- Coffee powder
- Washing powder
- Tea leaves
- Pieces of chalk
- Water
- Teaspoons
- Plastic cups or jars

Method:

Fill each cup with the same amount of water. Put one teaspoon of each substance in the water and stir well. What has happened in each cup?

Complete the table to record your findings.

Substance added to water	Clear liquid	Cloudy with tiny bits throughout	No mixing	Other observations
Sugar				
Sand				
Salt and pepper				
Coffee powder				
Washing powder				
Tea leaves				
Chalk				
Powder				
Flour				
Jelly				

The above 'model test' is used in the analysis below to highlight some salient aspects of the learner assessment process in the Grade 6 Natural Science classes at Tableside Primary, with particular reference to isiXhosa-speaking learners.

Language of Assessment

In my perusal of the learners' workbooks during the document analysis phase of the research it was evident that many of the isiXhosa-speaking learners struggled to express their ideas or views in English, the LOLT in Natural Science in Grade 6. The following are excerpts which typify some of the learners' responses to selected questions in the Assessment Task/Test 1, Activity 1 (2009). The sample of isiXhosa-speaking learners' responses is contrasted with a sample of English-speaking learners' responses in the same class to the same question, to highlight the difference in the quality of the responses between the two.

For example, in answering the question "What has happened in each cup?" of the experiment in the above "Model Test", the following learners wrote:

L08 (isiXhosa-speaking learner) wrote:

1) *"i put a tea leavers in the water*
2) *I talk a sugar and water and I mixed in the water and ther sugar*
3) *I talking the haming and water I put a washing powder in the water*
4) *Talking salt and pepper I talking the water and salt and pepper and mixed in the water*
5) *I put jell in the water*
6) *I talking teaspoons and coffee pawder I put coffee pawder in the teaspoons I put water*
7) *I talk chalk I greading chalk I talk water I mixed chalk in the water*
8) *I talking flaur and water I mix flour in the water*
9) *I talking pawder I mixed water I the pawder*

L07 (isiXhosa-speaking learner) wrote:

> *Some of the things didn't dissolve. We couldn't get powder because the person who suppose to give it done hers at home and never brought it so we couldn't do the experiment. At first we did ours wrong but then ma'am said its wrong so we had to do it over in five minutes, after we done everything ma'am said pack-up so we had to tick'*

> *everything and and we went back to class. Oh I forgot to tell you we didn't have cups at least there were cups there in the tech room and we needed knives luckily there were knives to and we never messed on our its was the people next to us because they were working very wild and like to brag about how fast they worked we new one person is going to make a mistake and ruin it for everybody.*

L04 (isiXhosa-speaking learner) wrote:

> *Some of them just went to the bottem but like the sugar dissolved you couldn't even see there was something. the same with the salt.*
>
> *What I did:*
>
> *First we rinsed the 10 cups and threw water in each of them and then put different ingredients in each cup, (only a teaspoon). We all got something to do then we waited a while for all the ingredients to settle then we filled in the table. When that was done we packed away our things and went to wash the cups. Then we wiped our table and sat down. We went back to our class then wrote a report on all the ingredients.*

The above samples of Grade 6 isiXhosa-speaking learners' responses are contrasted with sample responses of ordinary English speakers in the same grade, below:

L052 (English-speaking learner) wrote:

> *My group and I have worked hard to get done and get marks. We mixed all the substances and ended up with only one that clearly dissolved, the sugar.*
>
> *The salt dissolved, but when we added the pepper, nothing happened and the salt and the pepper are together. The salt and pepper was ticked under the 'no mixing' column and so was sand and tea leaves. The washing powder and the baby powder was under the 'cloudy with tiny bits throughout' column. I put the coffee powder, the flour and the jelly under the other observations column because they all dissolved but not into a clear liquid so I couldn't put it with sugar under clear liquid. The chalk was a weird one. Some of it dissolved and some didn't so I ticked it under 'other observations'.*
>
> *My group was successful and hope my group and I have good marks.*

L057 (English-speaking learner) wrote:

> *Today my group and I did an experiment on which few substances dissolve, that is a mixture and insoluble.*
>
> *We needed: sugar, sand, salt + pepper. Coffee powder, washing powder, jelly, chalk, tea leaves, powder and water + spoons + cups*
>
> *We then had to fill each cup with the same amount of water, then put each substance in the water, stir it well and see what happened.*

> *In the beginning we ha a problem with the cups. There were 2 different types of cups, which made difficult to put the same amount of water in them. We solved the problem by filling the smaller cups full of water, and then pouring that into the larger cup, this making it equal. By just making the small full to the brim and large cups half full.*
>
> *Only the sugar + water dissolved into clear liquid. The sand, salt + pepper and tea leaves did not dissolve, and the washing powder, chalk, powder and jelly became cloudy, with tiny bits throughout. However the coffee powder and flour became other observations.*

Level of abstraction[20]

There seems to be a qualitative difference between the responses of the isiXhosa-speaking learners and those of their English-speaking counterparts. The IsiXhosa-speaking learners seemed to experience a language difficulty not only in following instructions but also in expressing their ideas or in describing their observation of the science experiment, compared to their English-speaking peers. It seems that, because they understood the LOLT, the English-speaking learners were able to understand, follow the instructions, and take the observation discussion to a higher level. They had a qualitatively higher focus, whereas the isiXhosa-speaking learners, perhaps because of the LOLT and Language of Science disadvantage, either focused on the wrong thing (not understanding or following the instructions) or failed sufficiently to describe the phenomenon under observation, thus receiving lower scores on the assessment.

L08 clearly had a language problem or difficulty, as shown or evidenced by his/her grammatical errors: poor spelling: e.g. tea '*leavers*'- for tea leaves, '*talk*' - for take, '*flaur*' – for flour, '*pawder*' – for powder, etc.; and no punctuation marks. In contrast, L52 and 57 (both English speakers) were able firstly to describe their activities during the experiment very clearly, and secondly to organize their thoughts and present their activities in a systematic way, giving the outcome of every action taken in the experiment. L08 (an isiXhosa-speaking learner), on the other hand, did not give an indication of any observations she made during the experiment, and therefore did not give any outcome of the experiment. She also did not seem to know the purpose of the experiment and consequently what to focus on. She seemed not to have understood the instruction, possibly due to a language, reading, comprehension or interpretation difficulty or problem. Similarly, L07, another isiXhosa-speaking learner, did not focus on the relevant aspects of the experiment. Although she gave

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[20] In this study, the term 'abstraction' is used to refer to the process of conceptualisation or understanding of subject matter by the learners and does not imply any abstract intellectual thinking. Since the Grade 6 learners (ages 11-12 years), who are the focus of this study, are at the "stage of concrete intellectual operations" (Piaget, 1980: 6), they are considered to be not yet capable of abstract thinking.

some indication of the outcome by stating that *"Some of the things did not dissolve,"* she failed to focus on describing activities relevant to the task at hand, namely putting a teaspoon of each of the substances, stirring well, observing and reporting what happened. Although the experiment was done in a group (as evidenced by the 'we' responses of the other learner candidates), L08 answered in the 'I', as if he/she had been conducting the experiment alone. Although L04 showed some spelling mistakes, e.g. 'bottem' – for bottom, and did not give a detailed observation of every action in the experiment (in comparison with L08), she did give an outcome of the experiment by mentioning that "Some of them just went to the bottem but like the sugar dissolved you couldn't even see there was something. the same with the salt." L04's report also had a better focus and structure, in so far as it gave a detailed description of what they did in his/her group, compared to L08's report.

The isiXhosa-speaking learners seemed to have some subject content knowledge, but appeared to lack the language skill to put it across. Because of the language difficulty, they seemed to have a lower *level of abstraction* of scientific knowledge in comparison to their English-speaking peers. The principle of (linguistic/cultural/cognitive) border crossing (Aikenhead & Jegede, 1999; Fakudze, 2004: 272-275) may explain the nature and cause of the difficulties experienced by isiXhosa-speaking learners in this regard. This will be discussed more comprehensively in Chapter 6.

The following table reflects the *scores per question* obtained by isiXhosa speaking learners on the above test (Assessment Task 1 of 2009).

Question **Maximum score**	**1** **(5)**	**2** **(4)**	**3** **(4)**	**4** **(6)**	**5** **(4)**	**6** **(6)**	**7** **(5)**	**8** **(6)**	**Total score T1**	**% score**	**Level of entry**
Learner Code											
L01	2	2	4	6	2	6	5	6	33/40	82.5	Gr. R
L02	0	1	4	4	3	6	0	5	23/40	57.5	1
L04	X[21]	X	X	X	X	X	X	X			5
L05	3	0	4	6	1	4	5	5	28/40	70	R
L06	0	0	4	0	0	4	3	4	15/40	37.5	6
L08	2	1	3	0	1	3	5	0	15/40	37.5	6
L09	3	1	4	0	4	6	5	4	27/40	67.5	4
L010	1	1	4	0	4	6	0	4	20/40	50	6
L011	0	0	1	0	2	6	3	4	16/40	40	6
L012	1	0	4	2	2	6	0	0	15/40	37.5	5
L013	1	0	4	0	2	6	5	6	24/40	60	1
L014	X	X	X	X	X	X	X	X			3
L015	2	0	2	0	2	6	2	6	24/40	60	1
TOTAL	15	6	38	18	23	59	33	44			
AVERAGE	1.4	0.5	3.5	1.6	2.1	5.4	3	4			
AV. %	32	12.5	85	31.7	55	91.7	68	65			

Table 5.12: Learner Assessment scores per question (in Task 1) in 2009

The following table reflects the *scores per question* obtained by an English speaking comparative select group of peers (Cohort 2).

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[21] X: denotes - no record of score in Learner's Portfolio.

Question	1	2	3	4	5	6	7	8	Total score T1	% score	Level of entry
Maximum score	(5)	(4)	(4)	(6)	(4)	(6)	(5)	(6)			
L58	3	1	2	0	3	6	3	6	24/40	60	
L03	2	1	4	6	4	6	5	6	34/40	85	
L52	4	4	4	3	4	6	5	6	36/40	90	
L054	3	1	4	6	4	6	5	6	35/40	87.5	
L057	5	1	4	6	4	6	5	6	37/40	92.5	
TOTAL	17	8	18	21	19	30	23	30			
AVERAGE	3.4	1.6	3.6	4.2	3.8	6	4.6	6			
AV. %	68	40	90	70	95	100	92	100			

Table 5.13: Comparative Group Learner Assessment scores per question (in Task 1) in 2009

When one compares the learners' demographic information in Table 5.2 and Table 5.3 with the learners' academic performance in Table 5. 9 and Table 5.10, some salient points can be observed.

Firstly, in Table 5.9 it is significant that all isiXhosa-speaking learners who scored below 50% had entered the school in Grade 6 or Grade 5. Secondly, the two highest scoring isiXhosa-speaking learners (L01 = 82.5% and L05 = 70%) had entered the school in Grade R. Thirdly, although the difference in academic performance between the learners was not very big, there seemed to be a correlation between the isiXhosa-speaking learners' overall performance in the assessment and the level at which the learners had started at the school. L13, who started at the school in Grade R, was the only isiXhosa-speaking learner in the 6S class, which was regarded by the educators as the highest performing class among the Grade 6 learners in 2008, although other factors might have come into play here, e.g. the educators' positive halo effect, (and concomitant reinforcement) towards L13, as well as L13's familiarity with the systems within the school. However, the level at which the learners started at the school, seemed to have had an effect on the academic performance of isiXhosa-speaking learners. There seems to be evidence to support the educators' views (in the interviews) that learners who entered the school earlier, i.e. in the lower grades, performed better academically than those who entered the school at higher grade levels, i.e. after Grade 4 (see paragraph 5.2.4).

5.2.3.3 Categories of assessment questions

Related to the language of assessment was the issue of the *type of question* that isiXhosa-speaking learners had difficulty in answering. They seemed to perform better on contextual and recall questions than on interpretive, discussion or essay questions, as will be demonstrated by the next series of quarterly Assessments/Tests administered to all learners at the end of every school term, as required by the Education Department. The following Table 5.14 gives an analysis of the learners' performance scores per *question-type* in the end of (1st) term Assessment/Test (for March 2008, Cohort 1).

Learner Code	**Q. 1.1-1.6: Matching columns (6)**	**2.1-2.6: Choose correct words (in brackets) (6)**	**3.1-3.2: Give reasons (2)**	**3.3: Stating/ recall where (1)**	**3.4-3.6: Name 3 things/ functions (3)**	**4.1-4.6: Missing words/ recall (no clues) (6)**	**5.1-5.6: T/F[22] (6)**	**Total score**	**%**
L1	4	4	0	1	0	1	5	15	50
L2	6	4	1	0	0	2	6	19	63.3
L3	6	3	1	1	0	2	5	18	60
L4	2	3	0	0	0	0	2	7	23.3
L5	5	3	2	1	0	0	5	16	53.3
L6	4	5	1	1	0	3	5	19	63.3
TOTAL	27	22	5	4	0	8	28	94	313.2
Average	4.5	3.7	0.8	0.7	0	1.3	4.7	15.7	52.2
Av. %	75	61.7	40	70	0	21.7	78.3		

Table 5.14: A select group of Grade 6 isiXhosa-speaking learners' performance scores per *question-type* in the end of 1st term Assessment/Test for March 2008

The assessment samples for the scores reflected in the above Table are attached as Appendix M. The number of learners has been limited to 6 to minimize the volume of attachments in

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[22] T/F (column 8) denotes 'true' or 'false' statement.

the study. The first column of Table 5.14 reflects the coded list of names of Grade 6 isiXhosa-speaking learners at Tableside Primary who took the Natural Science term test (drawn from the Educators' Portfolios). Columns 2 to 8 depict the various question numbers and *question-types* in the term Assessment or Test to which the learners had to respond, as well as the learners' scores in each of the questions concerned. The same format or pattern is followed with all three quarterly/term tests examined in the documentary analysis process for March, June, and September (2008 and 2009).

It is significant to note that all the learners in this cohort scored nil on Question 3.4-3.6. This question required the learners to *state the functions*, which amounted to some form of discussion question. This suggests that Grade 6 isiXhosa-speaking learners experienced language difficulties when they had to answer *discussion (cognitive)* questions.

The following table gives an analysis of the learners' performance scores per *question-type* in the end of (2nd) term Assessment/Test (for June 2008). The model question paper or memorandum is found in paragraph 5.2.3.2 above, while samples of learner scripts or responses are attached as Appendix M.

Learner Code	**Q. 1.1-1.6: Matching columns (6)**	**2.1-2.6: Choose correct answer (in brackets) (6)**	**3.1-3.6: Complete sentences (6)**	**4.1-4.3: Name 3ways (3)**	**4.4-4.5: What is (2)**	**4.6: Name/ where (1)**	**5: Write a paragraph (6)**	**Total score (30)**	**%**
L1	2	4	2	1	0	1	6	16	53.3
L2	1	2	1	3	1	0	5	13	43.3
L3	3	5	2	3	1	1	3	18	60
L4	0	5	0	1	0	0	0	6	20
L5	3	4	1	1	0	0	0	10	33.3
L6	4	3	1	3	1	0	1	13	43.3
TOTAL	13	23	7	12	3	2	15	76	253.2
Average	2.2	3.8	1.2	2	0.5	0.3	2.5	12.7	42.2
Av. %	36.7	63.3	20	66.7	25	30	41.7	42.3	

Table 5.15: Select group of Grade 6 isiXhosa-speaking learners' performance scores per *question-type* in the end of 2nd term Assessment/Test for June 2008

Regarding the first term test (depicted in Table 5.14), Question 5 was basically a listing of safety precautions the learners should take with electricity. In answering the question, L3 wrote *"Don't salotape any electrical use"* and could have been credited with a point had he/she written 'appliance' instead of 'use'. This is a classic example of the lack of cognitive academic language proficiency (CALP) which puts second language/isiXhosa-speaking learners at a disadvantage. In question 2, L4 was able to find the correct answer(s) when the clue was narrowed down to two choices. This suggests that he/she struggled when many words were used and no clues to the answer were presented in the sentence. Thus, in response to question 5, where he/she was required to use his/her own words to construct a response, this learner showed lack of conceptualization of the question and used incomprehensible language. He/She wrote his/her 'paragraph' as follows:

1) *do not seal on the coal wold you sleep*
2) *yields only small amounts of electricity*
3) *Requires land areas*
4) *people safely your electricity at home*
5) *and do not open your water*

The learners' poor conceptualization is further highlighted by his/her response to some of the questions, for example:

Question 4.4: *What do we call the loud bang that we hear during a storm?*

L4 Answer: *Coal*

Question 4.6: *Where are the Sasol plants?*

L4 Answer: *Electricity;*

L5 answered: *"down in the soil"* – An indication that he/she made a literal translation of the word or concept 'plants'.

There was a similar pattern in performance between the three quarterly assessments examined for both Cohort 1 and Cohort 2 (where the learners obtained better scores on questions that required them to identify or select an answer, and poor scores on questions that called for reasoning and discussion. It is significant that all the learners scored zero on the paragraph question (Question 5), where they had to discuss and present an argument, using language skills. It is also significant that there was a progressively poorer overall average percentage performance of all the learners as the year progressed, namely 52.2% in the first term, 42.2% in the second term, and 29.4% in the third term (see Tables 5.14; 5.15; 5.16). This suggests that the learning difficulties among the Grade 6 isiXhosa-speaking learners were compounded in Natural Science as the year progressed. The progressively poorer performance of the isiXhosa-speaking learners in the second and third terms (June to September) may be attributed to the fact that there were cognitively and linguistically more demanding or challenging (reasoning) questions and less memory or recall questions than was the case in the first term tests. This re-affirms the argument or notion that language (including academic language) affects and influences cognitive functioning or understanding.

Given the evidence shown by the learners' performance in the above analyses, it appears that most isiXhosa-speaking learners function below level 3 (Application) of Bloom's Taxonomy of Educational Objectives in Natural Science assessments. At best, they seem to function at level 2 (i.e. at the Comprehension level) of Bloom's Taxonomy (Anderson & Krathwohl, 2001; Bloom, 1957; Po, 2006).

In summary, evidence found in the document analysis showed the following:

1. ***Entry-level***: There seems to be a relationship between level of entry at the school and academic performance of isiXhosa-speaking learners. Learners who joined the school at the lower level seemed to do better academically than those who joined at the higher level. Although the difference in academic performance between the learners was not very big, there seemed to be a correlation between the isiXhosa-speaking learners' overall performance in the assessment and the level at which they started at the school.

2. ***Language (LOLT) difficulty***: IsiXhosa-speaking learners seemed to experience a language difficulty in expressing their ideas or in describing their observation of science experiments, compared to their English-speaking peers.

3. ***Level of abstraction***: Because of the apparent language difficulty, isiXhosa-speaking learners appeared to have a lower level of abstraction of scientific knowledge, in comparison to their English-speaking peers.

4. ***Difficulty with science concepts***: IsiXhosa learners further struggled with conceptual words such as, 'solution', 'photosynthesis', 'water cycle', and 'solar system'.
5. ***Difficulty with interpretive/discussion/essay questions***: IsiXhosa-speaking learners seemed to perform better on contextual and recall questions than on interpretive, discussion or essay questions. It is significant that they scored lowest on the paragraph question (Question 5), where they had to discuss and present an argument, using language skills.
6. ***Level of cognitive functioning***: It appeared that many of the Grade 6 isiXhosa-speaking learners at Tableside Primary functioned below level 3 (Application) of Bloom's Taxonomy of Educational Objectives (See Appendix M) in Natural Science Assessments, instead functioning at level 2 (i.e. at the Comprehension level) (Anderson & Krathwohl, 2001; Bloom, 1956; Po, 2006).
7. It is also significant that there was a progressively poorer overall average percentage performance of all the learners as the year progressed.

5.2.4 Interviews

As mentioned in the introduction to this chapter, the fourth and final research method used in this study to assess the difficulties experienced by isiXhosa-speaking learners was the interviews. These were conducted with all 26 Grade 6 isiXhosa-speaking learners (13 learners each year in 2008 and 2009), all four Grade 6 Natural Science educators, the School Management Team (SMT), and four isiXhosa-speaking parents (two for each year, in 2008 and 2009).

During the learner interview phase of the study, many *Cohort 1 learners* initially denied that they had difficulties in learning Natural Science. However, on further probing, they conceded that they did have difficulties in the subject. To obviate the initial denial response, the researcher decided to start the Cohort 2 learner interviews with a more 'positive' question: *What makes it easy for you to learn Natural Science?* The result was that the learners were less defensive and more open and willing to discuss the difficulties they experienced in learning Natural Science at the school.

Many Grade 6 isiXhosa-speaking learners (both Cohort 1 and Cohort 2) stated that they found Natural Science easy to learn, *when the teacher explains it 'properly'* (L2; L09[23]; L12). In explaining their use of the expression 'properly', the learners said that this was when the teacher gave the lesson in a language that they understood, 'using simpler words'.

> *The things that they write – because some of the things they don't explain properly* (L09).

> *Like, when you ask a question, she* (the teacher) *won't explain it like, in the way that you want her to explain it. She will explain it in another way, but not in the way you want.* (L12)

In response to the question, *What difficulties do you find in learning Science at school?* two Cohort 1 learners responded as follows:

> *"Xa kuthethwayo"* (When it is spoken). *"Yho!"* (Exclamation in isiXhosa). *"Aku-explain-wa right apha"* (they don't explain right/properly here). *"We don't understand things. Sometimes we don't understand the meaning of what is said in English. The meaning of the difficult words, they are not explained properly."* (L2)

> *The teacher only uses English. Not that I don't understand English. It's difficult words like when teacher explains something to you she will use another word like, 'exhausted' – I didn't know the word, 'exhausted'. I looked it up in the dictionary. So, I do know, for example, 'tired' for 'exhausted'. I didn't know what 'exhausted' means. You don't know all the words in English, only a little bit. When teacher says 'I was so exhausted', you're confused and you think, 'what does exhausted mean?' It happens a lot in Science.* (L12)

Many Grade 6 isiXhosa-speaking learners also stated that they found difficulty in Natural Science Assessment when they were asked *interpretation, discussion* or *essay questions* and could not express or explain themselves properly and sufficiently:

> *I don't understand. Sometimes the questions are so difficult and I don't know what to do, then I don't answer the question in the module and I leave it. For example when you are asked to write a paragraph or describe a weather cycle or something else.* (L2)

> *It does have some difficult questions like discuss something or explain it. Sometimes it talks or asks about water and electricity, how a globe lights.* (L01)

> *Xa kubuzwa ii-interpretation questions* (when interpretation questions are asked), *e.g. explaining why you chose a certain answer, and writing or explaining in a few sentences. Because of the language, some of the things I can't explain properly or clearly.* (L02)

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[23] The numbering in the coding of Cohort 2 learners is preceded by a 0 (zero). This was done to distinguish them from Cohort 1 learners. Thus, L09 denotes that the learner concerned was coded as L9 in 2009.

> *When we are required to write an essay, e.g. 'How you can use the environment.'* (L02)

> *Xa mhlawumbi senza i-Natural Science, kufuneka sijonge kwi-module yethu, kufuneke sichaze, mhlawumbi kuthiwe ....., ndiyilibele le nto, kodwa kufuneke sijonge emaphini sichaze ii-answers* (when maybe we do Natural Science, we are required to look into our module, we are required to explain, maybe it is asked/said ….. I have forgotten this thing, but we are required to look into the map and give answers). (L6)

> *I found that ... when you write about all things and animals uhmm ... In fact flowers and all that stuff ... Yeah. When my teacher is asking the question like "what does the animal do or how does an animal give birth? Something like that – and flowers. I found difficulty in remembering the names or terms.* (L12)

When asked, *What would you change to make Natural Science easier to learn?* two learners responded:

> *I'd change the History of Science ... When did man go to the moon , ... Whatever, ever, ever. How ... 'ja' (yes) ... Something like that, ... And the History of Science is very difficult to me. I'd change the History of Science and nothing else.* (L12)

> *Make experiments simpler to understand; long words shorter or simpler; or use another method to make it shorter.* (L13)

In response to the question, *What difficulties do you find in learning Science at school?* some learners responded as follows:

> *The solar system – the planets. Some I don't know. Otherwise, no other difficulties.* (L1)

> *Eziny'izinto ze planet ne moon andiziqondi* (other things relating to planets and the moon I don't understand). *Ukuba iqala njani* (how the moon starts) *and ii-Moslem ziyazi njani ukuba i-full* (how do the Moslems know that the moon is full). *The ideas of 'full moon', 'waning' and 'max' I do not understand.* (L3)

> *There are things I don't know. I don't know things about the weather. I don't know what the difficulty is.* (L4). [The learner had great difficulty in explaining his difficulty and answered in isiXhosa].

> *I don't know some things, like, I don't know all the insects but some I know. Not that I don't understand, but I don't know them. Last time the teacher told us she is going to bring a movie about Science but didn't.* (L5)

As can be seen from the learners' responses, their answers narrowly focused on a particular or specific aspect of the *subject matter*, such as 'the solar system' or 'the weather' or 'the insects', rather than science as a field of study or science as a subject.

In summary, the following issues were identified by Grade 6 isiXhosa speaking learners as causes of their difficulty in learning Natural Science:

1. Understanding English, the language of instruction (i.e. LOLT)
2. The language that is used in science: terms and concepts (language of science)
3. Lack of 'proper' explanation by teacher
4. Answering essay questions in Natural Science or when writing assignments and tests

The ***educators*** highlighted the following challenges and/or difficulties in teaching Natural Science to isiXhosa-speaking learners.

To the question: *What difficulties do you find in teaching Natural Science to isiXhosa speaking learners in Grade 6 at the school?* the educators responded as follows:

> *To the new comers it is often the first time that they are taught entirely in English and that they hear difficult words or terms and struggle to understand. Those who started in Grade 4 and earlier do much better. The learners tended not to answer or ask questions.* (E1)
>
> *The scientific terms: learning in English is a big jump for them, and now added to that you use scientific terms. When I give them assignments, they can't follow instructions, especially to complete observations or investigations. The language barrier is most prominent.* (E2)

The educators, therefore, emphasized that the time or level at which the learners entered the school was very important. IsiXhosa-speaking learners, arriving at the school in Grade 6 for the first time, had difficulty in understanding English (LOLT), and as a consequence, struggled in Natural Science.

In terms of the above educators' view, all the Grade 6 isiXhosa speaking-learners who had spent three years or more at the school (in 2008 and 2009) should have been doing very well in Natural Science. However, this assertion is challenged by the assessment results (Tables 5.9 and 5.10 under paragraph 5.2.3.1). In terms of the ranked scores in Table 5.10, learners L10, L7, L4, and L2 scored below 50% in the 2008 (T1-T3) end-of- term assessments. These learners had spent four years or more at the school. On the other hand, learners L11 and L1, who had only been at the school for two years, scored above 50% in the assessments. In 2009, except for learners L09 and L010, the majority of learners who scored above 50% in the assessments had spent more than four years at the school. It is also significant that learner L09 joined the school at the 'critical' *entry level* (according to the educators). If the assessment scores for 2008 and 2009 are taken together, except for a few exceptions, the majority of learners who scored above 50% in the (T1-T3) term assessments entered the school in Grade 4 or before, which seems to confirm the educators' view.

To the question: *What do you think are the barriers to the learning of Natural Science through English for Grade 6 isiXhosa-speaking learners?* the educators responded as follows:

> *Language. The learners only hear English in class and not at home. The terminology can also be difficult, except for those who were in the school earlier* (E1).
>
> *They are used to isiXhosa, transition to English is difficult, plus the scientific terms. Learners who came to our school earlier, e.g. in the Foundation Phase, show a marked difference to those who came at Grade 5 and later. They perform better academically as they are used to our system and do not have a language problem* (E2).
>
> *Most Xhosa-speaking learners (at the school in 2009) started here at our school and have very few difficulties with the English language* (E3.2)

According to the educators, the isiXhosa-speaking learners tended not to answer or ask questions during lessons, which could be a further indication of a language barrier.

> *It is a language barrier – not so much the comprehension of the content, but more the language* (E2).

The educators also argued that some learners came from isiXhosa-medium schools, where teaching was done in isiXhosa, into an entirely English-medium school. It is 'common knowledge' that in Xhosa-medium schools the learners are either taught in isiXhosa, or where they are taught in English, the teachers explain the lessons in isiXhosa when the learners do not understand (Probyn, 2005).

> *The difficulties are that the majority of learners coming in from Xhosa speaking schools come at the beginning of the year having been taught in isiXhosa. They are taught here in English as a medium of instruction and they struggle. Xhosa learners who started here in Grade 1 and have gone through our system, and have done all the materials, do very well and do not have any problems. They are confident, don't struggle with the work academically. New Xhosa learners haven't learnt the terminology used in Grade 4 and 5 in Science.* (E1 in focus group interview, 2008).

It is interesting that none of the educators mentioned the fact that some of the educators themselves were not first-language English speakers and might, therefore, have struggled to explain concepts or impart knowledge to the learners in English.

One of the key factors that contribute to learning is learner motivation. The educators felt that many of the isiXhosa-speaking learners lacked the motivation to learn at school.

For example, in response to the question *What difficulties do you find in teaching Natural Science to isiXhosa-speaking learners in Grade 6 at the school?* one of the educators responded:

> *They are all over the place; are not focused on the work; seem to be all over the place. They don't know what's going on in the work because they are not used to the system. Also, the level of the work is higher: the material that we are doing is higher than they've done, and they do not have the background knowledge – higher knowledge.* (E1)

Another educator said:

> *It is difficult to encourage these learners: they don't do their homework; we try to encourage them to do their homework at school; we try all kinds of things in class; we liaise with the librarian to provide them with the necessary materials for assignments and projects. Some rush to catch their bus immediately after the last bell. We do many things in getting them interested in the content.* (E1)

Again, it is interesting that none of the educators mentioned that some of them were not first-language English speakers and could themselves be struggling to explain concepts (Language of Science) or to transfer knowledge in English (LOLT).

In summary, the following were identified by the educators as the difficulties experienced by isiXhosa-speaking learners in learning science:

1. Difficulty in understanding English (LOLT);
2. Many learners came from schools where they were taught in isiXhosa;
3. Difficulty in understanding scientific terms and concepts, i.e. the Language of Science
4. Inability to follow instructions;
5. New isiXhosa-speaking learners were not familiar with the (module) 'system' used in science at the school; and

6. Poor learner motivation.

The ***SMT*** mentioned the following difficulties in supporting the learners.

> *Lack of money, especially with regard to buying apparatus for conducting experiments. Our school falls in Quintile 5 which means that we receive minimum funding from the Department; We also have time constraints.*
>
> *Learners travel far and often find it difficult to stay behind as they get home late. We also experience lack of parental involvement and support.*

The SMT therefore identified the following difficulties in supporting the learners.

1. Financial constraints;
2. Time constraints;
3. Learner transport problems; and
4. Lack of parental involvement and support.

In their interviews, the ***parents*** mentioned the following difficulties in supporting their children in learning science:

> *Not being able to demonstrate what I explain to the child because I do not have the necessary equipment or apparatus. Sometimes I need pictures. Not having facilities like the internet. The time given for homework or projects is too short. The child is given work today to hand in tomorrow and there is little time to help her. Sometimes I have to do research for the child with some of the projects and I don't always have time to do that.* (P1)
>
> *As I said, sometimes I don't remember some of the things that are done at school. Sometimes the child has no textbook and I get the information from the internet.* (P2)
>
> *Sometimes umsebenzi awumakwanga (sometimes the work is not marked) or it is marked after so many days. Then it may be possible that the child has not been in class, and you don't know as a parent. Sometimes, when there is a change of teachers (for example, when one teacher is on leave) the child takes time to adapt to the new teacher.* (P03[24])
>
> *Amaxesha amaninzi izinto ezifundwayo esikolweni ngoku zohlukile kwezo sasizenza ngelethu ixesha* (Most of the time the things that are learned at school now are different from what we did in our time). *Ezinye izinto ndazilibala* (Some of the things I have forgotten). *Ngoko ke ndingakwazi ukumnceda* (Then I am unable to help him,

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[24] The numbering in the coding of Cohort 2 parents is preceded by a 0 (zero). This was done to distinguish them from Cohort 1 parents. Thus, P03 denotes that the parent concerned was coded as P3 in 2009.

i.e. my child). *Kodwa ndiyazama ukumnceda kangangoko ndinako* (But I try to help him as much as I can). (P04)

The parents clearly experienced the following difficulties in supporting their children in learning Natural Science:

1. Lack of facilities (e.g. internet and books) to support their children;
2. Inability to support their children because of time constraints;
3. Insufficient time given to complete the homework;
4. When the children's work is marked irregularly;
5. Keeping abreast with changes in the curriculum ; and
6. Helping their children to adapt to a new teacher.

In summary, the following emerged from the *interview* method in relation to the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science:

1. ***Teacher method of explanation***: Many Grade 6 isiXhosa-speaking learners (both Cohort 1 and Cohort 2) stated that they found Natural Science easy to learn, *when the teacher explains it 'properly'*. The teacher's method of explanation was crucial for them and they depended on it.

2. ***Type of Assessment questions***: Many Grade 6 isiXhosa-speaking learners also stated that they found difficulty in Natural Science Assessment when they were asked interpretation, discussion or essay questions.

3. ***Level of entry of learners***: The educators stated that isiXhosa-speaking learners arriving at the school in Grade 6 for the first time had difficulty in understanding English (LOLT), and as a consequence struggled in Natural Science. IsiXhosa-speaking learners who arrived at the school earlier (than in Grade 6) were seen to perform better than those who came in at Grade 6 level.

4. ***Language of learning and teaching (LOLT)***: Both the learners and the educators stated that the learners had difficulty in understanding English. The educators argued that some learners from isiXhosa-speaking schools came into an entirely English-

medium school and so were not familiar with the English medium of instruction, causing them difficulties in conceptualizing and understanding what the teacher was saying during the science lessons. The educators further noted that isiXhosa-speaking learners only heard English in class, and not at home, which exacerbated the situation.

5. ***Language of Science***: Both the learners and the educators stated that the learners had difficulty in understanding scientific concepts and terms like 'solar system', 'electric circuit', etc.
6. ***Financial constraints***: The school struggles to buy science equipment as it receives minimal financial support from the Education Department due to its Quintile 5 status.
7. ***Learner transport***: Learners travelled far and could not remain for after-school support.
8. ***Parental involvement and support***: The SMT experienced lack of parent involvement and support.
9. ***Lack of resources***: The parents indicated that they did not always have the resources to assist their children in science.
10. ***Time constraints***: The parents stated that they were not always able to assist their children to do their school work because of time constraints. The SMT also experienced time constraints in supporting the learners.
11. ***Changes in curriculum***: The parents indicated that they were unable to assist their children because they could not keep abreast with the latest curricular changes.

5.2.5 Triangulation of data: Difficulties experienced by Grade 6 isiXhosa-speaking learners

To recap, the first research question of this study was, *What are the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through the medium of English?*

In summary, the key themes that emerged *across all methods* used in the research, in relation to this question, are:

1. ***(Poor) socio-economic conditions***: The majority of isiXhosa-speaking learners lived in a township or informal settlement and were subject to the poor socio-economic conditions associated with such areas.

2. ***Longer schooling period***: The majority of isiXhosa-speaking learners were in Grade 6 between the ages of 12 and 13 years, while the majority of their English-speaking peers were in the same grade between the ages of 11 and 12 years. This suggests that the majority of Grade 6 isiXhosa-speaking learners had taken at least one extra year to reach Grade 6, in comparison with their English-speaking peers.

3. ***Familiarity with the school system***: The majority of isiXhosa-speaking learners in 2008 had spent a minimum of four years at the school. They should, therefore, have been familiar with the systems at the school. However, this is contrary to the educators' assertion that one of the reasons for the poor academic performance of isiXhosa-speaking learners was that "they are not used to the system."

4. ***School entry level***: From the document analysis evidence there seemed to be a relationship between level of entry at the school and the academic performance of isiXhosa-speaking learners in the science assessments (see Tables 5.10 and 5.11). Learners who joined the school at the lower (Foundation Phase) level seemed to do better in science assessments than those who joined at the higher level. According to the document analysis, it would appear that the educators' *entry-level* assertion was applicable to 50% (aggregate between 2008 and 2009) of isiXhosa-speaking learners over the two years, and was therefore potentially significant. The evidence suggested that the critical entry-level for academic achievement in Grade 6 Natural Science for isiXhosa-speaking learners was Grade 4 (as the educators suggested).

5. ***Educators' teaching styles***: The three Grade 6 Natural Science educators (E1 – E3) approached the same lesson (on 'weather') differently and emphasized different aspects of the topic under discussion. However, despite their different approaches to the lessons, the educators experienced similar if not the same difficulties (predominantly, language) in teaching science to isiXhosa-speaking learners.

6. ***Teaching strategies used by the educators***: The common teaching strategies used by the Grade 6 Natural Science educators were mainly question and answer method; telling method (talk and chalk); demonstration; class activity; group planning (radio

station weather report); simulation (weather report) presentation; group experiment (e.g. constructing a weather barometer).

7. ***Language***:

7.1.1 ***Language of learning and teaching (LOLT) usage***: IsiXhosa-speaking learners seemed to experience a language difficulty in expressing their ideas or in describing their observations in Natural Science, compared to their English-speaking peers. Their informal communication in interaction with their peers in class indicated that these learners seemed to manage to speak English (LOLT) at basic interpersonal communication (BICS) level in communicating with other learners, but struggled to use it academically.

7.1.2 ***Code switching***: There were manifestations of 'informal' or secret code switching to their home language among isiXhosa-speaking learners in group discussions or in conversation among themselves (a case of *subtractive bilingualism*). The educators could not use this strategy as they did not speak isiXhosa, and this disadvantaged both them and the learners.

7.1.3 ***Language of Science***: IsiXhosa-speaking learners seemed to struggle with scientific concepts such as 'satelite' and 'weather station', and 'electricity' concepts such as 'current' and 'circuit'. These learners appeared to have a lower level of abstraction in their discussion of scientific knowledge, compared to their English-speaking peers. This could be attributed to both the apparent limited proficiency of isiXhosa-speaking learners in English and their lack of understanding of the Language of Science.

8. ***Difficulty with interpretive/discussion/essay questions***: IsiXhosa-speaking learners seemed to perform better on contextual and recall questions than on interpretive, discussion or essay questions.

9. ***Level of cognitive functioning***: It appeared that most of isiXhosa-speaking learners functioned below level 3 (Application) of Bloom's Taxonomy of Educational Objectives in Natural Science assessments functioning instead at level 2 (i.e. at the Comprehension level).

5.3 ROLE PLAYED BY THE LOLT IN THE CONTEXT OF THE DIFFICULTIES

All four research methods were used in answering the above question, namely the questionnaires, classroom observation, document analysis, and the interviews.

5.3.1 Questionnaires

The analysis of data from the questionnaires showed that 100% of isiXhosa speaking learners indicated that they could speak, read and write in English. However, this study has shown that they only did so at the basic interpersonal communication skills (BICS) level but struggled when they had to use English at the cognitive academic language proficiency (CALP) level.

5.3.2 Classroom observation

During the classroom observation it became evident that a *subtractive bilingualism* policy was followed in the science classes. All the lessons were conducted in English, but the isiXhosa-speaking learners spoke their home language informally among themselves and sometimes in their group discussions.

5.3.3 Document analysis

Evidence from the analysis of the Learner Portfolios, Educator Portfolios, and Assessment records revealed that although the Grade 6 isiXhosa-speaking learners could write in English, they appeared to do so at a superficial (BICS) level. They seemed to struggle when it came to using academic language (CALP), both in answering interpretation questions in assessment, and describing their observations in science experiments or science projects (i.e. using both the *language of learning and teaching*, LOLT, and the *language of science*. As a result of their difficulties with both the LOLT and the Language of Science, the isiXhosa-speaking learners appeared to have a low level of abstract scientific knowledge and seemed to function below their age-appropriate level in terms of Bloom's Taxonomy of educational objectives (Bloom, 1956; Anderson & Krathwohl, 2001).

5.3.4. Interviews

During the interviews, both the learners and the educators acknowledged that Grade 6 isiXhosa-speaking learners experienced language difficulties in learning Natural Science. For example, the learners commented:

> *It's the language, English. Sometimes, I wish that it can be translated into isiXhosa.* (L08)
>
> *The words that are used in science. For example, there are difficult things when we deal with weather, e.g. when they explain the amount of wind in the weather lesson. I don't understand the temperatures and degrees.* (L7)

The educators, on the other hand, commented:

> *It is a language barrier – not so much the comprehension of the content, but more the language.* (E2)
>
> *If they know the* (English) *language they learn like other learners.* (E1)
>
> *They are used to isiXhosa, transition to English is difficult, plus the scientific terms.* (E2)

In summary, although isiXhosa-speaking learners could speak, read and write in English, the evidence showed that they did so at a superficial, conversational level, and seemed to struggle when it came to using academic and scientific language. Consequently they seemed to have a low level of abstract scientific knowledge and appeared to operate or function below their age-appropriate level in terms of Bloom's Taxonomy of educational objectives.

5.3.5 Triangulation of data: The role played by LOLT in the context of the difficulties

Language was a golden thread running through the responses to all the foregoing research questions. The key themes that emerged *across all methods* used in the research, in relation to language in Question 1, were:

1. ***More time spent in the phase***: Demographic evidence suggests that many isiXhosa-speaking learners spent at least one year extra, as compared to their English-speaking counterparts. This delay on the part of isiXhosa-speaking learners may be attributed to difficulties associated with learning through a (English) second language.

2. ***Language***:

2.1.1 ***Language of learning and teaching (LOLT) usage: IsiXhosa- speaking learners*** seemed to experience a language difficulty in expressing their ideas or in describing their observations of science phenomena, compared to their English-speaking peers. They seemed to manage to speak English (LOLT) at basic interpersonal communication (BICS) level in communicating with other learners, but struggled to use it academically.

2.1.2 ***Code switching***: There were manifestations among isiXhosa-speaking learners of 'informal' or secret code switching to their home language in group discussions or in conversation among themselves (a case of *subtractive bilingualism*). The educators could not use this strategy as they did not speak isiXhosa, and this disadvantaged both them and the learners.

2.1.3 ***Language of Science***: The learners seemed to struggle with scientific concepts like 'satelite' and 'weather station', and 'electricity' concepts like 'current' and 'circuit'. Because of the apparent language difficulty, isiXhosa-speaking learners appeared to have a lower *level of abstraction* (in their discussion) of scientific knowledge, compared to their English-speaking peers.

3. ***Difficulty with interpretive/discussion/essay questions***: IsiXhosa-speaking learners seemed to perform better on contextual and recall questions than on interpretive, discussion or essay questions.

The following emerged as the key themes (across all the used research methods) in relation to language in Question 2:

Language as a barrier: Many Grade 6 isiXhosa-speaking learners experienced difficulty with the *English medium of instruction* and expressed the desire to have English and isiXhosa used concurrently in the teaching of Natural Science.

The learners' language difficulties were aggravated by the Language of Science, which uses specialized terms and concepts. These are usually ordinary English words which assume specialized meanings in reference to specific scientific phenomena.

Both the learners and the educators acknowledged that the teachers were unable to speak isiXhosa and were, therefore, not able to use the code switching strategy, which was a disadvantage to both. This added credibility to the isiXhosa-speaking learners' charge that the teachers did not explain adequately during science lessons.

Document analysis showed that many Grade 6 isiXhosa-speaking learners performed best in answering questions the required one word and/or recall questions in Natural Science. They performed worst in answering higher-order/level thinking questions (Anderson & Krathwohl, 2001; Bloom, 1956; Po, 2006), that is, questions that required them to discuss or express their ideas.

Because of the language difficulties manifested above (and during the learner and educator interviews) it appeared that many Grade 6 isiXhosa-speaking learners attained lower levels of abstraction of (science knowledge) content, and consequently lower levels of cognitive functioning. The educators attributed the low levels of subject content in isiXhosa-speaking learners to a paucity or lack of prior knowledge and the existence of logistical problems (e.g. lack of access to internet and other resources) in learning science.

In conclusion: IsiXhosa-speaking learners seemed to speak English (LOLT) at a basic interpersonal communication (BICS) level in communicating with other learners. However, they seemed to struggle with 'weather' concepts such as 'satelite' or 'weather station', and with 'electricity' concepts like 'current' and 'circuit'. There were manifestations among isiXhosa-speaking learners of 'informal' or secret code switching to their home language in group discussions or in conversation among themselves (a case of *subtractive bilingualism*). The educators could not use this strategy, as they did not speak isiXhosa and this possibly disadvantaged both them and the learners.

As evidence in this study has shown, the bottom line is that the Grade 6 IsiXhosa-speaking learners experienced difficulties in accessing the science curriculum due to the English language of instruction (LOLT) and the language that was used in science (scientific terms and concepts). This was exacerbated by the fact that the educators could not use the code switching strategy to enable the learners to understand the subject better.

5.4 THE TEACHING AND LEARNING CONTEXT

Only three of the research methods (namely *classroom observation*, *document analysis*, and *interviews*) were used to answer the question: What factors within the teaching and learning situation contribute to these difficulties? The above question was aimed at the conditions under which learning, especially in Natural Science, took place at the school, particularly as perceived by both (isiXhosa-speaking) learners and the educators.

5.4.1 Classroom observation

The following themes relating to the teaching and learning environment emerged from the classroom observation: inadequate resources; language (LOLT) barrier; and, level of questioning.

5.4.1.1 Inadequate resources

During the class visits, my first observation was that there was no science laboratory at the school. Most Grade 6 Natural Science lessons were held in the ordinary classroom. In cases where an experiment had to be conducted, the learners were either taken to the Technology Laboratory or the teachers brought the necessary apparatus or equipment to the classroom. This absence of a science laboratory seemed to limit the ability of the educators to 'demonstrate things', as suggested by one learner (L2) during the interviews. Secondly, there was no prescribed science textbook for the learners. Instead, the learners and educators used science *modules*, developed and compiled by the educators.

The School Management Team (SMT) attributed the inadequate resources at the school to the fact that the school was categorized as falling under Quintile 5. Because of this classification the school received minimal funding from the Department of Education, in line with the provisions of the *Norms and Standards for School Funding* (Department of Education, 1998).

5.4.1.2 Language (LOLT) barrier

The fact that none of the Natural Science educators could speak isiXhosa was an impediment or limitation both to themselves and the learners, in that code switching could not be used as a strategic tool to support or scaffold the learning process. Code switching can be a very powerful linguistic tool, especially in explaining new science concepts (Probyn, 2005; Donald et al, 2010). The educators sometimes made up for this shortcoming by asking isiXhosa-speaking learners to explain to each other in their home language when one of them did not understand or could not follow instructions. The learners, however, used the strategy of code switching informally among themselves, in group discussions and in private conversation.

5.4.1.3 Level of questioning

Other than checking for prior knowledge and understanding, the educators asked questions which required simple and straight forward answers. The educators rarely asked questions that challenged and stretched the learners' cognitive skills or (their own) scientific knowledge construction, either during lessons in class or during learner assessment. The educators rarely asked higher order questions (see paragraphs 5.2.3.1 'Model Test'). As a result of this approach, the learners appeared to have had no opportunity to practice and develop their cognitive or thinking skills and thus to improve their level of abstraction in scientific knowledge. This shortcoming corroborated or confirmed what was manifested by the learners obtaining relatively high scores on questions that required recall or single word answers (Tables 5.14 and 5.15), but low scores on questions calling for interpretation and discussion during assessment.

In summary, the following findings emerged from the classroom observation in relation to Question 2 of the research:

1. ***Inadequate resources***: There was no science laboratory at the school and instead a Technology Laboratory was used.

2. ***Language (LOLT) barrier***: None of the Grade 6 Natural Science educators could speak isiXhosa, and this prevented them from using code switching as a strategy to support their isiXhosa-speaking learners.

3. ***Level of questioning***: The educators rarely asked questions that challenged or stretched the learners' cognitive skills (i.e. 'higher-order' questions). This could deprive the learners of the opportunity to practice and develop their cognitive skills and thus improve their level of abstraction of subject content.

5.4.2 Document analysis

During the document analysis phase, both the Learner Portfolios and Educator Portfolios, as well as records of assessment or mark schedules, were perused for evidence of the learners' academic performance. The aim was to identify the factors that positively or negatively affected the quality of learning and academic performance of Grade 6 isiXhosa-speaking learners in science. In other words, the aim was to find out, by perusing the learner and educator documents and records, what factors facilitated or inhibited the academic performance of Grade 6 isiXhosa-speaking learners in Natural Science.

The findings of the document analysis will now be discussed under the following sub-headings: Language Policy; Alternative Assessment; and Home background.

5.4.2.1 Language Policy

Scrutiny of the Learner and Educator Portfolios as well as class work and learner assessment records or documents revealed that learning and teaching in Natural Science was done exclusively through the medium of English, in line with the school's Language Policy. Because many isiXhosa-speaking learners seemed not sufficiently proficient in the English LOLT, they appeared to understand and perform their academic work mainly at a superficial level. This was manifested in their performance in assignments and projects, and in the assessment of their achievements. The analysis discussion under paragraph 5.2.3.2 is testimony to the shortcomings manifested by isiXhosa-speaking learners, due to their limited English proficiency (LEP). Their language disadvantage was made worse by the fact that they were not allowed to use isiXhosa (code switching) in their writing (a case of *subtractive bilingualism*).

5.4.2.2 Alternative Assessment

Little or no evidence of alternative forms of assessment being applied to cater for learners who experienced LEP was found in either the Learner Portfolios or the Educator Portfolios. Although the educators gave the learners a variety of creative science projects, these essentially required the learners to report or record their findings or results through the medium of English. Given that the educators had developed *science modules*, and were using them instead of a prescribed textbook, this could have provided them with the opportunity to find creative ways of alternative assessment to support learners with limited English proficiency. For example, they could have devised forms of assessment or projects that required more diagrammatic representations (e.g. different forms of electric circuits) and fewer (English) words. There was also no evidence of the integration of the learners' traditional background knowledge (IKS) in the learners' assessment activities or (science) projects.

5.4.2.3 Home background

Evidence from the questionnaires showed that the majority of isiXhosa-speaking learners came from townships or informal settlement areas. As these areas are associated with poor socio-economic conditions, such as poverty and limited resources, the implications are that learners coming from these areas did not have access to facilities such as the internet or libraries to support their learning. Because many of these learners used public transport to school, they arrived late at school and left at the last bell, unable to stay for after-school classes, as they had to travel far. The educators also reported that these learners were tired when they arrived at school (as they had to wake up early to catch the bus or train) and were less motivated to do school work.

In summary, the following findings emerged from the document analysis:

1. ***Language policy***: Natural Science learning and teaching was done exclusively through the medium of English, in line with the school's Language Policy. As manifested in their performance in assignments, projects and assessment achievements, many Grade 6 isiXhosa-speaking learners appeared to understand and perform their school work in science only at a superficial level, possibly due to their not being sufficiently proficient in the English LOLT.

2. ***Alternative Assessment***: There was limited evidence of alternative forms of assessment being applied to cater for learners with limited English proficiency (LEP), or was there evidence of the integration of the learners' traditional background knowledge (IKS) in assessment.

3. ***Home background***: As evidence from the questionnaires showed that the majority of isiXhosa-speaking learners came from townships or informal settlement areas, the motivation of these learners was likely to be negatively affected by the poor socio-economic conditions associated with such areas

5.4.3 Interviews

Both the learners and the educators mentioned a number of factors within the school environment that they thought contributed to the learning difficulties experienced by isiXhosa-speaking learners. In the case of the educator interviews, although three educators were interviewed, the third educator (E3) was not only new to the school but also in her first year of teaching. She was employed at the school as a substitute for a teacher who was on leave until the end of the year. It will be noticed, therefore, that the educator responses to the interviews were mainly from two educators (E1 and E2) and that very little was said by E3.

The findings based on the interviews will now be discussed under the following sub-headings: Factors as perceived by learners; Factors as perceived by educators; and Social factors.

5.4.3.1 Factors as perceived by learners

Factors which were perceived by the learners as contributing to their learning difficulties in science included: the language of learning and teaching (LOLT); the Language of Science; and inadequate teaching or explanation methods.

Some of the factors which were considered to contribute to the learning difficulties in the teaching and learning situation were best demonstrated by what the learners suggested should be changed within the school to make the learning of science easier for them.

Language learning and teaching (LOLT):

In response to the question, *What would you change to make Natural Science easier to learn?* two of the learners responded as follows:

> *I would change the language, so that Xhosa is also used in class. Use English and Xhosa. (L1)*
>
> *I would change language to Xhosa and English during lessons. Some learners don't understand English.* (L4)
>
> *It's the language, English. Sometimes, I wish that it can be translated into isiXhosa.* (L08)

It is clear that the English LOLT was a major barrier to the learning of Natural Science by Grade 6 isiXhosa-speaking learners in Grade 6. It appeared that they preferred to be taught the subject in both English and isiXhosa in order to understand it better.

Language of Science:

Allied to the issue of the language of instruction (LOI[25]) was that of the Language of Science. When asked, *What, do you think, makes science more difficult to learn?* some learners answered:

> *Amagama asetyenziswayo andiwa-understand-i* (I don't understand the words that are used). (L6)
>
> *The words that are used in science. For example, there are difficult things when we deal with weather, e.g. when they explain the amount of wind in the weather lesson. I don't understand the temperatures and degrees.* (L7)
>
> *The language, e.g. "percentage" – like 10% and the sun.* (L8)
>
> *Izinto abaziyuzayo* (the things they use), *like, la nto ye "wind"* (like the thing they use to demonstrate the wind). *I- "wind sock" (the "wind sock").* (L9)
>
> *I have difficulty with remembering some of the concepts, for example weather concepts like temperature and .....* (L10)
>
> *Andiwazi amanye amagama asetyenziswayo* (I don't know some of the words that are used). *Nothing else.* (L1)

With regard to the level of questioning, some learners commented as follows during the interviews:

> *Sometimes the questions are so difficult and I don't know what to do, then I don't answer the question in the module and I leave it. For example, when you are asked to write a paragraph or describe a weather cycle or something else.* (L012)
>
> *The maps. Andikwazi kuzifumana, like, zonk'ii-answers* (I can't find all the answers). *Xa mhlawumbi senza i-Natural Science, kufuneka sijonge kwi-module yethu, kufuneke sichaze, mhlawumbi kuthiwe ....., ndiyilibele le nto, kodwa kufuneke sijonge emaphini sichaze ii-answers* (when maybe we do Natural Science, we are required to look into our module, we are required to explain, maybe it is asked/said ….. I have forgotten this thing, but we are required to look into the map and give answers). (L6)
>
> *Xa kubuzwa ii-interpretation questions* (when interpretation questions are asked), *e.g. explaining why you chose a certain answer, and writing or explaining in a few*

---

[25] In this study, Language of Instruction (LOI) and Language of Learning and Teaching (LOLT) are regarded as synonymous terms and are, therefore, used interchangeably.

> *sentences. Because of the language, some of the things I can't explain properly or clearly.* (L02)

From the above, it is clear that the learners experienced a major difficulty in understanding science words and concepts. It seems that as a result of not understanding the science concepts, isiXhosa-speaking learners struggled to conceptualize or understand science phenomena or make a connection between the instrument or apparatus that was used to demonstrate and the phenomenon being demonstrated or measured (e.g. the sock that was used to indicate 'the direction in which the wind is blowing' at a given time). As a result, they failed to fathom or capture the (demonstrated) scientific principles and/or rules.

Inadequate teaching method

Many learners stated that they had difficulty in learning science because the teachers did not explain enough or to their satisfaction. In response to the question, *What difficulties do you find in learning science at school?* one learner responded:

> *Xa kuthethwayo* (When it is spoken). *Yho!* (Exclamation in isiXhosa). *Aku-explain-wa right apha* (they don't explain right/properly here). *We don't understand things. Sometimes we don't understand the meaning of what is said in English. The meaning of the difficult words, they are not explained properly.* (L2)

In response to the question, *What, do you think, makes science more difficult to learn?* some learners answered:

> *Some of the teachers don't explain to us. It's very difficult to know because it might not be a favourite subject. Not everyone likes science.* (L5)
>
> *You don't get easy explanation. If you don't get [understand] everything to know, the teacher won't always explain. Let's say, like, if you learning about history of science, when you're asking, 'Miss, how can you write about this? I think she will tell you ... write about a paragraph, people in the old days – she won't explain it in a proper way.* (L12)
>
> *The teacher does not explain well and I do not fully understand the English language.* (L8)
>
> *When the teacher sometimes doesn't explain and says you must follow the rules.* (L13)
>
> *Simplify things and not difficult things. For example, mix the simple with the difficult. The teacher must demonstrate things* (more practical work), *e.g. giving pictures instead of just words.* (L2)
>
> *Sometimes the teachers don't talk very well. Bathethela phantsi* (they speak very softly) *and you can't hear properly. And when you ask them to repeat or explain it is*

> *as if uyabhoxa (you are being funny). Then you don't know what to do. And sometimes I don't know the word that is used.* (L3)
>
> *Sometimes Miss gives you stuff to do, lots of work and she teaches and writes on the board at the same time. You don't know whether to listen to her or write.* (L07).

The above learner responses suggest that the teachers needed to operate always on the assumption that isiXhosa-speaking learners could not readily understand science concepts or science phenomena, and that for the learners' benefit, they (the teachers) needed to demonstrate, illustrate and explain more in their teaching. The responses also showed an over-reliance by isiXhosa-speaking learners on the explanation of the teacher.

> *If I don't understand Science I would go to another person to explain to me or teach me Science after school; or come to school early and ask Miss (the teacher) some questions. I would even ask the principal to explain.* (L3)

This seems to suggest that the learner needed the teachers to be more accessible.

5.4.3.2 Factors as perceived by educators

The educators mentioned a number of factors in the school environment as contributing to the difficulties they experienced in teaching Natural Science to isiXhosa-speaking learners. These factors included overcrowded classes; poor or low level of abstraction of content (by learners); less effective curriculum delivery methods; inadequate Learning Support; poor learner motivation; and social factors.

Overcrowded classes

There were a total of 25 learners in each of the three Grade 6 classes at Tableside Primary, both in 2008 and 2009. In answering the question, *What factors within the teaching and learning situation contribute to these difficulties?* the educators stated:

> *Overcrowded classes limit our ability to give individual attention to isiXhosa learners who need it more than others. As a result, they lag behind with the work.* (E1)
>
> *The number of learners in the class negatively affects the quality time you spend with the learners.* (E2)

It should be noted that the classrooms in ex-Model C schools were designed to accommodate about 20 white learners during the apartheid era. A class of about 25 learners, therefore, would be overcrowded both physically and in comparison to what the ex-Model C teacher was accustomed to.

Curriculum: Subject content

Responding to the question, *What do you think are the barriers to the learning of Natural Science through English for Grade 6 isiXhosa-speaking learners?* one educator stated:

> *The content of science – sometimes it's above their level. The curriculum – we do it the way it should be done. When it comes to projects, they don't know what is expected of them. They don't use the internet and other resources like the library because often they have to rush after the last bell as they must catch their home transport in time.* (E1)

To the question, *What factors within the teaching and learning situation contribute to these [learning] difficulties?* one educator responded:

> *Many of them lack the required prior knowledge – the subject content covered in grade 4 and 5; even projects done in other schools are of a lower standard. When they come here, we are focused on the curriculum and do it the way it should be done. They are not used to this manner of working.* (E1)

The above comments seem to question the learners' prior knowledge, which is narrowly defined in terms of the Grade 6 learning programme. This suggests that other forms of prior knowledge were not even considered, as the educators repeatedly claimed that they *were focused on the curriculum and do it the way it should be done.*

Language usage

In answering the question, *What do you think makes teaching Natural Science to isiXhosa-speaking learners more effective?* one educator stated:

> *If they know the language, they learn like other learners.* (E1)

> *To the new comers, it is often the first time that they are taught entirely in English and that they hear difficult words or terms and struggle to understand. Those who started in Grade 4 and earlier do much better.* (E1)

It therefore emerged from the interviews that isiXhosa-speaking learners who joined the school in Grade 4 or earlier fared better in Natural Science than those who joined the school after Grade 4.

Regarding code switching, one educator responded:

> *We are disadvantaged as teachers in that our teachers are not proficient in isiXhosa but try to accommodate the learners as much as we can.* (E2)

Inadequate resources

In answering the question, *What factors within the teaching and learning situation contribute to these difficulties?* one educator highlighted:

The inadequate use of the labs. (E2)

This corroborates the *classroom observation* (see paragraph 5.2.2.4, Table 5.10), where it was stated that there was no science laboratory at the school. A Technology room was used for Natural Science, mainly by the teacher in Grade 6ST. It seemed though that the educators did not make optimal use of the available resources at the school. During the interview another educator stated that:

> *We are probably not making optimal use of our resources, e.g. the library, and the lab.* (E3.1)

Yet another educator responded:

> *Less effective use of time (i.e. less effective time management).* (E2)

The educators also indicated that the shortage of textbooks was one of the factors contributing to the learning difficulties. As one of the educators said:

> *There is a shortage of textbooks –the teacher has to make photocopies and notes.* (E2)

Indeed, the educators and learners did not use a 'prescribed textbook' but rather a 'Science Module' which was developed by the educators.

5.4.3.3 Social factors

The educators identified the following socio-economic factors as further barriers to learning by Grade 6 isiXhosa-speaking learners: coming late to school and problems associated with the public transport system, which negatively affected the learners.

Late coming

During the research interviews, the educators pointed out that the majority of isiXhosa-speaking learners often arrived late at school due to public transport problems, and were still settling down while the rest of the class were already engaged in their learning activities.

> *Many of them are up early and have to travel a long distance. Those factors contribute to learning. Because they've been (long) on the road they don't have focus on the learning. (E2)*

> *They come in tired – don't get much sleep, they are already on another vibe. They are actually not afraid to sleep (in class). They are always tired because they've been up early. You want them to sit and focus, but they don't really want to do that.* (E1)

> *Sometimes they have problems with the public transport and they get here late, take long to settle, when the rest of the learners have settled in to the routine and they miss out.* (E2)

The above educator responses suggest that isiXhosa-speaking learners experienced serious time constraints. Not only do the learners have to wake up very early to make the time for school but they also have to leave school early or rush after the last bell in order to catch the bus/taxi. This becomes a vicious circle, as when they arrive home they have to go to bed early in order to be able to wake up early to catch the first train or bus to school the following morning. All this suggests that the Grade 6 isiXhosa-speaking learner spends far less 'time on task' on school work and consequently his/her academic performance is generally negatively affected.

Educators found it difficult to support the isiXhosa-speaking learners, as their parents did not respond to calls. The following comments by two educators support this point:

> *The school holds open days every term – some parents don't even come. They make excuses. So the child just hops along. There are also problems in communicating with the parents, as some of the learners don't deliver letters from the school to their parents.* (E1)

> *Many (learners) come from fairly poor socio-economic background and do not get the academic support (e.g., homework, research projects) from their homes or parents. Some, when they go home have to help clean the house, look after younger children, etc. Many of them have to run the home while the parents are at work. So it's a matter of eating and going to bed again. This disadvantages them in relation to the other learners.* (E2)

In summary, the themes that emerged from the interviews with learners and educators in relation to factors in the teaching and learning situation that contributed to the difficulties in learning science were:

1. ***Medium of instruction***: Both the Grade 6 learners and the educators acknowledged that many isiXhosa-speaking learners experienced difficulty with the English medium of instruction. Many Grade 6 isiXhosa-speaking learners expressed the desire for

English and isiXhosa to be used jointly in the teaching of Natural Science. Both Grade 6 learners and educators acknowledged that isiXhosa-speaking learners experienced difficulties in comprehending the concepts and terms used in science (i.e. the language of science).

2. ***Inadequate (teacher) explanation***: Many learners felt that teachers did not provide enough explanation to facilitate understanding and learning.

3. ***Overcrowded classes***: Educators felt that overcrowded classes limited their ability to provide individual attention to isiXhosa-speaking learners.

4. ***Curriculum: subject content***: The educators claimed that the subject content of science was sometimes above the learners' level of understanding; that many of the learners lacked the basic prior knowledge – the subject content covered in Grades 4 and 5; that when it came to doing projects, they did not know what was expected of them; and, that they could not use resources such as the internet (available after school) due to transport problems. However, as this study has shown, the Grade 6 IsiXhosa-speaking learners clearly experienced difficulties in accessing the science curriculum due to the English language of learning and teaching (LOLT) and the language used in science (scientific terms and concepts). This was exacerbated by the fact that the educators could not use a code switching strategy to help the learners understand the subject better.

5. ***Inadequate resources***: Educators argued that factors within the school, such as inadequate funds, inadequate resources (no science laboratory or interactive whiteboard), limited use of available resources (such as the library), and the ineffective use of time, contributed to the difficulties experienced by the Grade 6 isiXhosa-speaking learners in learning science.

6. ***Lack of parental support***: Educators found it difficult to help isiXhosa-speaking learners as the parents did not attend open days arranged by the school. The educators also experienced problems in communicating with the parents, as some of the learners did not deliver letters from the school to their parents.

7. ***Poor socio-economic conditions***: Both in the home background of isiXhosa-speaking learners and within the school itself, there was only limited access to resources that could support their learning.

5.4.4 Triangulation of data: The Teaching and Learning Context

Question 2 of the research was, *What factors, within the teaching and learning situation, contribute to these difficulties?* The following emerged as the key themes (across all the research methods used) in relation to this question: Language as a barrier; Teaching methods; School environment: Inadequate resources; Social factors.

Language as a barrier

Many Grade 6 isiXhosa-speaking learners experienced difficulty with the *English medium of instruction* and expressed a desire for English and isiXhosa to be used concurrently in the teaching of Natural Science. For example, one learner (L07) commented as follows during the interviews.

The learners' language difficulties were aggravated by the Language of Science which used specialized terms and concepts. These were usually ordinary English words which assumed specialized meanings in reference to specific scientific phenomena.

Both the learners and the educators acknowledged that the teachers were unable to speak isiXhosa and that their inability to use a code switching strategy was a disadvantage to both. This added credibility to the isiXhosa-speaking learners' charge that the teachers did not give adequate explanations during science lessons.

Document analysis showed that many Grade 6 isiXhosa-speaking learners performed best in answering questions that required only one word and/or recall questions in Natural Science. They performed worst in answering higher-order/level thinking questions (Anderson & Krathwohl, 2001; Bloom, 1956; Po, 2006), that is, questions that required them to discuss or express their ideas.

Because of the language difficulties manifested above (and during the learner and educator interviews) it appeared that many Grade 6 isiXhosa-speaking learners only attained lower levels of abstraction of (science knowledge) content and, consequently, lower levels of cognitive functioning. The educators attributed the low levels of abstraction and cognitive in isiXhosa-speaking learners to a paucity or lack of prior knowledge and the existence of logistical problems (e.g. lack of access to internet and other resources) in learning science.

Teaching methods

The difficulty with both LOLT and Language of Science was manifested in the learners' assertion that the educators did not provide enough explanation during science lessons. During the interviews, learners mentioned that teachers needed to 'demonstrate' and 'simplify' things so that they could understand the science. The educators themselves also acknowledged that they probably did not make optimal use of resources (such as the Technology Laboratory and the library) available at the school in their teaching, nor were they making effective use of time.

School environment: Inadequate resources

Factors in the school such as overcrowded classrooms, the absence of a science laboratory, no interactive white boards, insufficient textbooks, and insufficient funds, although affecting all the learners, added to the learning difficulties experienced by isiXhosa-speaking learners in learning science.

Social factors

Social factors seem to have had a negative impact on learning in the school. These included late-coming due to transport problems, lack of academic support from home, and lack of general parental support. Grade 6 isiXhosa-speaking learners seemed to experience serious time constraints. As a result, they spent far less 'time on task' on school work, thus negatively impacting on their academic performance in general.

5.5 HOW THE LEARNERS AND EDUCATORS COPED WITH THE CHALLENGES

Only three research methods were used to answer this question, namely classroom observation, documentary analysis, and interviews.

5.5.1 Classroom observation

One of the main focal points of the classroom observation visits was to see what coping strategies both the learners and educators used to address or deal with the difficulties that they encountered in the learning and teaching of science. The aim was to look at whether such coping strategies were adequate and, if not, how they could be improved to make the learning of science more effective and easier for isiXhosa-speaking learners.

The findings will now be discussed under the subheadings Coping with the LOLT and Language of Science; Educators' teaching styles; Learner discipline; and Learner participation.

5.5.1.1 Coping with the LOLT and Language of Science

During my class visits, I observed, firstly, that all the Natural Science educators at the school used English exclusively to deliver their lessons. Furthermore, isiXhosa-speaking learners tended to speak in their home language when addressing one another and switched over to English when addressing learners of other language groups or when speaking to the teacher. The same also occurred during class group discussions, where two or more isiXhosa-speaking learners happened to be in the same group. As none of the Grade 6 science educators could speak or understand isiXhosa, they were unable to use code switching as a strategy to support their isiXhosa-speaking learners. Some isiXhosa-speaking learners asked their English speaking peers to explain to them when they did not understand something.

5.5.1.2 Educators' teaching styles

As mentioned previously, the educators mainly used the telling method, the question and answer method and group activity during their teaching. However, they approached the same lesson in different ways and with different emphases. I noted that, to cope with the difficulties experienced by isiXhosa-speaking learners in understanding English, the educators asked some of the learners' peers to explain to them. There was virtually no evidence of the integration of the learners' traditional background knowledge (IKS) in all three educators' teaching and/or class activities.

5.5.1.3 Learner discipline

The classroom observation highlighted that the educators applied discipline in different ways with the learners. Some learners (e.g. L2; L8; L17) in 6 FS manifested disciplinary problems, as they often either did not co-operate with the teacher or *back-chatted* the teacher, possibly because they struggled with the work, or did not understand it. At one stage, they were sent to detention (i.e. put into isolation) and subsequently moved from E2's to E1's class. Both the responses of the learners and the educator's reaction to their behaviour were manifestations of negative coping strategies that both parties may need to address through the intervention of a third party at a later stage.

5.5.1.4 Learner participation

Although the learners actively participated in the lessons and the relevant group discussions in both Cohort 1 and Cohort 2, they were not challenged by their teachers to use high-level cognitive functioning and cognitive skills during questioning. For example, in introducing the 'weather' lesson, the educator (E3) of Cohort 1 asked the learners, *"When you wake up every morning what is first thing that you usually check, except time?"* When, after a few guesses and inputs from various learners, they mentioned that they checked the weather conditions outside their room, the educator went on to discuss weather patterns and the symbols used to denote various weather conditions. While this was a good strategy, the educator could, for instance, also have posed further questions that required learners to solve some hypothetical problems or raised issues relating to their indigenous knowledge system (IKS) pertaining to weather. A similar pattern of lesson presentation and activities was followed with the other two classes as well.

In summary, the research findings emerging from the classroom observation, in relation to the coping strategies used by both learners and educators, were:

1. ***Language Policy and Code switching***: Evidence in this study showed that the school followed a subtractive bilingualism policy. All Natural Science lessons were conducted exclusively in English. However, isiXhosa-speaking learners tended to speak to one another in their home language and secretly did the same during group discussions, when two or more learners were in the same group. None of the Natural Science educators could speak or understand isiXhosa. They were thus unable to use code switching to support their learners when they did not understand. However, during the interviews, the educators indicated that they sometimes asked isiXhosa-speaking learners to explain to one another in their home language. It seems, therefore, that there was a conflict between policy and practice with respect to the application or use of code switching as coping strategy (for language difficulties) in the Grade 6 science classrooms.

2. ***Educators' teaching styles***: The three educators approached the same lessons (on 'Weather' and 'Electricity') in different ways and with different emphases. It seemed that there was no uniform teaching strategy among the educators to cope with the lack of understanding of science by isiXhosa-speaking learners, nor was there evidence of any integration of the learners' traditional background knowledge in the lessons or class activities.

3. ***Learner discipline***: Although the learners were generally well disciplined and co-operated with each other as well as with the teacher, some learners in Grade 6 FS manifested poor coping through ill-discipline, as they often did not co-operate with the teacher. This could be because they struggled with the work, or did not understand it. This represented a poor coping style both on the part of the learners, and on the teachers who resorted to sending the learners to detention.

4. ***Learner participation***: Although the isiXhosa-speaking learners actively participated in the lessons and the relevant group discussions, they were not challenged to use higher-order reasoning or to draw on their indigenous knowledge experiences.

5.5.2 Document analysis

It was not easy in the document analysis to identify any evident coping strategy used by the learners. However, there seemed to be some evidence that they drew on their own life experiences (or used common sense) to 'make sense' of their learning. For example, some of the learners responded to the question, *Write a paragraph about the advantages of plastic* (Q.5, September 2008), as follows:

L5 wrote:

> *1 plastic is good so that you can carry stuff.*
>
> *2 People need plastic to put dirt stuff.*
>
> *3 all when you go to the you need plastics*
>
> *4 plastic is good to use.*
>
> *5 You mus'nt cut plastic and throw it away*
>
> *you must keep it good*

L6 wrote:

> *In the plastic bag you can only put things like fish oil, tin of fish, etc, like small stuff. You can't put things like 10 kg of mealie mielie because it is very hard, and in can tear the plastic bag then you food will fall down.*

In the above answers, it is clear that the learners drew on their township experiences, where plastic bags are normally put to many uses, mainly as carrier bags. In their experience plastic is therefore a very useful commodity, especially since plastic bags have been sold in retail shops as part of the campaign to reduce environmental pollution.

In summary, the research findings emerging from the document analysis, in relation to coping strategies suggest that the Grade 6 isiXhosa-speaking learners drew on their own life experiences to 'make sense' of their learning when required to answer discussion or interpretation questions about a topic with which they were not familiar. They did not appear to have considered or answered the question on the use of plastic on the basis or context of its scientific composition or qualities. This seems to suggest poor conceptual understanding of the topic under discussion.

5.5.3 Interviews

The following were identified as the coping strategies used in dealing with the difficulties they experienced in learning science: Dependence on the teacher; Code switching as a strategy; Using peer support; Seating arrangements; Additional support programmes; Managing the language of science (barrier); Monitoring science projects; Other coping strategies; and Remedial programmes.

5.5.3.1 Dependence on the teacher

Most isiXhosa-speaking learners depended on the teacher to address their learning difficulties in Natural science. In answering the question, *What do you do to deal or cope with these (learning) difficulties?* the learners responded:

> *I study, or look for meanings in the dictionary. Or "ndibuze uMiss"* (or I ask Miss – i.e., the teacher). (L1)
>
> *Sometimes I ask Miss* (the teacher) *but when I understand the questions I answer them, when I understand question by question what is happening. Sometimes I try to do it myself or ask another learner if I am doing the right thing, or to explain the question.* (L2)
>
> *If I don't know the word. Sometimes I look it up in the dictionary, or ask the teacher, or find out on my own, or ask my parents.* (L3)
>
> *The learner next to me explains to me. I also ask the teacher. If not, I don't do the work.* (L4)

> *I just go to my teacher and say, 'Miss, I don't understand this, can you explain it to me', or ask my group to help me.* (L5)
>
> *Ndifunda, maybe two times or three times* (I read over two or three times) *okanye ndibuze abanye abafundi* (or ask other learners) *or I ask Miss* (the teacher). (L6)
>
> *I ask miss* (i.e. the teacher) *to explain on her laptop.* (L7)
>
> *I ask my friend next to me. My friend helps by explaining to me.* (L8)
>
> *I ask the teacher to explain everything. Like, sometimes I take Science books and read until I understand it. I have one at home.* (L9)
>
> *My mother reads for me – sometimes when I read on my own I don't understand. I also ask my teacher to read and explain to me.* (L10)
>
> *Ndibuza kuMiss"* (I ask the teacher). *Ndiqale ndiyifunde ndiyijong'ukuba ndizokwazi na ukuyenza, and then ndibuze kuMiss* (I first read it to see if I can do it, and then ask the teacher). *Sometimes ndiyastudisha and ingene kakuhle* (sometimes I study understand it well). (L11)
>
> *I just go to my teacher. Then she will explain to me, not in a proper way, but she will try to explain to you.* (L12)
>
> *I ask my teacher or a group that I work with, or go to the internet, or ask my mom, or read some books.* (L13)
>
> *You have to study or revise the other stuff. With new stuff you can ask the teacher to give the information. Sometimes you can use the computer in research.* (L06)
>
> *Mostly we have dictionaries* (for the difficult words). *Sometimes I ask the teacher to help me. Sometimes I research on the internet.* (L09)

Although the learners used a variety of coping strategies, virtually all of them mentioned that they asked the teacher to explain to them when they encountered some learning difficulty. It is also interesting to notice that only three learners (L06; L09; L13) mentioned that they used the internet. This suggests that this very informative facility was not accessible to, or not used by the majority of the Grade 6 isiXhosa-speaking learners.

5.5.3.2 Language strategies

The majority of Grade 6 isiXhosa speaking-learners, inclusive of 2008 and 2009, stated that there was no (formal) code switching in the Natural Science class, certainly not by the teacher. However, there was informal or secret code switching, practised mainly by isiXhosa-speaking learners, in group discussions among themselves.

To the question, *Is code-switching (i.e. changing from one language to another) used in your Natural Science class?* some isiXhosa-speaking learners stated:

> *Yes, code-switching is used sometimes.* (L1)
>
> *Yes. Learners sometimes talk to one another in their own language.* (L2)
>
> *Yes, during the Afrikaans lesson. Only English is used in Science. Sometimes we speak Xhosa with my partner (i.e. the learner next to me).* (L3)
>
> *It is not used in class. I used code switching with the (isiXhosa speaking) learners around me.* (L4)
>
> *Sometimes naba bathetha isiXhosa, sithetha isiXhosa* (among those that are isiXhosa-speaking, we speak in isiXhosa). *When Xhosa-speaking learners work together.* (L6)
>
> *Yes. Other learners do code switching. I also use code switching – to Afrikaans among other learners – other learners and I use Xhosa.* (L7)
>
> *Yes, code switching is done. We do change among ourselves as Xhosa-speaking learners.* (L8)
>
> *No code switching is done. Sometimes, among learners. Sometimes when we speak in Xhosa I get more confused, but also I have a little bit of (better) understanding.* (L9)
>
> *Yes. But no code switching is done by the teacher.* (L10)
>
> *Sometimes isiXhosa-speaking learners and Afrikaans-speaking learners use their language to talk to one another.* (L06)
>
> *Sometimes some learners talk in their home language among themselves.* (L07)
>
> *Coloured learners sometimes use Afrikaans. Sometimes Xhosa learners speak in isiXhosa, but we are not in one group.* (L15)

The strategies used in managing the language of science will be discussed under the following sub-headings: Asking clarifying questions; close monitoring of learner progress; campaigns to stimulate interest in science; and specialized interventions.

Asking clarifying questions

One educator confirmed that Grade 6 isiXhosa-speaking learners sometimes asked clarifying questions to gain a better understanding and that the teachers also provided necessary encouragement to the learners:

> *They do ask if they need clarity with some of the terminology or concepts, which is not that often.* (E3.2)
>
> *If you can use the isiXhosa term as well as the English (LOLT). If you let them work with advanced learners who speak their mother tongue, especially when you give them instructions.* (E2)
>
> *Sometimes I ask other learners to explain in their own language. They learn better from each other sometimes. Sometimes they call you and ask you to read to them.* (E2)

Close monitoring of learner progress

> *We try to encourage them to do their homework at school; we try all kinds of things in class; we liaise with the librarian to provide them with the necessary materials for assignments and projects. ... We do many things in getting them interested in the content.* (E1)

Campaigns to stimulate interest in science

> *The school holds open days every term ...* (E1)
>
> *We involve learners in projects like the Olympiads and excursions or camps.* (E2)

Special intervention

To address isiXhosa-speaking learners' difficulties in answering interpretive, discussion or essay questions (in Natural Science), the educators indicated:

> *Sometimes I ask other learners to explain in their own language. They learn better from each other sometimes. Sometimes they call you and ask you to read to them.* (E2)
>
> *Give remedial activities, e.g. more contextual questions as opposed to interpretative questions and build up; Bringing the (lab) resources to class; concretize and visualize.* (E2)
>
> *Patience and* (apply) *one-on-one teaching, if they do not understand.* (E3.2)

5.5.3.3 Using peer support

Both the learners and the educators acknowledged that they sometimes used peer support during science lessons or group discussions to enhance learner understanding.

> *Sometimes if you don't understand in class the teacher asks another person* (isiXhosa speaking-learner) *to explain to me in my mother tongue.* (L01, Cohort 2)
>
> *No, if a Xhosa learner don't understand, the teacher asks me to explain to the other learner in Xhosa and I would do that. Only English is used in Science. Like, if you*

> *have to do an experiment, not everybody's parents understand English, so you read, do research etc. In our group we help each other. I just go to the library and use internet.* (L5, Cohort 1)

The *educators* stated that the following was done to address the language (LOLT) barrier experienced by Grade 6 isiXhosa-speaking learners.

5.5.3.4 Seating arrangements

One educator pointed out that they (i.e. the educators) sometimes employed the strategy of deliberately mixing isiXhosa-speaking and English-speaking learners. The assumption was that the mixed learners would be forced to communicate with each other (in English) from time to time.

> *Couple isiXhosa-speaking with English-speaking learners* (i.e. put them in mixed pairs). *However, the English-speaking learners are very few.* (E1)

Regarding the seating arrangements, however, the proposed coupling (i.e. asking an English speaker to seat next to an isiXhosa speaker) of isiXhosa-speaking learners with English-speaking learners was not readily apparent during the classroom observation visits. The learners sat randomly, and the practice did not appear to be strictly observed, although there were incidental instances of such coupling in the classes. Some of the isiXhosa-speaking learners tended to stick together for most of the time, although they also mixed with the rest of their counterparts in the class.

5.5.3.5 Support interventions

The educators noted that they used various strategies to support the learners.

> *The school is very accommodative to isiXhosa-speaking learners. We have a learner support programme to try and get them up to standard: e.g., after school extra English support classes. Basically, if their English is not up to par they struggle in Science.* (E1)

Learning support programmes

In response to the question, *How is the learning of Natural Science promoted in the school?* the educators answered:

> *By bringing the world of science to them: through science magazines, videos, films etc. We participate in a lot of support programmes, e.g. Olympiads.* (E1)

> *There are more than enough resources (in the school). We take them to the lab and demonstrate experiments. We take them to a science camp where all the learning takes place in the open. We also take them to the planetarium.* (E2)

In order to enhance the above coping strategies, the educators mentioned that they had set up the following special programmes to support isiXhosa-speaking learners in learning science.

> *Help to Read* (programme);
>
> *Read Right* (programme);
>
> *Support classes in the afternoons.* (E3.2)
>
> *Learners attend Help-to-Read and Read Right classes in order to improve their reading and writing ability in the English language.* (E3.2)

Early school entry (Grade R-Foundation Phase)

An interview with the school Principal elicited the following response:

> *Language acquisition plays an important part of learning. We experience greater success with learners who have been at our school since Grade R-Foundation Phase than those who join later in the Phase.*

Teaching strategies

In response to the question, *What do you think makes teaching Natural Science to isiXhosa-speaking learners more effective?* the educators indicated that the following coping strategies seemed to work for them.

Practical and visual presentations

The educators noted that when they did practical demonstrations, showed visual representations of phenomena or gave more practical activities, the learners understood and remembered the work better.

> *Practical work, e.g. taking them to the garden; Posters in the class; Doing demonstrations.* (E1)
>
> *More practical activities and visual representations of what they have learned.* (E3.2)
>
> *The school is part of the "Eco-Schools", in partnership with Kirstenbosch Botanical Gardens, the teacher takes learners regularly to the gardens to observe certain phenomena.* (E1)

> *Group work. Many of them work better in a group than as individuals.* (E3)

To improve the poor work ethic of isiXhosa speaking learners, one educator stated that they:

> *Give project two to three weeks beforehand. Let the learners do their project in class, otherwise, they don't do it. If they do not finish, let them do it during interval. Sometimes they do it on their own.* (E1)

5.5.3.7 School Management

The School Management Team (SMT), consisting of the principal, the deputy principal, and two heads of department (HODs), indicated that, to promote the learning of Natural Science (NS) in Grade 6 at the school, they took the following measures:

> *We organized for the establishment of the MTN Science Centre.* (Principal)
>
> *We also ensure that qualified teachers are available.* (HOD2)
>
> *And, we organized homework classes for all learners.* (HOD1)

The HODs also mentioned that they ensured that there was correct time allocation in time-table for the Learning Area; attended SMT workshops for science; disseminated information on science (from the workshops and other sources) to all concerned; and selected the best qualified educators to teach the Natural Science Learning Area. (SMT Focus Group interviews)

To support Grade 6 Natural Science educators, the SMT indicated that they sent educators on training; liaised with CA (Curriculum Advisor) on a regular basis; ensured that adequate resources were available; and moderated planning, worksheets, assessments, and marking.

To further support Grade 6 isiXhosa-speaking learners in Natural Science, the School Management Team (SMT) arranged: Regular meetings with parents at which feedback was given, including an introductory meeting at the beginning of the year. School Governing Body members were also present at all meetings and were available should a parent wish to speak to them. They also set meetings for later in the evenings to accommodate as many as possible. However, parent involvement was low as they did not have transport; there was a language barrier with some parents (as they were not fully conversant in English while the educators could not speak isiXhosa); and the parents often worked unusual hours.

It would appear from the SMT interviews that the support given by these structures was general for all the learners, in order to ensure good administration for learning at the school. It was not specifically aimed or directed at promoting science or science learning per se.

In my view, the above were general provision measures that were not specifically geared to provide special support to second-language learners. It seems, therefore, that there was no special provision to meet the exclusive or peculiar needs of second-language learners at the school.

5.5.3.8 Parental support

During their interviews, the parents of isiXhosa-speaking learners mentioned that they supported their children in the following ways:

> *I act, not necessarily to support the school, but to help my child: I check that the child does her homework; ensure enough time for school work; I check the child's books; fortunately, the school has a diary which indicates what work has been given to the children, and which I check.*(P 1)
>
> *I attend meetings; get feedback from the child on where she is facing difficulties. I also contribute to fundraising ventures although I don't always have time.* (P2)
>
> *I attend meetings at all times. I also attend (school) functions and buy tickets for functions in advance. I also respond when the teacher(s) call me. For example, when my child was in Grade 3 I was called and had a meeting with the teacher. The teacher advised me that the child had difficulty with the (English) language and was not ready for Grade 4. The teacher suggested that, because the child's age was permitting, she should remain in Grade 3 and I agreed. Since then the child has done very well with her subjects. Ndayithanda into eyenziwa yiloo tishala* (I liked what that teacher did). *I think bahamba ekhondweni kwesa sikolo* (I think they are on the right track at that school). *At some schools the parent just finds "Fail" in the final report.* (P03)

The above comments made by the parents seem to contradict the view that there was little or no support from them.

In summary, the following findings emerged from the interviews in relation to how the learners, educators, SMT and parents were coping with all the mentioned challenges:

1. ***Language usage***: The majority of Grade 6 isiXhosa-speaking learners stated that there was no (formal) code switching in the Natural Science class. However, there was informal or secret code switching, practised mainly by isiXhosa-speaking learners in group discussions among themselves. Although the educators did not practice code switching, they indicated

that they sometimes asked isiXhosa-speaking learners to explain to each other in their home language when some of them did not understand what had been said. Thus code switching was used informally as a coping strategy to deal with the English LOLT and language of science (LOS) difficulty experienced by isiXhosa-speaking learners. There was, therefore, a contradiction between 'policy' and practice in this regard.

The educators stated that they used a variety of strategies to address the LOLT barrier. These included coupling isiXhosa-speaking with English-speaking learners, running special programmes such as *Help-to-Read and Read Right* classes, as well as providing English classes after school.

2. ***Dependence on the teacher***: Most Grade 6 isiXhosa-speaking learners depended on the science teacher to address their learning difficulties in Natural science. Although the learners used a variety of coping strategies, virtually all of them mentioned that they asked the teacher to explain to them when they encountered learning difficulties.

3. ***Teaching strategies***: To deal with isiXhosa-speaking learners' difficulties in answering interpretive, discussion or essay questions (in Natural Science), the educators stated that they used a variety of strategies, such as asking other learners to explain in their own language, or giving remedial activities, e.g. more contextual questions as opposed to interpretative questions, and then building up from there.

4. ***SMT support***: From the SMT input, it appears that they gave generalized role-related support to all learners, in all the learning areas offered at the school. There did not appear to be any special support specifically aimed at addressing the exclusive or particular needs of second-language learners.

5. ***Parental support***: Contrary to the input made by the educators and SMT, the parents indicated that they supported both their children and the school. Parental support was expressed by phrases such as: "To help my child, I check that she does her homework", "I ensure enough time for school work", and "I check the child's books."

5.5.4 Triangulation of data: Coping Strategies

Question 4 of the research asked, *How are the learners and educators currently coping with all these challenges?* The following emerged as the key themes across the three research methods used.

Educators' teaching styles: During the classroom visits, I observed that, although the educators approached the same lesson differently and emphasized different aspects of the subject content or topic under discussion, they used some common coping strategies, such as the telling method, as well as demonstrations. Individual learner activities were not used as often. The learners were rarely challenged by their teachers to use 'higher order' cognitive skills during questioning in the science class or during assessment. It seemed that the educators were reluctant to raise the bar too high, lest the learners be overwhelmed.

Dependence on the teacher: The majority of isiXhosa-speaking learners depended on the teacher to address their learning difficulties in Natural science. Although some mentioned that they might use the dictionary, ask a parent or a fellow learner, the majority indicated that they would rather ask their science teacher. Significantly, only three of the twenty-six interviewed learners mentioned that they used the internet.

Manifestation of poor learner discipline: Although the learners were generally well disciplined and worked well with the educators, in one class (Cohort 1) three learners manifested some frustration by constantly back-chatting the teacher and resisting instructions. Possibly, this was a strategy to cope with their lack of understanding and inability to do the work that was required of them. Further research would be needed for a deeper understanding of this dynamic.

Learner participation: IsiXhosa-speaking learners participated in the lessons and relevant group discussions during class activities. However, they were hesitant and sometimes reluctant to lead the discussions or do presentations on behalf of their group, preferring instead to stand back in favour of their English-speaking peers.

Strategies to address the language of learning (LOLT): Informal code switching was practised mainly by isiXhosa-speaking learners, either among themselves or in class group discussions. While the teachers could not use code switching as a coping strategy, they sometimes asked isiXhosa-speaking learners to explain to each other in their home language when some of them had not understood the teachers' explanation or instructions.

Preference for single word responses: The document analysis revealed that isiXhosa-speaking learners had difficulty in answering interpretation questions and with discussions during assessments, achieving better scores in questions that required single word answers, questions that required them to choose the correct word, or true/false statements. They also used their commonsense and drew on their township experiences when they were not sure of the correct answer to a question.

The educators stated that they used a variety of strategies to address the LOLT barrier, including coupling isiXhosa-speaking with English-speaking learners. The assumption behind this coping strategy seemed to be that isiXhosa-speaking learners would learn the language from their English-speaking peers, since they would be forced to communicate with them in English. The educators also provided special programmes, such as *Help-to-Read* and *Read Right* classes, as well as English classes after school. All these strategies seemed to be aimed at developing the proficiency of isiXhosa-speaking learners in the English LOLT.

Strategies to address the Language of Science: To address the learners' difficulties in answering interpretive, discussion or essay questions (in Natural Science), the educators used a variety of coping strategies, such as asking other learners to explain in their own language, and providing remedial activities, e.g. giving more contextual questions as opposed to interpretative questions.

The educators further indicated that they liaised with the librarian to provide the learners with the necessary materials for assignments and projects. The school also held open days on science every term. The educators involved learners in projects like the Olympiads and excursions or camps where science was the focus of activities in order to stimulate their interest in the discipline or subject and content of science. These strategies seemed to be aimed at familiarizing isiXhosa-speaking learners with the language of science through regular or constant exposure to science (intensive) environments.

Parental support: Contrary to the educators' views, the parents indicated that they supported the learners and the school in specific ways, such as helping their children with their homework and projects, following up with the school when they encounter problems supporting the school by attending meetings and school functions, and buying tickets for functions.

5.6 WHAT CAN BE DONE TO ASSIST BOTH LEARNERS AND EDUCATORS TO OVERCOME THE DIFFICULTIES?

In order to avoid speculating or giving only the researcher's personal opinion on what could or should be done to assist both learners and educators, the *interview* research method was used to explore this question. The learners and educators have thus suggested many ways in which the learning and teaching of Natural Science to isiXhosa-speaking learners in Grade 6 could be improved.

In this section, the interview responses from the various participants are grouped under the following sub-headings: Support to understand science; Support to develop the language of learning and teaching (LOLT); IsiXhosa as LOLT; Support to develop the Language of Science; Curriculum delivery; Soliciting support; and Promoting the culture of science.

5.6.1 Support to understand science

To underline their need to understand, some learners stated the following:

> (I need) *Support to understand; to be able to learn; by being given Science books. Nothing else.* (L1)
>
> *Give more time to Science, so that we can understand it well. The period for Science, e.g. 10:00 to 10:30 is too little or too short.* (L2)
>
> *Have Natural Science books like comics, movies and DVDs on Science. And, maybe board games.* (L09)
>
> *I need to read more about Science; more Science books. I need to do more experiments so as to get used to it.* (L13)
>
> *Advertise (publicize) Natural Science to the country, e.g. TV and radio.* (L06)
>
> *Have free books or magazines on Science for learners. Have Science dictionaries freely available for learners so that they can find Science words.* (L09)

In the above responses, the learners indicated an overwhelming need to be provided with the means to enhance their understanding of science as a field of study, with a particular emphasis on the need for accessible books and other tools.

5.6.2 Support to develop the language of learning and teaching (LOLT)

In order to improve their proficiency in the LOLT, the learners suggested:

> *When I don't know English properly. To improve English and understand it better. Somebody explains in Xhosa. To be able to read myself. More Science books.* (L8)

The educators made similar suggestions to those of the learners:

> *If you can use the isiXhosa term as well as the English (LOLT). If you let them work with advanced learners who speak their mother tongue, especially when you give them instructions.* (E2)
>
> *Language acquisition plays an important part of learning. We experience greater success with learners who have been at our school since Grade R-Foundation Phase than those who join later in the Phase* (School Principal).
>
> [This seemed to suggest that isiXhosa-speaking learners should be introduced to English (LOLT) in the Grade R-Foundation Phase].

It would appear that the educators needed to identify the specific aspects of language learning that would enable the early arrivals at the school to be successful and use them as levers to develop all the learners. This suggests a need for a bridging programme to develop such essential skills.

5.6.3 IsiXhosa as LOLT

As a possible solution to their language difficulties, many isiXhosa-speaking learners proposed that isiXhosa be introduced and used jointly with English as the language of instruction.

> *Since there are some Xhosa-speaking learners, have two or three teachers that can interpret the English lesson to Xhosa or Afrikaans.* (L013)
>
> *Speak in Xhosa. Explain things until one understands.* (L15)
>
> *Sometimes the questions must be explained again by the teacher. Also, if it (Natural Science) can be explained or taught in isiXhosa it would be better.* (L012)
>
> *Invite other people (from the Department) who are good in English and Xhosa to come and explain.* (L14)
>
> *There must be a Xhosa* (speaking) *teacher to teach Science in Xhosa, or get extra classes in Science.* (L15)

One parent also highlighted the need to introduce isiXhosa at the school:

> *IsiXhosa should be taught at the school, not only as an SGB post, but for balance and diversity in the curriculum. There are many isiXhosa-speaking learners at the school. A good foundation in isiXhosa can build the children's confidence to develop in other languages.* (P03)

5.6.4 Support to develop the Language of Science

In order to develop the Language of Science, the learners made the following suggestions:

> *In school, in science class, if you don't understand, the teacher could call you aside and explain, or you could be given science books to learn more about science.*(L2).
> *Explanation of difficult term – "photosynthesis"...* (L04).
> *Have science dictionaries freely available for learners so that they can find science words.* (L09).

The educators also underscored the need to develop the learners' understanding of the field of science:

> *(We need to do) More practical activities and visual representations of what they have learned.* (E3.2)

The above comment was an indirect acknowledgement of the need to broaden and deepen the learners' understanding of science as a learning field.

One of the parents highlighted the need to promote science and commented:

> *Science is one of the most important subjects. Science is part of our daily living. It should be promoted. It should be done (i.e, taught) by experienced teachers and should be fun-based on practical things, e.g. one teacher blew different lengths of straw to produce different sound tones, and did the same with different sizes of bottles. In this way the teacher related science to art and music. Otherwise, children see science as a difficult subject.* (P03)

5.6.5 Curriculum delivery

To make science learning easier, one learner proposed that only one theme be covered per term, instead of a whole range of topics.

> *Senze into eyi-one yonke i-term* (we must do one topic for the whole term), *not Electricity, then Map* (i.e.mapwork), *etc. in one term* (i.e., not many things/topics in one term). (L01)

Some of the educators noted that many isiXhosa-speaking learners learnt better when they worked in a group than when they worked on their own.

> *Many of them* (learners) *work better in a group than as individuals.* (E3)

For effective curriculum delivery, one educator suggested that attention be paid to the size of the classes:

> *Reduce the size of the classes. The big classes also make it difficult to take such a big group out.* (E1)

In order to support the educators in curriculum delivery, some parents made the following suggestions:

> *Children who do not have resources should be allowed to stay at school as long as possible after (school) hours to use the available resources there as the resources do not exist where we live. Secondly, teachers should give two to three days before homework is due or should expect homework to be handed in after weekends.* (P1)

> *Teachers must be able to advise parents on how to get extra study material, or identify the children's weaknesses. They must seek to speak to and advise the parents on where to step in to support the child.* (P2)

> *The management of the school has a role to play. The role played by management affects the level or quality of the work done.* (P03)

5.6.6 Soliciting support

Both learners and educators expressed the need to have an assistant teacher or an isiXhosa-speaking teacher to assist the isiXhosa-speaking learners when they experienced a language problem, but the educators felt this was impractical. However, they did suggest that a parent could come and assist. One educator said:

> *We need support from the parents. It is difficult. Parents don't respond to calls, for example, you invite them to come to school and view their child's work but they never come.* (E2)

The educators also highlighted the need for more focused support for science from the local Education District office.

> *We need District support.* (E3)

> *We attend a lot of workshops organized by the district office. However, we are not aware of any special support for Science from the district.* (E2)

> (We need) *more workshops on how to deal with multilingual classes. Currently I am just 'feeling my way'.* (E1)

> (We need the) *District to give more guidance regarding teaching Science and also organize Science exhibitions.* (E2)

> *The school or District Office could provide means to take learners for outings or excursions.* (E1)

5.6.7 Promoting the culture of science

The educators highlighted the need to promote the culture of science at the school, saying that this would benefit the isiXhosa-speaking learners more, as most of them came from a less stimulating environment (in the townships and informal settlements).

> (We need*) More interaction between teachers who teach science at school and between schools; (*we also need*) Schools coming together to show what they are doing (*i.e. sharing good practice in Science*).* (E2)

> (We need*) More practical activities and encouragement for the learners.* (E3.2)
> *The school or District Office could provide means to take learners for outings or excursions.* (E1)

5.6.8 Triangulation of data: Addressing the challenges

Question 5 of the research study was, *What can be done to assist both learners and educators to overcome these difficulties? In summary*, the following themes emerged from the interview method, the only research method used to explore this question.

Support to understand science: The learners expressed the need for support to help them to gain a deeper understanding of science. They suggested that this deepening of their understanding of science could be carried out, among other strategies, by exposure to a broad array of science sources including scientific comic books, science magazines, video presentations and footages (movies and DVDs) on science, as well as public broadcasts about science on television and the radio (picked up under curriculum).

Support in addressing the language (LOLT) barrier and Introducing isiXhosa as LOLT: Many learners suggested that, since they had difficulty with English as the language of instruction, isiXhosa should also be introduced as a language of instruction, to run concurrently with English. As an alternative, they also suggested other measures, including more time devoted to Natural Science than was currently being given, and using the support of science specialists coming from outside the school.

Curriculum delivery: The learners acknowledged that they lacked a deep understanding of science. As a possible solution to this problem, they suggested that more time be devoted to the subject. According to one learner, this could be done by devoting a whole term to a single topic, so that they could understand it in more depth. Another learner said that the time-slot allocated to Natural Science in the school time table was too short and should be increased.

Soliciting support: Educators indicated that they needed support from the parents. They experienced difficulties because parents did not respond to calls. For example, educators had invited parents to come to school and view their children's work, but they never came. A further difficulty was that some of the learners did not deliver the letters to their parents.

The educators thought that the school or District Office of the Department of Education should provide the means to take learners out for science excursions. They further suggested that the District Office should give more guidance regarding the teaching of science and also organize science exhibitions.

Promoting the culture of science: To promote the culture of science, the educators suggested that there should be more interaction between science teachers, both within the school and between schools. Teachers should also share *good practice* and successes by coming together to showcase what they were doing in their Grade 6 Natural Science classes. Both teachers and learners said that there should be more practical activities, the learners specifically highlighting their need to practice doing science experiments. To be able to supervise learners more closely, educators advocated reducing the size of the classes.

5.7 SUMMARY AND CONCLUSION

This summary gives an overview of the research findings across all the four research questions and across all the research methods used in the study. Five broad themes, each with a number of subthemes, were identified in these findings:

- Language as a barrier to learning;
- Curriculum delivery factors;
- School environment;
- Social factors; and
- Coping strategies.

5.7.1 Language as a barrier to learning

Various barriers to the learning of Natural Science were experienced by Grade 6 isiXhosa-speaking learners, the most prominent being the language used in the subject, including both the language of learning and teaching (LOLT), and the language of science (LOS).

The difficulty with the language of learning and teaching (LOLT) in Natural Science for Grade 6 isiXhosa-speaking learners arose from the fact that the subject was taught in English, which was not the learners' home language. Although the learners appeared to be proficient in basic interpersonal communication skills (BICS), they seemed to struggle, not only in understanding academic language but also in expressing their ideas, especially when they had to answer interpretation or discussion questions (Anderson & Krathwohl, 2001; Baker, 1993; Bloom, 1956; Cummins & Swain, 1986; Po, 2006). As a result, the isiXhosa-speaking learners appeared to operate or function at a superficial level, and were not able to deepen their understanding of science and scientific phenomena.

To express its ideas, science uses special language, terms and concepts that are unique to this field of study. This study discovered that the Grade 6isiXhosa-speaking learners had difficulty in understanding scientific concepts. The difficulty they experienced with the language of instruction seemed to weaken their grasp of abstraction and understanding of scientific phenomena, as well as their ability to observe and describe such phenomena (as required by LO 1 of the OBE Curriculum Statement for Grade 6 Natural Science).

The educators argued that, in addition to the language barrier, lack of prior knowledge coupled with logistical problems (e.g. lack of access to internet and other resources), limited the level of abstraction of isiXhosa-speaking learners. As a result, they lacked deep scientific knowledge (construction) and operated at a low level of cognitive functioning.

5.7.2 Curriculum delivery factors

Some factors within the curriculum delivery process contributed to (or exacerbated) the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science.

It was evident that the educators not only approached the same lesson differently but emphasized different aspects of the topic under discussion. However, despite these differences in the educators' approach, the isiXhosa-speaking learners invariably indicated that the educators did not explain 'properly' or to the learners' satisfaction. This situation was aggravated by the fact that the educators could not use the strategy of code switching to clarify or explain to the learners when they did not understand a science concept or science phenomenon.

The educators' level of questioning, both during science lessons and assessment, did not seem to stretch or challenge the learners' cognitive skills and their classroom activities or tasks seemed to be geared towards the acquisition of information or knowledge, rather than higher-order cognitive skills in terms of Bloom's Taxonomy (Anderson & Krathwohl, 2001; Bloom, 1956).

5.7.3 School environment

The teachers pointed out that the necessary apparatus was available at the school and that they sometimes brought their own charts and posters to supplement the scarce learning materials. The school also offered a number of programmes to support isiXhosa-speaking learners, including remedial lessons, extra English support classes after school, and Help-to-Read and Read Right classes. The educators also involved learners in projects such as the Olympiads and excursions or camps. However, the educators highlighted the following limitations.

There was inadequate learning support at the school. This refers to the kind of additional support that is given to the learners to facilitate their learning, including in science. It includes *mediation* and *remediation* of learning by the teacher, as well as the learner and educator support material that is used in the learning process.

The educators felt that overcrowded classes limited their ability to give individual attention to isiXhosa-speaking learners, who needed it the most. As a result, the learners struggled with the work. The educators also stated that the number of learners in the class negatively affected the quality of the time they spent with the learners.

Each of the three Grade 6 classes had a total of 25 learners, boys and girls of between 11years and 12 years, on average (both in 2008 and 2009). It must be borne in mind that the ex-Model C classrooms were designed during apartheid education, to accommodate about 20 exclusively white learners. A class of about 25 learners was therefore relatively congested, both physically and in comparison to what the educators had been used to in the former Model C context.

The educators also stated that they had difficulties in dealing with multilingual classes. For example, they had to contend with French-speaking learners (refugee learners from the Congo and other African states), as well as with isiXhosa-speaking learners.

Factors within the school, such as inadequate resources (e.g. the fact that the school did not have a science laboratory), the limited use of available resources (such as the library), and the ineffective use of time, contributed to the difficulties experienced by isiXhosa-speaking learners in learning science. In particular, the educators noted that there was a shortage of textbooks at the school, such that the teachers had to make photocopies and notes. They also noted the less effective use of time (i.e., poor time management) and the inadequate use of the labs as other problematic factors.

5.7.4 Social factors

A number of social factors were perceived as contributing to or exacerbating the difficulties experienced by isiXhosa-speaking learners.

The questionnaires revealed that the majority of isiXhosa-speaking learners lived in a township or informal settlement, and that most of them in 2008 and 2009 travelled to school by public *transport* (i.e. by bus, taxi, or train). This had implications for the time they had to wake up in the morning, the time they arrived at school, and their state of readiness to receive tuition when they arrived (often late) in the classroom. The educators spoke about how these learners often had problems with public transport, which caused them to come to school late and tired, and to take longer to settle down to their classroom activities, while the other learners in the class had settled into their routine. As a result, the isiXhosa-speaking learners were disadvantaged and underperformed.

Many isiXhosa-speaking learners came from fairly *poor socio-economic backgrounds* and did not receive academic support from their homes or parents, for example, in doing their homework or research projects. Some even had to help clean the house or look after younger children when they arrived home. These circumstances further disadvantaged isiXhosa-speaking learners.

The educators indicated that it was difficult to encourage isiXhosa-speaking learners, as they did not do their homework. As a result, the educators tried to encourage them to do their homework at school and liaised with the librarian to provide them with the necessary materials for assignments and projects. In general, however, it is evident that the apparent *poor motivation* of isiXhosa-speaking learners may be attributed or traced to their poor socio-economic conditions.

The educators found it difficult to support isiXhosa-speaking learners, as most of their *parents* did not respond to calls, failed to attend school open days to view their children's work, and made excuses when they were invited to school. The educators also noted that they had problems in communicating with the parents as some of the learners did not deliver letters from the school to their parents. The parents, on the other hand, noted that they found it difficult to attend school meetings due to logistical problems relating to the time of the meetings, lack of transport and the fact that they worked at unusual hours.

5.7.5 Coping strategies

To cope with the difficulties experienced in learning science, both the learners and science educators used a number of strategies.

Most isiXhosa-speaking learners *depended on the teacher* to address their learning difficulties in Natural Science. In response to the question, *What do you do to deal or cope with these (learning) difficulties?* the common thread that ran through their answers was that they would ask the teacher, although some mentioned coping strategies such as consulting a dictionary, or asking another learner. Significantly, only three of the twenty-six isiXhosa-speaking learners who were interviewed mentioned that they consulted the internet.

In an attempt to partly cope with the language barrier, learners used *code switching* into isiXhosa when talking informally and during group discussions.

To address the language barrier experienced by isiXhosa-speaking learners, the educators used strategies, such as asking learners to explain to each other in their own language or arranging the seating in the classroom to pair isiXhosa-speaking with English-speaking learners.

Learner support programmes, such as after-school extra English support classes, Help-to-Read and Read Right classes, were offered in order to improve their reading and writing ability in the English language. To address isiXhosa-speaking learners' difficulties in answering interpretive, discussion essay questions in Natural Science, the educators gave more contextual questions, as opposed to interpretative questions, and built up from there. They also exercised more patience and applied one-on-one teaching, if the learners did not understand.

To improve the work ethic of isiXhosa-speaking learners, the educators gave projects two to three weeks beforehand, and allowed the learners do their projects in class or during the interval.

In conclusion, there is very clear evidence that Grade 6 isiXhosa-speaking learners experience specific difficulties in learning Natural Science. These difficulties are manifested mainly in language, specifically the language of instruction (LOLT) and the Language of Science. These language difficulties were further exacerbated by factors associated with the learners' socio-economic backgrounds, in turn inherited from the country's apartheid past, and, to a lesser extent, by some curricular delivery factors within the school.

In the next chapter, the research findings presented in this chapter will be discussed, taking into consideration the relevant literature and theoretical frameworks discussed in Chapters 2 and 3 above.

CHAPTER 6

DISCUSSION OF RESEARCH FINDINGS

6.1 INTRODUCTION

This chapter discusses the research findings of the study as presented in Chapter 5. The discussion focuses on the key themes that emerged from the findings. As mentioned in Chapter 1, the focus of the thesis is on the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through the medium of English in an ex-Model C school in the Western Cape. The study seeks to understand the difficulties and to learn about the strategies used by both the learners and their science educators to address the challenges that they face.

Based on the research findings presented in Chapter 5 and literature related to the emergent issues or themes, this chapter first examines language as a barrier to learning, focusing in particular on the language of learning and teaching (LOLT) and the Language of Science. The chapter then looks at curriculum delivery factors which appear to have contributed to the learning difficulties, focusing on the educators' teaching styles, learner assessment techniques, and the limiting school environment, including inadequate learning support, overcrowded classrooms, multilingual classes, and inadequate resources. Next, contributing social factors are discussed, including the poor socio-economic background of the learners, poor learner motivation and work ethic, as well as lack of parental support. Finally, the coping strategies used by both the learners and their science educators are examined in some depth.

6.2 LANGUAGE AS A KEY BARRIER TO LEARNING

It is crucial that all role players have a sound understanding of the language through which the learning and teaching process is communicated and mediated. This study found language to be a major barrier in the learning of Natural Science by Grade 6 isiXhosa-speaking learners. This barrier to the learning of Natural Science manifested itself mainly at two levels, namely the *language of instruction* (LOLT) and the special language used in the learning and teaching of science (the *Language of Science*).

In the following section, the language of learning and teaching as a barrier to learning is discussed, showing how the grade level (i.e. learners' 'entry-level') at which the isiXhosa-speaking learners entered Tableside Primary, seemed to have contributed to their English language proficiency and potential academic achievement in Natural Science in Grade 6. This is followed by a discussion on the Language of Science.

6.2.1 Language of learning and teaching (LOLT) as a barrier

This section examines and discusses how the English LOLT impacted on the learning of Natural Science by Grade 6 isiXhosa-speaking learners at Tableside Primary. This is done by first highlighting the findings of the study and then discussing the findings with particular reference to the relevant literature and theoretical framework.

Language usage

A close examination of the Grade 6 Learners' Portfolios and Assessment records during the document analysis phase of this study seemed to indicate a qualitative difference between the responses of the isiXhosa-speaking learners and those of their English-speaking counterparts, both in terms of English language proficiency and the level of abstraction of content knowledge in Natural Science. IsiXhosa-speaking learners seemed to experience a language difficulty in following instructions, expressing their ideas or in describing science phenomena, including describing their observations of science experiments, in comparison to their English-speaking peers. This double-barrel language difficulty not only impeded their understanding of science but also undermined their efforts at science knowledge construction. As a result, except for a few exceptional cases, the majority of isiXhosa-speaking learners seemed to perform below their age appropriate level in terms of Bloom's Taxonomy (Anderson & Krathwohl, 2001; Bloom, 1956; Po, 2006).

The language difficulties experienced by isiXhosa-speaking learners were further corroborated during the Classroom Observation visits and subsequently during the learner interviews. Although isiXhosa-speaking learners seemed to manage to speak English in informal communication with their classmates and educators, that is, at BICS (common *language usage)* level (Cummins & Swain, 1986), these learners seemed to struggle with 'weather' concepts such as 'satelite' and 'weather station', and 'electricity' concepts such as 'current' and 'circuit' (*Language of Science).*

The educators argued that some learners came from isiXhosa-medium schools, where teaching was done in isiXhosa, into an entirely English-medium school. It is 'common knowledge' that in Xhosa-speaking schools the learners are either taught in isiXhosa, or, where they are taught in English, the teachers explain the lessons in isiXhosa when the learners did not understand (Holmarsdottir, 2009; Probyn, 2005). It is not surprising therefore that isiXhosa-speaking learners struggle in situations where such translation is not provided.

Until the learners have mastered the language of instruction (and consequently the language of science) they will be unlikely to succeed in constructing their own understanding of scientific knowledge, since this is fundamental to learning the subject (Baker, 1993; Cummins & Swain, 1986). Similarly, any prior knowledge the learners might have cannot be successfully communicated, as the learners will not possess the (academic) language proficiency (CALP) to relay that knowledge (Abriam-Yago et al., 1999; Baker, 1993; Cummins & Swain, 1986). In other words, before a learner can even begin to understand the language of science (i.e. the CALP), he/she should possess at least a reasonable understanding and command of the language of instruction (LOLT). An additive bilingualism approach to the use of the LOLT is proposed in this study in order to address this challenge. This is an approach whereby the learners would be encouraged to use both their home language and the LOLT if this leads to their better understanding and explanation of Natural Science phenomena. This implies that the educators would make a serious effort to understand the learners' home language as well as employ alternative (flexible) methods of assessment.

South African policy makers and researchers unequivocally acknowledge and support the use of home language instruction in the early years of schooling (Department of Education, 1997b; Department of Education, 2011; Republic of South Africa, 1996; Vinjevold, 1999). This affirmative spirit of the Language in Education Policy should be exploited in the best interest and highest benefit of the learners.

Many of the Grade 6 isiXhosa-speaking learners in this study seemed to have some science content knowledge, but lacked the language skill to put it across. Due to the language difficulty, they seemed to have a lower level of abstraction (and subsequent construction) of scientific knowledge in comparison to their English speaking peers. This situation was exacerbated, firstly, by the language that was used in Natural Science (i.e. the Language of

Science) and, secondly, by the inability of their educators to use a code switching strategy to explain the terms and concepts used.

During the classroom observation phase of the study, the findings around the language difficulties experienced by Grade 6 isiXhosa-speaking learners in the document analysis were corroborated. The difficulty around language of learning and teaching (LOLT) was also manifested in the learners' tendency to use their home language in group discussions. Some learners asked their isiXhosa- speaking peers to explain what was said, and the educator asked an isiXhosa-speaking learner to explain to their peer who struggled to understand an idea or concept or failed to understand and follow an instruction.

Inability to follow the educator's instructions was manifested in the failure of some learners to do what was required of them, as a consequence either of not understanding the LOLT or not understanding the scientific terms used. In some cases this manifested in behavioural problems.

The educators could not use the code switching strategy, as they did not speak isiXhosa and this disadvantaged both themselves and the learners they were supposed to support. Subtractive bilingualism (Department of Education, 1997a; Desai, 2012; Donald et al., 2010; Heugh, 1995) was thus practiced, as learners were not allowed to communicate in isiXhosa, but did so among themselves and in their group discussions. Code switching is advantageous in that it facilitates teaching and learning through a language that both teachers and learners understand, thus providing the learners with access to the curriculum (Holmarsdottir, 2009; Nomlomo, 2007). As a consequence, it also improves the learner's abstraction of the subject matter because of the deeper understanding which flows from the teaching strategy.

Language of Learner Assessment

This section of the study examines the findings on the manner in which the Grade 6 learner assessment in Natural Science was conducted at Tableside Primary School. The suitability and implications of such assessment processes are discussed, and possible ways in which the assessment process could be improved are explored. The key focus of this part of the analysis is whether the forms of assessment used were adequate (especially in the context of language as a barrier) and sufficiently varied (e.g. to include both formal and informal forms of alternative assessment), as required by the National Protocol for Assessment (Department of Education, 2005).

The African National Congress (ANC) Policy Framework for Education and Training (1994) and the White Paper for Education and Training, which ushered in a process of rapid educational change in South Africa, not only advocated an integrated approach to education and training but also a radically different system of assessment and accreditation (Department of Education, 1995; Johnson, 1995; Johnson, 1998). The dictates of the Outcomes Based Education (OBE) approach, which was launched in February 1998 (Johnson, 1998), called for a paradigm shift from the traditional assessment practices of testing to implementing a continuous classroom-based assessment, in line with its policy framework for assessment. This entailed, among other factors, the collection of significant learner achievements and keeping records of such achievements for individual learners. Educators were required to make a radical shift from 'content measurement' to 'performance assessment' (Department of Education, 2005; Johnson, 1998).

About the OBE approach to assessment, Johnson (1998: 384) notes that:

> This form of assessment ... is concerned not only with *what* is known (by the learner), but *how* it is known. It is concerned not only with what is achieved but with the barriers to achievement. It is concerned not only with one aspect of learning knowledge, but with the totality of a learner's experiences.

Due to its operational problems, the OBE (Curriculum 2005) was reviewed in 2000 and replaced with the Revised National Curriculum Statement (RNCS), which gave rise to the current National Protocol on Assessment, a new framework for assessment in South africa (Department of Education, 2002; Department of Education, 2005; Department of Education, 2011).

In keeping with international trends in changing the culture of assessment, the new assessment framework in South Africa places increasing emphasis on:

(1) Assessment to inform a teacher's planning (formative assessment);

(2) Describing learning outcomes in terms of specified criteria (criterion-referenced assessment);

(3) Trying to make assessment valid or authentic (performance assessment);

(4) Developing in teachers a wider range of skills in assessing learning outcomes (developing a wider repertoire of assessment strategies); and

(5) Learner and parental involvement in assessment (three-way assessment and reporting) (Johnson, 1998: 385).

With regard to "developing a wider range of assessment strategies", mentioned in point (4) above, there seemed to be very little evidence that this was employed by the educators in the assessment records perused during the documentary analysis phase of my research at Tableside Primary School. The records seemed to indicate that the educators were still inclined to follow the traditional order of teaching – learning – (and) testing, 'linked to each other in a linear way', and given at the end of term (Johnson, 1998: 384). There was little or no evidence that 'alternative assessment' was being practised, for example, with learners being allocated scores for involvement in debates, discussion or group work (i.e. collaborative learning) in the science class.

Learners who experience difficulties with the language of instruction can benefit immensely from alternative or varied methods of assessment, since they would be afforded an opportunity or allowed to demonstrate their knowledge in suitable ways to themselves (Department of Education, 1997b; Johnson, 1998). The National Protocol on Assessment requires that the design of assessment tasks for learners should "ensure that a variety of skills are assessed" and that such assessment tasks should "give learners opportunities to explore the Learning Area in exciting and varied ways" (Department of Education, 2005: 13).

In Johnson's 'Profiles of Learning' study, the author says that:

> Profiles were seen simply as a progress map rather than as a benchmark (a minimum acceptable standard or a critical level of literacy without which a learner will have difficulty in making significant progress at school). Teachers were thus asked to use the indicators of achievement ... as a general guide which shows the typical development of a learner in writing, reading, spelling, and handwriting, and to ask where the assessed learner's achievement lies on that continuum (Johnson, 1998: 390).

The 'three-way' collaboration model of learning and assessment proposed by the new assessment framework (Johnson, 1998) was, however, undermined by the alleged lack of parental support and the poor parental response to educator invitations or exhortations at Tableside Primary School.

Given the large class size highlighted by the educators, the question is whether it is reasonable to expect them to meet the considerable shift in emphasis (from content measurement to performance assessment) demanded by OBE (Johnson, 1998). Indeed, "The biggest challenge for the successful implementation of outcomes based education and the new assessment framework is its manageability in the contexts of large class sizes. Class size on its own is not the real problem; creating a culture for organizing large classes in such a manner that learning can be successfully mediated, is" (Johnson, 1998: 403).

The National Protocol on Assessment defines assessment as "a process of collecting, synthesising and interpreting information to assist teachers, parents and other stakeholders in making decisions about the progress of learners" (Department of Education, 2005: 5). It is, therefore, very crucial that this process be as accurate as possible, in order to present a true picture of the learner's academic performance and achievement. However, where learners experience learning difficulties, it is important that such an assessment assume a diagnostic nature so as to highlight the nature of the difficulties with a view to addressing them.

Johnson's (1998) paper on '*Teacher Assessments and Literacy Profiles of Primary School Children in South Africa'* provides a very useful exposition of how the literacy levels of primary school learners can be determined. Drawing on a number of models from the UK and Australia , the '*Profiles of Learning'* gives a criterion-referenced framework for assessing learner literacy, the first of its kind in South Africa, covering Reading, Writing, Spelling, and Handwriting. As Johnson describes it, "The Profiles of Learning consist of five levels of progression: initial, developing, independent, complex, and advanced. These levels are reflective of increasing competence and when they are related to children's age, the resultant matrix essentially constitutes a 'growth model' ... which projects a child's developing levels of performance" (Johnson, 1998: 387). From my perusal of the learners' workbooks during the document analysis phase of the research, it was evident that many of the isiXhosa-learners struggled to express their ideas or views in English, the language of learning and teaching (LOLT) Natural Science in Grade 6.

My argument is that it would be prudent for Grade 6 Natural Science educators to use programmes such as Johnson's framework for assessing their learners' level of literacy, so as to strategically use the information thus obtained for a more effective learning and teaching of Natural Science in their classes. The framework should, however, not be used as a 'check-list' of what the learners can do, but as a 'growth model' which provides an indication of the learners' current and probable future levels of performance (Johnson, 1998: 398).

Related to the Language of Assessment was the issue of the type of question that isiXhosa-speaking learners had difficulty in answering in this study. They seemed to perform better on contextual and recall questions than on interpretive, discussion or essay questions. It was significant that all the learners invariably scored zero on questions requiring them to *state the functions*, which constituted some form of discussion question. This further underlines the fact that Grade 6 isiXhosa-speaking learners experience language difficulties when they have to answer interpretation and discussion questions. During the *Interview* phase, many Grade 6 isiXhosa-speaking learners also stated that they found difficulty in Natural Science (Assessment) when they were asked interpretation, discussion or essay questions, and could not express or explain themselves properly and sufficiently.

6.2.2 Debate on home language versus second language instruction

While many writers argue for home language instruction in learning and teaching (Alexander, 1993; Cleghorn, 2005; Desai, 2012; Nomlomo, 2007), it seems (at this stage) that there are still numerous challenges that militate against this idea (Sutherland, 2002). Furthermore, it was pointed out in Chapters 1 and 3 that many black parents decide to send their children to formerly white schools because of the perceived socio-economic advantages and future employment opportunities these schools provide (Mazrui, 2002; Nomlomo, 2007).

As English is perceived to be the language of globalization (Bgoya, 2001; Prah, 2003), as well as the language of science and technology (Rubagumya, 2003), it is argued in this study that, while it is desirable to teach isiXhosa-speaking learners in their home language, since their parents chose English as the medium of instruction, their decision should be respected (NEPI, 1992a) and this should decide the issue. In this regard, the NEPI (1992a: 40) notes that:

> There is broad agreement that if parents want to choose an L2 as medium of instruction for their children, from year one (or thereafter), that choice should be available to them. The underlying supposition seems to be that, although initial mother-tongue instruction might be widely considered best for children, there are compelling reasons why many South African parents might prefer to opt for English (or Afrikaans) as medium of instruction from year one even if it is not spoken at all at home, and that this choice should be respected and provided for.

The decision, then, to conduct this study to find out the difficulties experienced by these learners with a view to recommending possible solutions, was based on this latter position. It is, therefore, necessary to introduce the learners as soon as possible to a language that makes science accessible to them. Desai (2012: 75) highlights the importance of keeping the debate on the home language versus international language in mind and using "constructs that take this tension into account and acknowledge the need for an international language of wider communication." For this study, the critical issue is (the language of) access to scientific knowledge by the learners. This brings us to the question of deciding the appropriate time to introduce these learners to the LOLT in science.

'Critical' School Entry Level

In this study, closely linked to the issue of English language proficiency (as noted by the Grade 6 Natural Science educators) was the level at which isiXhosa-speaking learners entered the school. Early entry into the ex-Model C school implied an earlier and longer exposure to English as medium of instruction and created the opportunity for the isiXhosa-speaking learners to interact with their English-speaking peers for a longer period of time. The assumption is that the early entry of isiXhosa-speaking learners in the school helped them to develop their communication skills in English through exposure to an English-speaking environment. Early entry also provided an opportunity for learners to familiarize themselves with 'systems within the school' as was mentioned by the educators during the interview phase of the study.

However, there are strong and research-based arguments against the teaching of children through a second language at an early age (Alexander, 1990; Mazrui, 2000; Nomlomo, 2007; Roy-Cambell 2001; Taylor & Vinjevold, 1999). The basic argument is that research has shown that learning is best achieved through the home language, especially in the primary phase of the child's development. It is also argued that the use of English to teach African children tends to devalue their indigenous languages and undermine efforts to develop them. This latter fact also goes against the spirit of both the South African Constitution (1996) and the new language-in-education policy (Department of Education, 1997a; Department of Education, 2011; Holmarsdottir, 2009), which accord equal status to all official languages in the country. As a case in point, the PRAESA report (Taylor & Vinjevold, 1999: 217) noted that "Indications are that the increasing use of English as the language of learning and teaching (LOLT) in the Foundation Phase at the expense of learners' primary languages negatively affects teaching and learning in many township schools."

As stated in Chapter 5, research evidence seems to support the educators' assertions that learners who entered the school earlier, i.e. in the lower grades, performed better academically than those who entered the school at higher grade levels, i.e. after Grade 4 (see paragraph 5.2.4). The educators suggested that this was because learners who arrived in lower grades became progressively used to the language of instruction and familiar with 'their systems and learning materials' that the educators used.

The educators in this study noted that the time or level at which the learners entered the school was very important. Their explanation was that isiXhosa-speaking learners arriving at the school for the first time in Grade 6, had difficulty in understanding English (LOLT), and as a result, struggled in Natural Science. IsiXhosa-speaking learners tended not to answer or ask questions during lessons (which could be a further indication of the existence of a language barrier). They attributed this to a language barrier; the problem was not so much the comprehension of the content, but rather with the language itself.

Evidence from this study suggests that Grade 6 isiXhosa-speaking learners who started at the school in earlier grades (i.e. in Grade 4 or before) performed better academically than those who started in Grades 5 or 6. The educators asserted that this was due to the learners having gone through their system, having done all the (Grade 4 and 5) materials, and having developed the 'necessary language' to master the Grade 6 curriculum. As one educator said: "*They perform better academically as they are used to our system and do not have a language problem*" (E2). Another stated that, "*New Xhosa learners haven't learnt the terminology used in Grade 4 and 5 in Science* (E1). On the basis of this evidence, it would seem reasonable and sensible to introduce isiXhosa-speaking learners to the language of instruction (LOLT) as early as possible, provided that the necessary learning support measures are put in place and implemented rigorously. The view held in this study is that this is the crucial time in which the additive bilingualism approach could be applied by developing both the English LOLT and the learners' home language simultaneously. If the learners' home language knowledge could be used to develop their English vocabulary (by, for example, using texts drawn from their home background), both languages would benefit or develop. This exercise could later be extended to introduce and develop (new) scientific concepts early in their scientific knowledge development. Mant et al. (2007: 1718) suggest that "all pupils need teaching from the earliest age that will inspire curiosity and scientific understanding," provided of course that they understand the language of instruction. The foregoing evidence also seems to suggest a relationship between entry-level, proficiency in the English language (both as LOLT and as the Language of Science), and performance in Grade 6 Natural Science. This could be further enhanced by the additive bilingualism approach where the LOLT is supported by the home language to deepen the learners' understanding of scientific phenomena.

6.2.3 Language of Science as a barrier

The research findings in this study revealed that Grade 6 isiXhosa-speaking learners struggled to understand specific words, terms, and concepts used in science. These included 'weather' concepts such as 'satelite', 'temperature', and 'full moon'; and, 'electricity' concepts such as 'current', or 'circuit'.

Science uses a specific language, generally referred to as the *Language of Science*. Learning science, therefore, entails learning the language of science, which is complex, abstract, highly specialized and replete with grammatical metaphors and lexical density (Halliday & Martin, 1993; Jones, 2000; Nomlomo, 2007; Sutherland, 2002; Wellington & Osborne, 2001). Furthermore, science uses diagrams, graphs, tables, mathematical symbols and formulae to enhance and deepen the learners' understanding, as well as to develop their scientific knowledge.

6.2.3.1 The role of Scientific Literacy

In this study, it is argued that understanding both the language of instruction and the language of science is fundamental to *scientific literacy,* which entails being able to read, interpret, and write about science and scientific phenomena (Johnson, 1998; Wellington & Osborne, 2001). Scientific literacy, in turn, facilitates the learner's scientific knowledge construction, that is, the ability to interpret and learn scientific principles and apply them in real life situations. However, for a learner to be able to conceptualize and make sense of what is taught, he/she must understand the language through which that teaching is mediated (i.e. he/she needs to have a good command of English). Evidence generated by this study suggests that many isiXhosa-speaking learners had superficial English language proficiency but struggled when they had to engage in academic subject-related class discussion. Thus their attempts to "describe, explain and predict natural phenomena in a precise manner" (Ogunniyi, 1998: 40) seemed to have been undermined by their poor English language proficiency. Wellington and Osborne (2001) provide useful practical guidelines on how teachers can assist learners to develop the necessary reading, writing, and comprehension skills for science.

In this study, difficulties with the Language of Science were manifested in the inability of many Grade 6 isiXhosa-speaking learners to understand scientific concepts or to describe their observations of science experiments, for example, explaining what happened in their process of constructing a 'weather' barometer using a wind-sock to determine the direction in which wind was blowing.

The Natural Sciences Learning Area in the South African Curriculum seeks to promote scientific literacy and provide a foundation on which learners can build throughout their lives (Department of Education, 2002; Nomlomo, 2007). In terms of the Revised National Curriculum Statement for the Intermediate Phase, the learning and teaching of the Natural Sciences Learning Area is guided by the following learning outcomes (LOs): (1) scientific investigations; (2) construction of science knowledge; and (3) understanding the relationship between, society and the environment (Department of Education, 2002: 6; Nomlomo, 2007).

The important role played by language in the achievement of the above learning outcomes by the learner cannot be overemphasized. With regard to LO1, the process of investigation entails the learner posing certain questions (and giving answers) to satisfy his/her curiosity with regard to the object of investigation. This necessarily involves the use of language (both LOLT and Language of Science). Equally, in describing the natural phenomena under observation or outcomes of the investigation, the learner relies on the use of *precise* language (Ogunniyi, 1998), that is, the use of (specific) scientific terms and concepts (language of science). With regard to LO2, the learner needs to be able to interpret scientific, technological and environmental knowledge (Nomlomo, 2007) with the aim of applying it. Interpretation implies that the learner should use his/her own words to make sense or meaning of the scientific knowledge at his/her disposal. In other words, the learner has to use his/her own language to construct his/her own understanding of new scientific knowledge. As regards LO3, understanding the relationship between science, society and the environment means that the learner must find and make connections and be able to describe or explain, through language, how these entities relate to one another. In all the above processes, the learner needs to be proficient in both the language of instruction (LOLT) and the Language of Science. This means scientific literacy on the part of the learner. Lack of language proficiency compromises and undermines the learner's ability to successfully fulfil the above outcomes.

In summary, as science uses a particular language, generally referred to as the *language of science,* learning science therefore entails learning the Language of Science. The Grade 6 IsiXhosa-speaking learners seemed to struggle with the terms and concepts used in the language of science. As it is argued in this study, understanding both the language of instruction and the Language of Science is fundamental to *scientific literacy*; it is therefore essential that isiXhosa-speaking learners should be scientifically literate. Evidence generated by this study suggests that many Grade 6 isiXhosa-speaking learners' attempts to 'describe, explain and predict natural phenomena in a precise manner' were hampered by their superficial English language proficiency (Ogunniyi, 1998).

6.2.3.2 The role of Indigenous Knowledge (IKS): Cultural/cognitive border crossing

The theoretical constructs of cultural/cognitive border crossing and collateral learning (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004) may be useful in explaining the nature and cause of the difficulties experienced by the Grade 6 isiXhosa-speaking learners in learning science through the medium of English in this study. Learning in a second language implies the crossing of cultural boundaries (Aikenhead & Jeged, 1999; Fakudze, 2004), from the culture of the learner's home language (indigenous knowledge) to the culture of the (dominant) language of instruction. This could mean a total breakdown in the child's learning if the child's (culturally-embedded) prior knowledge is not taken into consideration or integrated in the new teaching and learning situation. Culture, however, is not static but it is open to cross-cultural and other influences of a changing world, including globalization. The challenge for educators and curriculum developers (particularly for science) is to develop culturally sensitive curricula and teaching methods that take the learners' social context into consideration, so as to reduce the feeling among learners, especially in developing countries, that science is 'foreign' to their social or cultural context (Aikenhead & Jegede, 1999; Breidlid, 2004).

The informal code switching that was used by learners in this study could be seen as an effort at linguistic/cultural/cognitive border crossing by the learners (Cleghorn, 2005). A study of mathematics teaching in South Africa found that the students used their L1 first to discuss concepts informally among themselves, then switched to English for formal conceptual discourse (Cleghorn, 2005). This was interpreted to mean that learning may be taking place at the interface of the two languages, supporting the idea that the L1 needs official status in the classroom in order to promote learning. The foregoing suggests that English as the LOLT supports acculturation, if not assimilation, into another culture's way of looking (worldview) and another set of societal norms. This is because what is taught in school reflects a Western form of culture that is associated with English speakers, so the content of the curriculum often violates indigenous norms, values, and beliefs. Stated differently, a disjunction between the culture and language of the home and the culture and language of the school occurs, requiring the learner to literally cross borders in going from one to the other.

Acquiring and understanding the language of science is more likely to facilitate the process of linguistic/cultural/cognitive border crossing (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004), thus enabling the learners to move from the worldview they held before instruction to that of school science. The extent to which the (second-language) learners have managed border crossing between their culture and school science may be manifested by the extent to which they actively participate in the classroom activities.

Sutherland (2002: 5) notes that "some students for whom English is a second language may have the scientific understanding of a concept but may lack the scientific vocabulary to convey their understanding." Furthermore, the literature supports the view that teaching science in English to some non-Western groups of students does not provide them with equal access to information or knowledge (Po, 2006; Sutherland, 2002). By integrating the learners' background (indigenous) knowledge, or by learning their home language, the educators could have played a role in addressing the lack of acknowledgement of other knowledge systems.

6.2.4 Classroom management as a factor

Effective classroom management by the educator enhances the teaching and learning process. In this study, in their attempt to address difficulties with the medium of instruction, the educators resorted to changing the *seating arrangement* in the classroom by pairing isiXhosa-speaking learners with their English-speaking peers. This arrangement brings into focus two issues pertaining to the use of the seating arrangement by the Grade 6 science educators at Tableside Primary. Firstly, it relates to how the seating arrangement affected the task engagement and task performance of the learners. Secondly, it relates to how the educators used the seating arrangement to address the issue of 'multilingualism' in the classroom or teaching 'multilingual classes' (Desai, 2012; Skutnabb-Kangas, 1988). With respect to task performance, a study by Hastings and Schwieso (1995) found that there was a relationship between the seating arrangements of learners and task engagement in primary school classrooms (Griffiths, 1998; Hastings & Schwieso, 1995; Hastings & Wood, 2000). Hastings and Schwieso (1995: 279) noted that there was often a mismatch between classroom seating arrangements and the nature of pupils' tasks in that, "While children are typically seated in groups, their assigned tasks are generally individual."

The view held in this study is that seating arrangements should not be applied rigidly, but should primarily be informed by the teacher's intentions and the task demands in the particular lesson. Griffiths (1998: 39) notes that:

> ... colleagues have designed some research to test a method of classroom management by changing the seating in a classroom depending on the task set. Previous research has indicated that this technique has had a high degree of success in improving the achievement of the 'long tail' of low-achieving children in a range of different classrooms ... This is research with the potential of benefiting children at a socio-economic disadvantage in educational terms, since it is those children who are disproportionately represented in the 'long tail' of under-achievement.

Constraints of architecture, furniture, and logistics are other considerations which determine classroom seating arrangements (Donald et al., 2010; Hastings & Schwieso, 1995). Where the teacher's emphasis is on promoting individual learner engagement on a task, arranging the seating in rows seems to be the most appropriate. If, however, the teacher's intention is to promote collaborative work among learners, then the group seating arrangement would be most suitable (Griffiths, 1998; Hastings & Schwieso, 1995; Hastings & Wood, 2000). Warwick et al. (2010: 353) suggest that "a consideration of grouping arrangements and the development of activities and lessons that develop the use of group work and talk ... not only have a central role to play in promoting positive interactions in pupil groups, but also contribute positively to pupils' attainment in science." If inappropriately applied, however, the group setting may actually distract learners from their task or work (Hastings & Schwieso, 1995).

Since the introduction of the New Curriculum in South Africa, there has been a predominant shift in the seating arrangement in our primary schools from a 'rows' to a 'groups' arrangement. Apart from cases where learners have been engaged in group activities, the study by Hastings and Schwieso (1995) suggests that this arrangement may be detrimental to the individual focus of many learners, as the group setting may distract pupils (including isiXhosa-speaking learners) from their work (Hastings & Wood, 2000), especially those who are "least on-task" in the group arrangement (Hastings & Schwieso, 1995: 281).

Johnson (1998), on the other hand, notes that most classrooms involved in the author's 'Profiles of Learning' study were "organised along fairly traditional lines on the whole, teachers used whole class teaching methods" (Johnson, 1998: 402). It is crucial, therefore, for schools and educators to consider ways in which they can ensure a higher degree of match between classroom seating arrangements and the features of the different types of classroom tasks (Hastings & Wood, 2010; Johnson, 1998). This also has implications for the effective assessment of learners' academic performance. Johnson (1998: 402) notes that "If teaching practice does not become more differentiated (in terms of whole class versus group teaching methods), teachers will find it impossible to apply a framework of assessment, such as the Profile of Learning to pupils in their classes."

This study revealed that isiXhosa-speaking learners, when engaged in group discussions, tended to speak in their home language when two or more of them were in the same group. This could be a case of missed opportunities by the isiXhosa-speaking learners in terms of both their language development (in LOLT and the Language of Science) and the cross-pollination of ideas with other learners in the class. This seemed to be the idea behind the educators 'coupling' of isiXhosa- with English-speaking learners, *They learn better from each other sometimes* (E2).

The isiXhosa-speaking learners in this study were among those who participated least in the group discussion part of the science lessons. Hastings and Schwieso's (1995) found that those most affected by the changes in seating arrangements were those children who were least on-task in a group arrangement. In terms of this finding, isiXhosa-speaking learners would be the most affected by the change in seating arrangements, and would therefore benefit most in the change from group/cluster to a seating arrangement in rows.

As the group discussion teaching strategy is frequently used by educators during lessons, it would be advisable for educators to be consciously aware of the disadvantage at which such a strategy places isiXhosa- and other second- or additional- language speaking learners, and take measures to counter its effect by ensuring their active participation and input (even reporting during plenary) in such discussions.

Finally, Hastings and Schwieso (1995) note that there is widespread resistance to the idea that seating other than in the group/cluster arrangement can ever be desirable. However, they argue that, "What is undesirable is the retention of a standard classroom furniture arrangement regardless of the task. Attention to task appropriate seating arrangements can make an important contribution to improvements in behaviour and academic performance, *particularly for those children whose behaviour and progress cause concern"* (Hastings & Schwieso, 1995: 290 – my emphasis).

As regards the use of seating arrangement to address multilingualism in the classroom, the educators in this study noted that one of the difficulties they faced was in dealing with multilingual classes. For example, they had to contend with French- and Portuguese-speaking refugee learners from various African states, as well as isiXhosa-speaking learners. The terms 'multilingualism' and 'multilingual classes' can be defined differently (Desai, 2012; Skutnabb-Kangas, 1988). In the context of the Tableside Primary Grade 6 science class, the affirmative response to Desai's (2012: 7) questions 1, 2, and 3 would be applicable. This means that, in the above context, the term 'multilingual class' refers to one:

1. where pupils come from different language backgrounds;
2. where the teacher speaks a different language from the pupils; and
3. where pupils are taught in a language other their own.

It was in the above context that the Grade 6 science educators reported that they resorted to changing the *seating arrangement* in the classroom by pairing isiXhosa-speaking learners with their English-speaking peers.

In summary, in the above section (paragraph 6.2) it was noted that, due to their limited English language proficiency (LEP), the lack of academic language proficiency (CALP), and the consequent low level of abstraction of content knowledge in science, the majority of isiXhosa-speaking learners seemed to perform below their age appropriate level in terms of Bloom's Taxonomy of learning objectives. The inability of their educators to use the code switching strategy to explain the terms and concepts used, as well as the *subtractive bilingualism* approach (Desai, 2012) they adopted, compounded the problem. In this study, it is argued that, unless their LEP and CALP language skills are developed, Grade 6 isiXhosa-speaking learners at Tableside Primary will be unlikely to succeed in constructing their own understanding of scientific knowledge, which is fundamental to learning science. The advantages of using the code switching strategy in providing the learners access to the curriculum (Holmarsdottir, 2009; Nomlomo, 2007) were highlighted.

The language used in the assessment of the learners was also discussed, and the policy changes brought about by the new democratic order, as found in the relevant literature, were noted. In addition to government-sponsored policy initiatives, Johnson's (1998) '*Profiles of Learning*', which provides a criterion-referenced framework for assessing learner literacy, was recommended.

As regards the debate on home language instruction as opposed to second language instruction in science, the position held in this study is that, while it is desirable to teach isiXhosa-speaking learners in their home language, the critical issue here is the language of access to scientific knowledge by the learners. Furthermore, the fact that the isiXhosa-speaking learners or their parents have chosen English as the medium of instruction needs to be respected and should ultimately be the deciding factor. Hence the decision to conduct a study to find out the difficulties experienced by the learners in learning science through English, with the aim of recommending possible solutions. As English is perceived to be the language of globalization (Bgoya, 2001; Prah, 2003), as well as the language of science and technology (Rubagumya, 2003), supporting the learners in improving and developing their LEP and CALP skills seems to be the logical and sensible thing to do.

It is argued in this study that understanding both the language of instruction and the language of science is fundamental to *scientific literacy*. It is further argued that in developing the learners' scientific literacy their traditional background (IKS) should be taken into consideration. In this regard, the theoretical constructs of cultural/linguistic/cognitive border crossing and collateral learning (Aikenhead & Jegede, 1999; Cleghorn, 2005; Fakudze, 2004) may be useful.

Finally, classroom management was discussed, and it was noted how effective classroom management by the educator enhanced the teaching and learning process. The effect of seating arrangements on task engagement in primary classrooms (Griffiths, 1998; Hastings & Schwieso, 1995; Hastings and Wood, 2000) was highlighted, relevant studies in the literature being cited.

6.3 THE TEACHING AND LEARNING CONTEXT

It was mentioned in Chapter 5, that some factors in the curriculum delivery process at Tableside Primary School contributed to, or exacerbated the difficulties experienced by

Grade 6 isiXhosa-speaking learners in learning science. These factors included the educators' teaching styles, the learner assessment techniques, and the school environment.

6.3.1 Teaching and assessment methods or approaches

As mentioned in Chapter 5, the classroom observation visits revealed that the three educators at Tableside Primary largely used the traditional Telling Method ('chalk and talk') in their teaching, although to varying degrees. Regarding this *teacher-centred* approach, Johnson (1998: 402) noted that evidence "seems to suggest that teachers would require a great deal of training in re-orienting the classroom environment and teaching styles" in order to accommodate his 'Profiles of Learning' framework. He found that most classrooms involved in his study were "organized along fairly traditional lines and on the whole, teachers used whole class teaching methods." The situation at Tableside Primary was no different, possibly due to the overcrowding in the classes, as the educators noted during interviews.

Furthermore, the educators not only approached the same lesson differently but emphasized different aspects of the topic under discussion. Despite the differences in their approaches, during the interviews many isiXhosa-speaking learners indicated that the educators did not explain 'properly' or to the learners' satisfaction. Taylor and Vinjevold (1999: 143) highlight research studies conducted in South African schools which show "teacher-centred practices and very superficial engagement with pupils' conceptual development." They note the following common practices:

- Lessons are dominated by teacher talk and low level questions;
- Lessons are generally characterized by a lack of structure, and the absence of activities which promote higher order skills such as investigation, understanding relationships, and curiosity;
- Real world examples are often used, but at a very superficial level;
- Little group work or other interaction occurs between pupils; and
- Little reading and writing is done by pupils. When it is, it is of a very rudimentary kind.

Taylor and Vinjevold (1999: 132) link and explain the teacher-centred classroom practices to the doctrine of *fundamental pedagogics,* which they suggest "has had profoundly detrimental effects on teachers' thinking and practice." They describe fundamental pedagogics as "based on premises which can be interpreted as authoritarian (for example, the teacher, as knowing adult, leads the child to maturity)." Citing the NEPI (1992) report, Taylor and Vinjevold (1999: 133) state that "fundamental pedagogics has 'debilitating effects' and prevents teachers from 'developing and understanding of the relationship between education and the context in which knowledge and understanding are created and shared'." This situation is emphasized by the apparent hesitance of educators at Tableside Primary to integrate the learners' indigenous knowledge (IKS) in their teaching.

Undoing or counter-acting the effects of fundamental pedagogics on teachers' thinking and practice is seen to involve two steps, namely "the propagation of a liberatory ideology, and the institution of systems which encourage teachers to follow learner-centred classroom practices" (Taylor & Vinjevold, 1999: 133). Taylor and Vinjevold assert that these are the principles underlying the OBE (2005) Curriculum.

This study also revealed that the educators' level of questioning, both during the lessons and during the learner assessments, did not seem to stretch the learners' cognitive skills. In terms of Vygotsky's Zone of Proximal Develpment (ZPD) theory, effective mediation and support result when the learner is stretched beyond his/her current level of functioning (Cleghorn, 2005; Davey, 1996; Kuzolin, 1998; Thomas, 2004: 18). Language plays an important role in this 'scaffolding' process. The Grade 6 Natural Science educators' role in this regard at Tableside Primary was further encumbered or restricted by their inability to use the code switching strategy, thus limiting their one-to-one interaction with the learners (Bruner, 1964; Pea, 2004; Vygotsky, 1962). Knowledge of the learners' language could also reinforce the educators' teaching to make their lesson input in science more meaningful (in terms of Krashen's input hypothesis), thus promoting better understanding for the learners (Alderson & Beretta, 1992; Davey, 1996).

The above findings have implications for teacher development and support. Regarding teacher training, however, Johnson (1995: 133) notes that "training staff is not always sufficient. The functioning of trained staff ultimately depends on the environment in which they are working and thus institutional development is an extremely important component of capacity building."

During the document analysis there seemed to be no evidence of alternative assessment, other than the traditional written tests and exams (which seemed to suggest an over-emphasis on summative assessment by the educators). The view in this study is that where learners manifest specific learning difficulties it may be more prudent to lay more emphasis on formative forms of assessment, precisely because they provide an opportunity for an individualized learner response, in line with both the 'learner-based' and 'learner-paced' principles of the OBE/RNCS Curriculum, and Vygotsky's ZPD principle (Department of Education, 2002; Department of Education, 2005; Department of Education, 2011; Davey, 1996; Kozulin, 1998). This approach is also in line with the constructivist paradigm espoused in this study. Citing Black and Williams (1998), Thomas (2004: 24) highlights "the problems associated with summative assessment and the unsatisfactory procedure of determining students' abilities using short de-contextualized questions under test conditions."

One of the useful techniques that could have been used by the educators at Tableside Primary, for example, is learner self-assessment (Thomas, 2004). Regarding self-assessment, Thomas (2004: 23) suggests that:

> ... self-assessment by pupils is essential to formative assessment and ... students need to have an understanding of the following three elements before they can take action to improve their learning:
>
> 1. Recognition of the *desired* goal;
> 2. Evidence about the *present position*; and
> 3. Understanding of a *way to close the gap* between the two.
>
> Effective feedback as well as competent self-assessment would inform all three elements.

In paragraph 5.2.3.2, it was pointed out that the principle of (linguistic, cultural and/or cognitive) border crossing might be useful in explaining the nature and cause of the difficulties experienced by isiXhosa-speaking learners in 'abstracting', constructing, and communicating or conveying (their) scientific knowledge. These difficulties were particularly evident in the document analysis of the records of learner assessment.

In discussing "The Challenges of Culturally Valid Assessment", Ogunniyi (2005: 131) notes that:

> ... an assessment cannot be considered [as] culturally valid if it ignores the socio-cultural influences and contexts that shape the minds, thoughts, and attitudes of learners toward school science/technology. ... the school population (particularly in the new South Africa) for one reason or the other, has become greatly mixed. In South Africa ... the abrogation of apartheid laws and opening of schools in any locality to children of all races

> has resulted in the present multicultural classrooms. However, teachers are not well equipped to deal with this new phenomenon. ... the development of a new curriculum would be a futile exercise without the development of assessment protocols that are compatible with that curriculum. Closely related to the phenomenon of multicultural classrooms is the language of instruction.

With regard to learner assessment in science, the NEPI (1992c: 27) recommends a change from a norm-referenced system of examinations toward "criterion-referenced examinations including the examination of science-related practical skills." In other words, alternative forms of assessment to 'conventional' assessment are encouraged, as these allow the educator to use more creative ways of assessing the learners' competences. It is acknowledged that this "may be an expensive route to take," but that such an approach to learner assessment should be gradually phased in (NEPI, 1992c: 23).

6.3.2 School environment

In this study, the school is regarded as one of the important layers or levels of interacting systems which influence a learner's growth and development (Bronfenbrenner, 1979; Swart & Pettipher, 2006). The web of relationships that the learners have within the school environment not only influences relations between the educators and their parents, but ultimately influences their attitude towards learning. This study revealed certain limiting factors within the Tableside Primary school environment which added to the difficulties experienced by the Grade 6 isiXhosa-speaking learners in learning science. These limitations included educator attitudes, learners' psycho-emotional challenges, learning support, insufficient school funding and inadequate resources (including inadequate utilisation of resources).

Educator attitudes

The emotional environment in which learning takes place is very important and educators play a central role in ensuring a safe and inclusive school environment (Stofile & Green, 2007). However, many educators in South Africa are ill-prepared to meet the diverse needs of learners, as they were not trained for some of the 'new' roles they have to play (Nel et al., 2011; Stofile & Green, 2007). The educators in this study commented that it was very difficult to encourage Grade 6 isiXhosa-speaking learners (with reasons given). The implication of the educators' comments is that they might have branded these learners as underachievers. The Labelling theory suggests that there is a danger in stereotyping certain groups as being less likely to perform well at school (Hughes, 2010). Learners so labelled are also likely to become deviant learners and fit the image that is assigned to them as a deficit performing group.

The demonstrated decrease of enthusiasm of the teachers may also have impacted on the learners concerned and added to their apparent poor motivation (Mant et al., 2007). This kind of attitude can negatively impact on their self-image and self-esteem, and this manifests itself in their academic work performance. As Hughes (2010: 34) points out:

> Their own expectations, and those of others [including their educators and peers], influence performance itself through self-image, group image, and a deviant/deficit model of behaviour that fits with the stereotype, along with the lower performance expectations from those working with them ... Children's self-theories of intelligence influence their response to schools and their motivation to learn.

Hughes (2010: 34) argues that even the term 'English as an Additional Language (EAL)', used to describe English second language speakers (particularly in Britain), is problematic in that the learners affected "are frequently presented as having achievement that is lower than that of native English speakers." As a consequence, for many years these learners have been assigned to a category of special educational needs. Multilingualism was not valued, and lowered expectations of the learners' performance has perhaps led to missed opportunities for the learners concerned to use their home language to enhance their learning of English.

Hughes (2010) cautions about the measurement of performance, labelling, stereotyping, stigmatizing, and using the deficit model to explain contrasting educational outcomes. There is also "growing concern about the wholesale misuse in educational circles of terms such as *learning disabilities* (LD) and *attention-deficit/hyperactivity disorder* (ADHD). Widespread misdiagnoses and inappropriate prescriptions have compromised special education and clinical practice, confounded regular education, and undermined research" (Adelman & Taylor, 2006: xx).

The definition of 'barriers to learning' can create the impression that these barriers exist very much on the child's side. "It implies that it is the child who holds the barriers to learning within themselves, which a trained educational professional can help to break down" (Hughes, 2010: 8). For this reason, Hughes proposes an expanded definition that takes into account that "there are also other barriers that are created in the minds and structures of our society" (Ibid.). Hughes cites as an example, the manner in which research evidence has, in some instances, been gathered to give hard data about the performance of different social and economic groups, which lends itself to the stereotyping and stigmatizing of children who fit into specific groups. The author notes that these kinds of barriers are much harder to identify, as they are deeply embedded in our society and in our minds.

Secondly, Hughes notes that barriers to learning for some children may be a consequence of the institution of school itself and its place in our society. For example, the very early introduction to formal schooling places undue pressure on very young children, who would otherwise still be in kindergarten. In kindergarten, the focus is on a much more holistic, play-related curriculum, and not on the children. The very early introduction to formal schooling of children who may not be ready for direct teaching is detrimental to their further development, as it puts them at risk of poor academic achievement, which in turn may be due to a poor linguistic development or foundation (Stofile, 2008).

Learners' psycho-emotional challenges

The emotional condition of a learner plays a very important role and is considered a precondition for his or her learning success (Department of Education, 2001; Donald et al., 2010; Johnson & Green, 2007). Emotional factors such as anxiety, insecurity, and lack of motivation may become manifest if learners are not competent in the language used in the classroom (Nomlomo, 2007). The affected learners may then become shy and avoid participation in the classroom. Such learners may even develop low self-esteem that may lead to depression, and such behaviour can have a negative effect not only on their academic performance but on their academic achievement in general. The concept of a 'health-promoting school' goes a long way towards alleviating and preventing many such barriers to learning (Johnson & Green, 2007). Drawing upon the World Health Organization (WHO), Johnson and Green (2007: 165) state as follows: "A Health Promoting School can be characterized as a school constantly strengthening its capacity as a health setting for living, learning, and working." In other words, such a school commits itself to providing a safe social and physical environment that supports the promotion of health for the total school community.

During the interview phase of this study, the learners made it abundantly clear that they found the learning of science much easier 'when the educator explained in a language that they could understand.' When this happened they felt confident and were able to participate more in the classroom activities. Sladek, Miler, and Benarova (2009) attribute much of the lack of motivation or interest of present-day children in science to the deplorable level of mathematics and science as used in our population. They note that children of today often do not have the opportunity to experience nature at first hand or produce something in a workshop, and that the environment they grow up in does not present reality from the perspective of natural sciences.

> The problems posed by today's lifestyle do not require the skills of individuals that are the subject of natural sciences. The self-indulgence and the reluctance of people to deal with things goes hand in hand with the decline of the ability of critical thinking, with the imagination weakening, with the lack of coherence, which are needed to ensure that a person has completed all concrete work. In addition children are exposed to knowledge and adventure in a completely finished form – in the multimedia for the excogitation of consumers; it's the others who deployed their imagination, usually staffs of specialists. What you see on the screen is drawn up in detail with perfection that in reality does not exist (Sladek et al., 2009: 169).

To stimulate learners' interest in science and technology, Sladek et al. (2009: 169) propose that learners be put "on their own intellectual feet" by giving them a set of basic methods and concepts that can be used in analysing their life situations. This, of course, has implications for the teachers in terms of knowing their learners and the background from which they come. Instead of using "whole ready conceptions and terms", teachers could offer their learners "the possibility to discover nature by means of concrete, though less noble, problems and confront it with their incident experience," (ibid.) and provide them with the platform for practical applications of acquired knowledge, emphasizing their importance in the learners' future life. Sladek et al. (2009: 172) describe the purpose of motivation as "to intentionally induce curiosity and strained expectations [in the learner], in order to influence attitudes towards further activities." Through this constructive approach, learners could acquire the required scientific skills and develop their own insights. This could facilitate their scientific knowledge construction. Although this view does not refer exclusively to second language speaking learners (including isiXhosa-speaking learners), it is potentially pertinent to learners who come from indigenous knowledge (IKS) backgrounds.

In this study, the classroom observation revealed that the educators did not challenge the learners enough in their lessons or in their Assessment questioning. Challenging learners academically, either during the lesson, or during assessment, could have a motivating effect and increase their interest in the topic under discussion or the subject (i.e. Learning Area) in general. Mant et al. (2007) researched the effect on 11-year-old pupils of introducing more cognitively challenging, practical, and interactive lessons. Their hypothesis was that such lessons would increase the children's enthusiasm for science, as well as their engagement with the scientific process, thereby improving their education/academic performance. They reported an increase in the proportion of children achieving the top score in the intervention schools and that the pupils and teachers reported greater engagement and motivation. They noted that, "These findings suggest that moving from rote revision to_cognitively challenging, interactive science could help improve science education" (Mant et al., 2007: 1707). In other words, the findings propose a move from a less content-driven approach to one which encourages the learners' thinking through discussion and practical investigations (Anderson & Krathwohl, 2001).

Emphasis should be put on "enhancing classroom approaches and establishing a schoolwide component to enable all students to have an equal opportunity to succeed at school" by exploring the potential for school-family-community collaboration (ibid.). The notion of exploring school-family-community collaboration brings us to the issue of the 'learning support' given to second-language learners (including isiXhosa-speaking learners) at the school, which is discussed in the next section.

Learning support

Learning support relates to the kind of additional support that is given to the learners to facilitate their learning (Johnson & Green, 2007; Oswald, 2007; Taylor & Vinjevoldt, 1999). This includes *mediation* and *remediation* of learning by the teacher, as well as the learner and educator support material that is provided and used in the learning process. Learning support also relates to the support that is given to the educators to enable them, firstly, to perform their teaching function efficiently and effectively and, secondly, to act as change agents who can champion educational transformation in our schools (Oswald, 2007). Johnson and Green (2007: 160) prefer the concept of 'education support' to 'learning support', which they argue implies a broader understanding of the notion of support and which is more congruent with the concept of an inclusive education system. The notion of support to schools, however, entails both pre-service and in-service training and guidance, both within the school and from the Education Department, and is critical to the provision of quality education for all learners in South Africa (Oswald, 2007; Taylor & Vinjevoldt, 1999).

The educators in this study felt that *overcrowded classes* limited their ability to give individual attention to the isiXhosa-speaking learners. As a result, they struggled with the work. The educators stated that the number of learners in the class negatively affected the quality of the time they spent with the learners. This was particularly pertinent because each educator was responsible for teaching all eight learning areas in each of the three Grade 6 classes. There were, on average, about 25 learners in each of the Grade 6 classrooms. Applying Johnson's (1998) 'Profiles of Learning' framework (to maintain a record of literacy achievement for each learner) would be very difficult under such overcrowded circumstances, given the time constraints. The educators could, however, prioritise those learners who struggled to perform in Natural Science.

Regarding *learning support*, Adelman and Taylor (2006: 2) note that, although considerable efforts and resources are expended by the schools, education districts, and the community, "it is widely recognized that interventions are fragmented and poorly coordinated. And the whole enterprise is marginalized in policy and practice." This means that more effort and time should not only be expended on synchronizing and streamlining learning support but that in rendering such support policy should be matched with practice (Oswald, 2007). This requires a closer working relationship, involving partnerships between district service providers (i.e. Circuit Teams) and the school community (SMT, educators, SGB, parents, and surrounding community), to identify the problem areas and provide programmes and training workshops in collaboration with other public sector organizations and NGOs (Department of Education, 1997b; Engelbrecht, 2007; Oswald, 2007).

In their critique of the way learning support is utilized Adelman and Taylor (2006) note that there is a tendency (in the UK) for student support to be highly fragmented, an over-reliance on specialized services for individuals and small groups, and for support staff to function in relative isolation from each other as well as from other stakeholders. This results in a duplication of (specialized) services, redundancy, and counterproductive competition. "Furthermore, in every facet of a district's operations, an unproductive separation often is manifested between staff focused directly on instruction and those concerned with student support. It is not surprising, then, how often efforts to address barriers to learning and teaching are planned, implemented, and evaluated in a fragmented, piecemeal manner " (Adelman & Taylor, 2006: 11).

In explaining why the efforts towards learning support are not enough, Adelman and Taylor (2006: 12-13) point out the following:

- It is common knowledge that few schools come close to having enough resources to deal with a large number of students with learning, behaviour, and emotional problems.
- The contexts for intervention are often limited and makeshift because of how current resources are allocated and used. ... Support service personnel often must rotate among schools as itinerant staff. To make matters worse, little systematic inservice development is provided for new support staff when they arrive from their preservice programmes. All this clearly is not conducive to effective practice and is wasteful of sparse resources.
- Rather than address the deficiencies surrounding school-owned support programmes and services, policy makers seem to have become enamoured with the concept of school-linked services, as if adding a few community health and social services to a few schools is a sufficient solution. ... Whatever the reason, some policy makers have come to the mistaken impression that community resources alone can effectively meet the needs of schools in addressing learning, behaviour, and emotional problems.

Whether the emphasis is on school-based or school-linked student support or some combination of both, it is clear that there are not enough services and facilities to meet the demand in many public schools (Adelman & Taylor, 2006; Oswald, 2007; Stofile & Green, 2007). For the foregoing reasons, among others, it is imperative to rethink how schools provide essential learning support. While the difficulties mentioned above relate to schooling in the UK, they seem to be equally relevant and applicable to the current state of education in the new democratic South Africa.

Insufficient school funding

In chapter 2, it was pointed out that, due to lack of funds schools are not always provided with the resources they require to render effective support to learning and teaching (Department of Education, 1998; Sayed & Soudien, 2010). This study found this to be the case at Tableside Primary.

Public schools under the Western Cape Education Department are financed on a sliding scale based on a Quintile Classification System, in accordance with the guidelines of the National Norms and Standards for the Funding of Schools (Department of Education, 1998; Sayed & Soudien, 2005). The poorest schools, usually those situated in the socio-economically disadvantaged residential areas and including the mostly black schools that were previously under the Department of Education and Training (DET) and ex-HOR, are placed under Quintile 1 and are the most funded in the system. Depending on the degree of affluence of the residential area or community in which the school is situated, the schools are progressively placed in Quintiles 1, 2, 3, 4, and 5. Schools situated in the most affluent residential areas, mostly formerly white (ex-Model C) schools, are placed in Quintile 5 and are the least funded. Thus Tableside Primary, by virtue of being an ex-Model C school, falls under Quintile 5. It is clear that the school needs to engage, consistently and tirelessly, in a major fund-raising effort to transform itself to a sufficiently resourced and relatively independent learning institution. Taylor and Vinjevold (1999: 138) note that:

> ... people driven by an internal locus of control look to their own resources, in addition to what may be available from the outside, to contribute to improving their condition. Thus improved pupil results do need external resources such as textbooks and laboratories, but, with or without additional resources, better school management and teaching practices are also required, and there are many examples that demonstrate how these factors can make a significant difference on their own.

The inadequate funding of schools is not unique to South Africa. It is a feature of the process of globalization, which, through its competitive global markets, demands market discipline, thus forcing a reduction in government spending, including spending on education (Holmarsdottir, 2009).

It is argued in this study that the inadequate funding of schools is one of the reasons why the implementation of *Education transformative policies* such as the Language-in-Education Policy (Department of Education, 1997a), especially where the language of instruction is concerned, should not be left entirely in the hands of the school. In Chapter 1, it was pointed out that the qualification in the Bill of Rights statement that each person has the right to instruction in the language of choice *where this is reasonably practicable* (my emphasis) was problematic. It renders the principle of inclusive education inapplicable in that, where the school does not have the required resources (as was the case at Tableside Primary), the learners must "fit into" the existing system (Johnson & Green, 2007: 160; Swart & Pettipher, 2006: 8). In so far as there is no provision for its practical implementation at school level, the above policy statement amounts to what Soudien (2007: 138) describes as "inclusive at a liberal level but exclusive at a more fundamental epistemological level." The argument in this study, therefore, is that the African/isiXhosa-speaking learners (in Grade 6) at Tableside Primary school were not sufficiently provided for in relation to their *linguistic learning needs*

(Brock-Utne, 2000: 141; Obanya, 1980), particularly in relation to Natural Science, possibly because of insufficient funds to employ isiXhosa-speaking science educators.

The possession and use of scientific equipment is essential for the creation of a stimulating and conducive environment for the learning and teaching of science (Warwick, Mercer, Kershner, & Staarman, 2010). For example, the introduction and use of an interactive whiteboard (IWB) could assist both in stimulating interest in science (by providing fun) in the learners, and in offering more possibilities for learner participation and interaction. The IWB has the potential for creating 'collaborative classroom learning environments' as well as providing 'active, self-regulated and collaborative learning' opportunities to the pupils (Warwick et al., 2010: 351). It can be strategically used by the teachers 'to provide a more dynamic, interactive and appropriated learning experience' for the learners through particular, structured activities. Such collaborative and participatory learning environments would also provide language development opportunities (both LOLT and Language of Science) to second-language learners (including isiXhosa-speaking learners) and an opportunity to talk about science (that is, shared science knowledge construction through group talk and talking about science).

With regard to using the 'Profiles of Learning' framework, particularly in collecting evidence of learners' work, Johnson (1998: 401) notes that:

> Resource limitations proved to be an influence upon the amount and range of evidence of achievement which could have been accumulated. The historically white schools (which had begun admitting Black pupils) were clearly much better resourced than schools catering for African or 'Coloured' pupils. Here teachers were able to collect and reproduce a wider variety of samples of children's work. This included copies of worksheets and in some cases, photographs of children's art work.

As the notion of barriers to learning encompasses both external and internal factors (Adelman & Taylor, 2006; Department of Education, 1997b; Green & Engelbrecht, 20007; Johnson & Green, 2007), it stands to reason that good teaching can only take place in the context of both external and internal *school support*. To be effective, good teaching must be complemented with direct intervention to remove or at least minimize the impact of both external/environmental and learner-intrinsic barriers (Adelman & Taylor, 2006). Evolving an intervention framework that is comprehensive, multifaceted, and comprehensive at school and at district level "requires *rethinking infrastructure* and *policy* and using a sophisticated approach to facilitating major *systemic changes*" (Adelman & Taylor (2006: xxi).

Inadequate resources

Learning support also entails providing the educators with the necessary resources and technological assistance, especially since science learning and teaching relies on the use of scientific equipment for demonstrations and experiments.

Educators in this study argued that factors within the school, such as *inadequate resources* (e.g. no science laboratory and no Interactive_White Boards), inadequate use of available resources (such as the library), and the ineffective use of time, contributed to the difficulties experienced by isiXhosa-speaking learners in learning science. The educators also noted that there was a shortage of textbooks at the school, to the extent that the teachers had to make photocopies and notes. These challenges are supported by others in South Africa (Johnson and Green, 2007; Oswald, 2007; Taylor & Vinjevoldt, 1999).

During their interviews, the SMT stated that the school was further constrained economically by the Department's Quintile Classification System which automatically placed ex-Model C schools in Quintile 5 (the richest and therefore the least funded schools), irrespective of their circumstances. This situation contributed to the inadequate resources at Tableside Primary.

Adelman and Taylor (2006: 2) note that "schools do not come close to having enough resources to meet their needs," and that under these conditions learner performance is not likely to improve adequately until student supports are rethought and redesigned.

Inadequate use of resources

During the interviews, the educators in this study noted that the inadequate use of available resources such as the library and the ineffective use of time contributed to the difficulties experienced by isiXhosa-speaking learners in learning science. In addition, the educators noted that, because of public transport problems and the distances they had to travel from school, isiXhosa-speaking learners left school immediately after the last school bell in order to catch the next bus or train. This put them at a disadvantage, as they could not attend after school (learner support) classes or remain at school to use facilities such as the internet, either for self-enrichment or to help with their school projects.

A study on the teaching support materials produced by the Science Education Project, reviewing the support they provided to enhance the learners' understanding of the nature of science, noted that "there were very few instances in the materials that suggested ways to involve pupils in scientific ways of working such as investigations and problem solving" (Thomas, 2004: 18).

In summary, this section discussed some of the limiting factors within the Tableside Primary school environment which added to the difficulties experienced by the Grade 6 isiXhosa-speaking learners in learning science.

Educator attitudes: The educators' claim that it was difficult to motivate the Grade 6 isiXhosa-speaking learners in science gave the impression that they had given up on the learners. In this context the relevant (Labelling Theory) literature highlights the dangers of labelling learners as under-performers and the impacting this has on their self-image and self-esteem. Similarly, the definition of 'barriers to learning' can create the impression that these barriers exist very much on the child's side, thus impacting negatively on the learners.

Learners' psycho-emotional challenges: Factors such as anxiety, insecurity, and lack of motivation may impact negatively on learners' self-confidence and academic performance if they are not competent in the language used in the classroom. The literature attributes this insecurity and lack of motivation partly to the general lack of proper exposure and proper stimulation of learners in modern society, as well as specifically in science teaching. The role of the educators is to induce curiosity in the learners to afford them the possibility to discover nature by tackling concrete problems, and to provide them with a platform for practical applications of their acquired knowledge, emphasizing its importance in their future life. The importance of challenging learners cognitively, during both the lessons and assessment, in stimulating their interest and improving their academic performance has been emphasized.

Learning support: Educators in this study noted that overcrowding in the classes limited their ability to give individual attention and spend quality time with their learners. This was particularly pertinent, given that each educator was responsible for teaching all eight learning areas in each of the three Grade 6 classes. The literature notes that, although much time and resources are expended on lending support to schools, this support is often fragmented, duplicated or poorly co-ordinated. In order to avoid or limit this fragmentation, it is suggested in this study not only that more time and effort should be spent on synchronizing and streamlining learning and other forms of support, but that in rendering such support there should be matching of policy with practice. This requires a closer collaborative working relationship between the various district public service providers, the school community and NGOs in identifying the problem areas, and in planning and providing training programmes and workshops. This could go a long way towards realizing the required holistic and integrated approach to providing support services mentioned above.

The educators had also indicated they needed more support and training on, among others, how to handle multicultural classes.

Insufficient school funding: the educators and SMT in this study indicated that the status of the school as a Quintile 5 put it at a disadvantage, since it received minimum funding from the Education Department. As a result, the school did not have enough funds to buy all the resources it needed, and instead depended largely on its own fundraising. It is for this reason that the present study takes the position that the implementation of transformation policies such as the Language-in-Education Policy (Department of Education, 1997a), especially in so far as the language of instruction is concerned, should not be left entirely in the hands of the school. The above-mentioned consequences of insufficient funding of Tableside Primary militate against the principles of *inclusive education* and (equal) *quality education for all.*

Inadequate resources: Both the learners and educators in this study acknowledged that the limited resources at the school contributed to the difficulties experienced by isiXhosa-speaking learners in learning science. It is argued therefore that the possession and use of scientific equipment are essential for the creation of a stimulating and conducive environment for the learning and teaching of science.

Inadequate use of resources: The educators in this study noted that the inadequate use of available resources such as the library, and the ineffective use of time by both the learners and the teachers themselves, contributed to the difficulties experienced by isiXhosa-speaking learners in learning science. What made matters worse was that isiXhosa-speaking learners left school immediately after the last bell and did not take advantage of the proffered after-school classes or remain to use the internet and library, either to enrich themselves or do their school projects.

6.4 SOCIAL FACTORS AS BARRIERS TO LEARNING

Educational issues cannot, and should not, be divorced from broader social and economic agendas such as income, employment, health, housing, crime, living environment, or transport (Donald et al., 2010; Hughes, 2010). This study highlighted some of the factors in the social environment which appeared to have contributed to, or exacerbated the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science. These factors included the socio-economic background of the learners, learner motivation and work ethic, and lack of parental support.

6.4.1 Socio-economic background of learners

The questionnaires for this study revealed that the majority of isiXhosa-speaking learners lived in townships or informal settlements, which are associated with poor socio-economic conditions such as poverty. Child poverty is still seen as a major determinant of school performance (Department of Education, 1997b; Hughes, 2010; McKenzie & Loebenstein, 2007; Stofile, 2008). The questionnaires also revealed that the majority of isiXhosa-speaking learners in 2008 and 2009 travelled to school by public *transport* (i.e. by bus, taxi, or train). This affected the time they had to wake up in the morning, the time they arrived at school, and their state of readiness to receive tuition when they arrived (often late) in the classroom. The research interviews also revealed that many isiXhosa-speaking learners came from fairly poor socio-economic backgrounds and did not get the necessary *academic support from their homes or parents*, for example, in doing their homework or research projects. Some even had to help with household chores after-school and during week-ends while their parents were still at work. These circumstances seemed to disadvantage isiXhosa-speaking learners in relation to their English-speaking peers. Thus, besides geographical location, the *socio-economic factors* within the home environment of some of the learners, such as living in an informal housing settlement, unemployment, poverty, and the level of education of the parents, could have had an effect on their self-image, self-esteem, and, consequently, on their school performance and academic achievement (Department of Education, 1997b; Donald et al., 2010; Du Toit, 1996; McKenzie & Loebenstein, 2007; Nomlomo, 2007; Stofile, 2008; Swart & Pettipher, 2006).

Social class is a central variable in determining learner success in school (Thomas, 2004; Rollnick, 1998). It is important, therefore, to take the social class origins of the learners into consideration, in order to give them relevant and effective learning support. The social class origins of these learners may also have an impact on their 'orientation to meaning' in learning science, which "can be described as the selection and organisation of meaning, of what is seen as relevant and taken as the focus of attention in any situation, and the way in which these meanings are organised in practical discourse" (Thomas, 2004: 25). The interpretation and response of learners (L5 and L5) to the question on *the advantages of plastic* (paragraph 5.4.2) is a case in point. The orientation to meaning is considered to be class related (Thomas, 2004). A child from a working-class background manifests an orientation to meaning that often shows a *restricted code* that encourages participative thinking. This orientation differs from an *elaborated code*, which is geared "towards mastering complex meanings and taxonomic thinking patterns" (Thomas, 2004: 25). Thomas (2004: 25) defines restricted and elaborated codes as follows:

> Restricted code refers to linguistic practices which are centred around interpersonal interactions and that are context embedded. Elaborated code refers to linguistic practices, which are heavily centred towards the transmission of formal knowledge and language structures and that tend towards context independent meanings.

On the basis of the above definitions, it seems to me that the restricted code may be similar or related to Cummins' BICS concept, while the elaborated code may be similar to the CALP concept (Abriam-Yago et al., 1999; Baker, 1993; Cummins & Swain, 1986). The restricted code notion, then, is congruent with the finding in this research, in that the Grade 6 isiXhosa-speaking learners at Tableside Primary appeared to be superficially proficient in conversational English, but struggled with English academic language (including scientific terms and concepts).

6.4.2 Learner motivation and work ethic

The educators in this study painted a sombre picture of the Grade 6 isiXhosa-speaking learners' *motivation and work ethic.* They noted that they found it difficult to teach Natural Science to isiXhosa-speaking learners in Grade 6 because they did not get much sleep as they were up early to catch their public transport, and always came to school tired. Some were even not afraid to sleep in class. When they arrived in class, they took long to settle down, while the other learners were already into their routine. The educators wanted them to sit and focus on the work, but the learners did not really want to do that. The educators also indicated that it was difficult to encourage isiXhosa-speaking learners, as they did not do their homework. However, the educators tried to encourage them to do their homework at school and liaised with the librarian to provide them with the necessary materials for assignments and projects. The literature indicates that learners' socio-economic factors, such as poverty or the unemployment of their parents, have an impact on their motivation. As mentioned in Chapter 2 of this study, learners living under conditions of poverty are vulnerable to emotional stress, which adversely affects their learning and development (Department of Education, 1997b). Poverty is associated with under-nourishment, which further leads to lack of concentration and the inability of the learner to engage effectively with the curriculum or the learning process (Department of Education, 1997b; Stofile, 2008; Stofile et al., 2011). These conditions put learners at the risk of learning breakdown and often lead to poor academic performance, poor self-esteem and lack of self-confidence, all of which contribute to poor motivation.

6.4.3 Lack of parental support

The educators found it difficult to support isiXhosa-speaking learners, as most of their parents did not respond to calls, failed to attend school meetings or open days to view their children's work, and made excuses when they were invited to school. The educators also noted that they had problems in communicating with the parents, as some of the learners did not deliver letters from the school to their parents. The parents on, the other hand, noted that they found it difficult to attend school meetings mainly due to logistical problems relating to the time of the meetings, lack of transport, and the fact that they worked unusual hours.

The lack of parental support at the school could also be due to lack of recognition of the parents' role in the teaching and learning process (Department of Education, 1997b; McKenzie & Loebenstein, 2007). In Chapter 2, the central role that is played by active parental and community involvement in the teaching and learning process of the school to achieve effective learning and development was noted (Green & Engelbrecht, 2007; Nomlomo, 2009; Prinsloo, 2005). It was also highlighted that, where the parents were not recognized and empowered as primary caregivers or their participation facilitated and encouraged, effective learning and teaching was undermined and learning breakdown occurred (Department of Education, 1997b; McKenzie & Loebenstein, 2007; Prinsloo, 2005).

In summary, this section examined and discussed social factors as barriers to learning at Tableside Primary, as found in the study. It highlighted the following factors:

Socio-economic background of learners: The research revealed that many Grade 6 isiXhosa-speaking learners came from fairly poor socio-economic backgrounds and did not get the necessary academic support from their homes in doing their school work or research projects.

Besides geographical location, the *socio-economic factors* within the home environments of some of the learners, such as living in an informal housing settlement, poverty unemployment, and the level of education of the parents, could have had an adverse effect on their self-image, self-esteem, and, consequently, on their school performance and academic achievement. The relevant literature indicated that the social class origins of these learners might also have impacted on their 'orientation to meaning' in learning science, described as the selection and organization of meaning, of what is seen as relevant and taken as the focus of attention in any situation, and the way in which these meanings are organized in practical discourse. Thus the poor socio-economic background of isiXhosa-speaking learners seemed to have predisposed them to a restricted, as opposed to an elaborated, code orientation to meaning.

Learner motivation and work ethic: Difficulties resulting from the use of public transport and the long distances that the Grade 6 isiXhosa-speaking learners had to travel caused them to be ill-disposed to receiving tuition and to learning when they arrived at school. The literature indicates that socio-economic factors such as poverty and the unemployment of the parents have an impact on learner motivation. Learners living under conditions of poverty are subject to emotional stress, which adversely affects their learning and development. Poverty is also associated with lack of concentration and the inability of the learner to engage effectively with the curriculum or the learning process, conditions which often lead to poor academic performance, poor self-esteem, lack of self-confidence, and ultimately to poor learner motivation.

Lack of parental support: The parents of Grade 6 isiXhosa-speaking learners at Tableside Primary did not seem to meet the educators' expectations, as they did not respond to calls and failed to attend school meetings or open days to view their children's work. The parents, on the other hand, attributed their alleged failures and poor communication with the school to logistical problems relating to the timing of the meetings, lack of transport, and their unusual working hours. It is argued in this study that the apparent lack of parental support at the school could also be due to lack of recognition of their role in the teaching and learning process, as the literature suggests (Department of Education, 1997b; Engelbrecht, 2007; McKenzie & Loebenstein, 2007; Prinsloo, 2005). Parents should, therefore, be recognized and empowered as primary caregivers, their participation facilitated and encouraged in the interest of effective learning and teaching.

6.5 HOW LEARNERS AND EDUCATORS COPED WITH THE CHALLENGES

This part of the study examines and discusses the coping strategies used by both the learners and the educators to address the learning difficulties experienced by the Grade 6 isiXhosa-speaking learners. The discussion includes the role of the teacher, code switching, and learner support interventions.

6.5.1 Role of the teacher

Most Grade 6 isiXhosa-speaking learners in this study *depended on the teacher* to address their learning difficulties in Natural science. In response to the question, *What do you do to deal or cope with these (learning) difficulties?* the common thread that ran through their answers was that they would ask the teacher, although some mentioned coping strategies like consulting the dictionary or asking another learner. Significantly, only three of the twenty-six isiXhosa-speaking learners who were interviewed mentioned that they consulted the internet.

The learners' *overdependence on the science teacher* may be due to their trust in their teachers or it may be a manifestation of their own poor language skills. Ogunniyi (1988: 6) notes that "pupils' knowledge and image of the world are, to a large extent, determined by the recognition of what their teachers imply to be valid; and this, of course, may have little to do with reality in the sense that it reflects a scientifically accurate picture." However, this dependence needs to be managed through mediation and scaffolding (Cleghorn, 2005; Davey, 1996; Kozulin, 1998; Vygotsky, 1962). While asking questions and going to the teacher can be very positive responses as they constitute a learning relationship between isiXhosa-speaking learners and their Natural Science teachers, the learners could also make extensive use of resources like the Internet, the library and significant others in their eco-systemic environment (Bronfenbrenner, 1979; Donald et al., 2010; Johnson & Green, 2007; Swart & Pettipher, 2006).

Studies by various researchers have attributed the overdependence of African learners on the teacher to poor reading skills and poor language development (Langhan, 1990; MacDonald, 1990a; MacDonald, 1990b; Taylor & Vinjevold, 1999). The teacher, therefore, is faced with the task of changing this situation by focusing primarily on developing the language skills (i.e. in reading, writing and comprehension, as well as scientific literacy) of these learners to make them more self-reliant (Holmarsdottir, 2006; Ogunniyi, 2005; Roy-Cambell, 2001; Taylor & Vinjevold, 1999).

6.5.2 Code switching

To cope with the language barrier, most of the learners in this study stated that they used informal code switching as a coping strategy, in talking among themselves, or explaining to each other, or during group discussions. This was despite the fact that they were not allowed to code switch into isiXhosa in class. This subtractive bilingualism policy used at the school was not very helpful (Desai, 2012; Heugh, 1995). The educators could not use the strategy of code switching, as they could not speak isiXhosa. This limited their learner scaffolding opportunities (Brunner, 1964; Cleghorn, 2005; Davey, 1996; Kozulin, 1998; Pea, 2004; Vygotsky, 1962). Instead, they used the peer support strategy by asking the isiXhosa-speaking learners to explain to one another in their home language whenever there was a communication problem.

Kim and Wai (2007) note that one of the key factors in helping Limited English Proficiency (LEP) learners achieve better progress in learning science is making content accessible by lowering the language barrier. In this regard, teachers need to move beyond leaving the language to take care of itself. In such a multilingual setting as found in Tableside Primary, without the use code switching strategy, educators might be constrained to give superficial explanations of (scientific) terms and concepts, resulting from their inability to fully clarify or explain the concepts to their learners by using English only as a means of communication (Holmarsdottir, 2006; O-saki, 2005). Hence the claim by Grade 6 isiXhosa-speaking learners during the interviews, that there was a lack of 'proper' explanation by the teacher in their science lessons.

In her study on the implementation of the new Language-in- Education Policy (LiEP) at three (African) township schools in the Western Cape, Holmarsdottir (2009) found that the use of the strategy of code switching by the educators served a variety of functions, namely:

1. Provides access: Concepts are clarified in order to make lessons more accessible to learners;
2. Classroom management: Task instruction is clarified so that learners will understand what is expected;
3. Elicits student response: Used to encourage pupil participation and response; and

4. Interpersonal communication: Individual learners' attention is sought, and the focus is also on individual assistance.

The difference between Holmarsdottir's study and the ex-Model C setting, where this study was conducted, is that in the former, all the classes observed were composed of homogeneous groups of isiXhosa-speaking learners, as opposed to the heterogeneous and multilingual groups of learners in the classes of the latter. The point, however, in the latter case, is that, because the educators were unable to speak isiXhosa and could not use the code switching coping strategy, there was a strong possibility that they fell short of capitalizing on the above-stated functions of the strategy of code switching.

O-saki (2005: 42) distinguishes between "medium of instruction" and "medium of interaction," with the former being mandated and centrally enforced, while the latter is negotiated "to include languages in which most members are sufficiently proficient and can use comfortably." Code switching falls in the latter category and has been found to be a pragmatic coping strategy used by educators in situations where learners have limited proficiency in the official language of instruction (Holmarsdottir, 2006; O-saki, 2005). Educators who know the learners' mother_tongue make considerable use of the strategy.

6.5.3 Learner support interventions

In this study, learner support programmes including after-school extra English support classes such as *Help-to-Read* and *Read Right*, were organized for the learners in order to improve their reading and writing ability in the English language.

To address isiXhosa-speaking learners' difficulties in answering interpretive, discussion and essay questions (in Natural Science), the educators indicated that they gave remedial activities, e.g. more contextual questions, as opposed to interpretative questions, and built up and also exercised patience and applied one-on-one teaching, if the learners did not understand. Thomas (2004: 24) notes that the classroom practices and activities have to be planned in such a way as to provide "sufficient opportunities for students to learn and to show their understanding through tasks that are specifically designed to reveal student understanding (as opposed to simply revealing the procedural aspects of task completion)."

Thomas (2004: 398) further states that:

> If teachers are to understand and capture the progression of learners through the curriculum, then it is important that their judgement of learner competencies (where they are now) is tutored by their understanding of where they were before, and that this in turn informs their judgement of where they are likely to get to with encouragement, support and teaching.

In other words, the educators need to know the learners' Zone(s) of Proximal Development (ZPDs) in order to provide them with the relevant and effective scaffolding (Brunner, 1964; Cleghorn, 2005; Davey, 1996; Kuzolin, 1998; Pea, 2004; Vygotsky, 1962). Indeed, Johnson (1998: 400) points out that "the primary purpose of the profiles of learning framework was to gather formative data about learners' achievements in literacy."

To improve the work ethic of isiXhosa-speaking learners, the educators stated that they gave projects to the learners two to three weeks beforehand, and allowed them to do their projects in class or during school intervals.

In summary, in discussing how the learners and the educators coped with the challenges, the following issues were highlighted:

Role of the teacher: Given the overdependence of the Grade 6 isiXhosa-speaking learners on their science teacher, as found in the study, the teacher is faced with the task of turning this situation around. Various research studies have attributed the overdependence of African learners on their teachers to poor reading skills and poor language development (Langhan, 1990; MacDonald, 1990a; MacDonald, 1990b; Taylor & Vinjevold, 1999). It is, therefore, critical for the science teachers, in collaboration with their English-teaching colleagues, to develop the language skills (including scientific literacy) of these learners.

Code switching: Although the school followed a subtractive bilingualism policy, the code switching coping strategy was used informally by the learners. The educators also opportunistically used the strategy indirectly, by asking isiXhosa-speaking learners to explain to one another in their home language whenever a communication difficulty arose between an educator and one of the learners. The subtractive bilingualism policy (Desai, 2012) followed at the school was not helpful to the Grade 6 isiXhosa-speaking learners. Research studies suggest that the strategy of code switching is useful in giving learners with limited English proficiency access to the curriculum, facilitating communication and interaction (not only among the learners, but between the learners and their teachers), and effective classroom management (Holmarsdottir, 2006; Kim & Wai, 2007; O-saki, 2005). If used effectively, code switching can help to develop the learners' CALP skills. Code switching, however, is not the only way to make science learning more comprehensible. The educators could explore othe ways such as simple and slow instruction, the use of visual cues, and work toward providing comprehensible input for their learners, in line with Krashen's input hypothesis.

6.6 WHAT CAN BE DONE TO SUPPORT LEARNERS AND EDUCATORS

In the course of the research certain proposals and suggestions were made by the participants, about what could be done to address particular difficulties in the teaching and learning process, especially those relating to the support of Grade 6 isiXhosa-speaking learners. These include, and will be discussed under, learner support interventions, teacher training and support, and parent involvement.

Learner support interventions

In this study, the educators indicated that they conducted after-school classes to provide language development support in order to improve the Grade 6 isiXhosa-speaking learners' reading and writing ability in English. They also indicated that they gave remedial activities to address isiXhosa-speaking learners' difficulties in answering interpretive, discussion and essay questions in Natural Science. The literature suggests, firstly, that it is important that educators have a clear understanding or judgement of their learners' competencies, which is informed by where the learners are now and where they want to take them, through encouragement, support and teaching (Johnson, 1998; Thomas, 2004). Secondly, learner support interventions should provide opportunities for learners through tasks that are designed to reveal their understanding, as opposed to tasks which simply reveal the procedural aspects of task completion (Thomas, 2004).

Johnson & Green (2007: 160) prefer the concept of 'education support' rather than 'learning support', as the former has wider connotations and ramifications in terms of focusing the support not only on the learner but on the whole contextual system of which the learner is part (i.e. supporting the learner-in-context). The emphasis in this approach is on facilitating collaborative problem-solving by involving all stakeholders. This is in line with the eco-systemic model (Bronfenbrenner, 1979). The view held in this study is that the two concepts are not mutually exclusive but are both necessary, depending on the nature and level of the learning difficulty experienced by the learner. While it may be necessary to give learning support to individual learners in order to address specific learning difficulties, education support may be necessary as a back-up and to sustain such support, as well as to prevent difficulties from arising.

Teacher training and support

One of the difficulties mentioned by the Grade 6 Natural Science educators in this study was that of teaching multicultural or multilingual classes. It is argued that the development of negative attitudes and the ill-preparedness of many educators to embrace inclusion in South African schools is worsened by the "lack of strategies for teacher support," and that "systematic training and intensive preparation" would improve their attitudes to inclusion (Nel et al., 2011: 77; Oswald, 2007; Sofile & Green, 2007) . The educators in this study also stated that they had difficulties in dealing with *multilingual classes*. For example, they had to contend with French-speaking learners (refugee learners from the Congo and other African states) and isiXhosa-speaking learners. Clearly, a holistic and integrated approach to the provision of educational support services is required, as was suggested in Chapter 2 of this study (Department of Education, 2001; du Toit, 1996).

Teachers are the primary agents in education (NEPI, 1992b), and by extension the key agents of change in education (Oswald, 2007). It is critical, therefore, that teachers be provided with all the necessary skills and support. In the Tableside Primary context this would include, firstly, in-service training, particularly on addressing the diverse needs of learners in the inclusive education context of democratic South Africa (such as teaching multicultural/multilingual classes). Such training should, of course, also include the integration of the learners' traditional or alternative world-views and indigenous knowledge systems (IKS) (Breidlid, 2004). Secondly, the support should include the provision of appropriate learning and teaching materials. The NEPI (1992b) views these as some of *the minimum basic pre-conditions for competent teaching practice* (my emphasis). The NEPI (1992b: 1) notes that, "At the very least, such pre-conditions include an adequate number of classrooms, adequately equipped; an adequate supply of teaching materials; and manageable class sizes."

On improving the quality of teachers, the NEPI (1992b: 67) adds that:

> Ideally, a quality teaching corps would consist of competent, confident, resilient, and reflective practitioners, capable of revitilizing schools and responding to the changing demands of practice. This requires, at the very least, sound subject knowledge, fluency in the medium of instruction, a range of pedagogical and classroom

> management skills, and an appreciation of the central role of enquiry in both teaching and learning. Recent research on teaching suggests that pedagogical content knowledge is a primary factor in improving quality. However, attempts to improve quality cannot ignore quantitative concerns. The development of a quality teaching corps presupposes an adequate supply of teachers, appropriately qualified for a full range of levels and curriculum specializations. It also presupposes an adequate supply of properly equipped classrooms and systematic school support services.

School funding and support

The Education Department needs to revisit and research its Quintile System for School Funding on a regular basis, to see if it still serves the interests of the learners as originally intended. The demographic changes which followed the democratization of the country in 1994 changed the face of many ex-Model C schools. For example, in many of these schools the majority of the learners are now black (i.e. African, Coloured or Indian). This implies that the parents who must provide funding are no longer affluent, as was the case with Model C schools during apartheid. The funding formula used to subsidize such schools therefore needs to be revised to take this demographic change into consideration.

Parent involvement

Parental involvement has a positive impact on the success of children at school (Department of Education, 1996b; McKenzie & Loebenstein, 2007). However, the historical separation of the school from the community and the parents of learners has led to a transfer of responsibility for the education of the learner from the home to teachers (McKenzie & Loebenstein, 2007). In the context of inclusive education in a democratic South Africa, parents play an important role as change agents in the transformation of education (McKenzie & Loebenstein, 2007). Forming collaborative partnerships between the parents and educators is, therefore, essential for the movement towards the new inclusive educational setting (Department of Education, 1997b; Department of Education, 2001; Engelbrecht, 2007; McKenzie & Loebenstein, 2007). McKenzie and Loebenstein (2007: 186) note that this is indeed a new challenge for most parents, "one which does not reflect their own experience of schooling and to which they now need to be encouraged to adjust."

The Constitution of the Republic of South Africa and the South African Schools Act give recognition to the right of parents to be involved in the education of their children (McKenzie & Loebenstein, 2007; Republic of South Africa, 1996a; Republic of South Africa, 1996b). Citing Singh, Mbokodi and Msila (2004), McKenzie and Loebenstein (2007: 187) define parental involvement as "a range of activities that take place between the home and the school" involving the following features:

- Parents' insight into their children's progress;
- Parents' participation in decision making; and
- Parents being critical of information on education issues.

The above features of parental involvement are critical to effective learning and teaching at school. In order to facilitate the parents' involvement at Tableside Primary, their role as primary caregivers should be emphasized. Their participation should be encouraged, empowered and supported through training, as mentioned in paragraph 6.4.3 above.

6.7 CONCLUSION

The conclusion to this study must be viewed in the wider context of science education in South Africa as in crisis on two fronts. Firstly, the crisis marked by the findings of the TIMMS (2004) and PIRLS (2006) reports on science, mathematics, and reading literacy which revealed that South African learners do not meet international standards of performance at the fourth and eighth grade in the fields of Mathematics, Science and Literacy (Martin et al., 2004; Mullis et al., 2007; Taylor & Vinjevold, 1999; van Staden & Howie, 2008; Villanueva, 2010). The second crisis relates to the educational disadvantage placed on Grade 6 isiXhosa-speaking and other English second-language speaking learners in learning science, both in the South African context and globally, due to the English LOLT, which is highlighted in this study (Le Grange, 2007; Nomlomo, 2007; Probyn, 2005).

On the basis of the key themes that emerged from the data analysis and research findings in Chapter 5, this chapter discussed the findings in the context of barriers to learning, taking into account the views expressed in the relevant literature and the theoretical framework. First, *language as a barrier to learning* was examined, focusing in particular on the language of learning and teaching (LOLT) and the Language of Science. The conclusion made was that in this study language was found to be a major barrier to the learning of Natural Science by Grade 6 isiXhosa-speaking learners. This barrier to the learning of science manifested itself mainly at two levels, namely the *language of instruction* (LOLT) and the special language used in the learning and teaching of science (i.e., the *Language of Science*).

The position held in this study is that, until isiXhosa-speaking learners are sufficiently proficient in both the language of instruction and the Language of Science, they are unlikely to succeed in constructing their own understanding of scientific knowledge, which is fundamental to learning science (Abriam-Yago et al., 1999; Baker, 1993; Cummins & Swain, 1986). Efforts should therefore be made to develop their scientific literacy. This can be done by, among others, applying a more additive bilingual approach to the use of the LOLT in Natural Science. It is also argued in this study that it would be prudent for Grade 6 Natural Science educators to use programmes such as Johnson's '*Profiles of Learning*' framework to assess their learners' levels of literacy, using the information obtained for a more effective strategy in the learning and teaching of Natural Science in their classes. The framework should be used as a 'growth model' that provides an indication of the learners' current and probable future levels of performance (Johnson, 1998: 398).

The subtractive bilingualism policy (Department of Education, 1997a; Desai, 2012; Donald et al., 2010) practiced at the school was not helpful, nor was it successful, as the learners practised code switching informally. The educators also opportunistically used positive bilingualism when it was convenient for them, by asking the learners to explain to each other in their own language when there was a communication problem preventing one of the isiXhosa-speaking learners from following instructions.

The learning difficulties experienced by Grade 6 isiXhosa-speaking learners in Natural Science were aggravated by the fact that they had to cross linguistic, cultural, and cognitive barriers (borders) from their traditional home background in order to access scientific knowledge (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunniyi, 1986; Ogunniyi, 2005; Po, 2006; Sutherland, 2005). It is imperative, therefore, for educators to seek to integrate the learners' home background knowledge into their curriculum delivery. In this regard the additive bilingualism approach to LOLT, where both English and isiXhosa are used to complement one another in promoting deeper understanding of science by Grade 6 isiXhosa-speaking learners, is favoured in this study.

The chapter then looked at *curriculum delivery factors* which appear to have contributed to the learning difficulties. This involved focusing on the educators' teaching styles, learner assessment techniques, and the limiting school environment. The school environment included inadequate learning support, overcrowded classrooms, multilingual classes, and inadequate resources. The conclusion drawn from this exercise was that there is a need for teacher development and support that will encourage teachers to follow learner-centred classroom practices that take the learners' socio-economic backgrounds, including the IKS background, into consideration (Donald et al., 2010; Taylor & Vinjevold, 1999). Secondly, a holistic integrated approach to providing learning support to schools is required (du Toit, 1996). This calls for a collaborative effort between all stakeholders. It is argued in this study that the Education Department needs to take full responsibility for the implementation of policy programmes for educational transformation, such as the Language-in-Education Policy (Department of Education, 1997a; Department of Education, 2012), to ensure quality education for all learners, and not leave this mammoth task to the schools. Barriers to learning can arise from the lack of an enabling and protective legislation and policy governing the education system (Department of Education, 1997b). In this regard the NCSNET/NCESS Report (Department of Education, 1997b: 18) notes that:

> Where such legislation or policy fails to protect learners from discrimination or perpetuates particular inequalities, it directly contributes to the existence or maintenance of such barriers ... Similarly, legislation which fails to protect learners from discrimination and fails to provide for minimum standards which accommodate diversity allows for individual practices which may inhibit learner development or lead to provision which is inadequate and inappropriate for the needs which exist.

Green and Engelbrecht (2007: 5) also note that:

> Any education system that claims to respect human rights must inevitably be inclusive in principle. If it is, it must recognise the rights to quality education not only of those with disabilities, but also of the many learners who currently do not benefit in any meaningful way from the education they receive.

Regarding the debate for home language versus second language instruction in science, it is argued in this study that the final arbiter should be the parents. This study was based on the assumption that the parents of the isiXhosa-speaking learners at Tableside Primary took a conscious decision for their children to be taught science through the English medium of instruction. It was for that reason that this study was undertaken, to establish the nature of the difficulties experienced by these learners with a view to suggesting possible ways in which both the learners and their science educators could be supported.

As a next step, factors in the *social environment* which appeared to have contributed to, or aggravated the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science were examined. These factors included the socio-economic background of the learners, learner motivation and work ethic, and lack of parental support. The position taken in this study is that these difficulties can only be addressed by the educators in close collaboration with the parents. It is critical, therefore, that parents be recognized and empowered as primary caregivers, and their participation facilitated and encouraged as much as possible (Department of Education, 1997b).

Finally, the study looked at how the Grade 6 isiXhosa-speaking learners and their science educators *coped with the challenges* they were confronted with at this level. The coping strategies used by the learners included overdependence on their science teachers and informal code switching in the classroom. Various research studies have attributed the overdependence of African learners on their teachers to poor reading skills and poor language development (Langhan, 1990; MacDonald, 1990a; MacDonald, 1990b; Taylor & Vinjevold, 1999).

The coping strategies used by the science educators included exploiting peer support by asking isiXhosa-speaking learners to explain to each other in their home language (indirect informal code switching). Research studies have found code switching to be a pragmatic coping strategy used by educators in situations where learners have limited proficiency in the official language of instruction (Holmarsdottir, 2006; Kim & Wai, 2007; O-saki, 2005). Educators who know the learners' mother_tongue are at an advantage and make considerable use of this strategy. The conclusion made in this study is that educators need to be trained on how to teach multilingual and multicultural classes in order to make the curriculum accessible to all their learners.

In answering the study's research questions: the overarching question to this study was, What are the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning Natural Science through the medium of English? Responding to this question, the findings of this study will now be summarized under the following sub-headings, based on the study's research questions:

1. *What difficulties did the Grade 6 isiXhosa-speaking learners experience in learning Natural Science through English?*
2. *What role did the language of learning and teaching (LOLT) play in the context of the difficulties?*
3. *How did the teaching and learning context contribute to the difficulties?*
4. *How did the learners and the educators cope with the challenges?*

5. *What can be done to support both learners and educators in overcoming the difficulties?*

What difficulties did the Grade 6 isiXhosa-speaking learners experience in learning Natural Science through the medium of English?

The isiXhosa-speaking learners experienced the following difficulties in learning science at Tableside Primary:

Language: The learners experienced difficulties with both the English LOLT and the Language of Science. Their language difficulties were aggravated by the subtractive bilingualism policy followed by the school.

School environment: Factors within the teaching and learning environment were found to contribute to the learning difficulties experienced by isiXhosa-speaking learners in learning science. These factors included inflexibility in the curriculum, (inadequate) teaching methods or strategies used by the educators, inadequate resources, inadequate learning support, and overcrowded classes.

Social factors: Social factors were also found to contribute to the difficulties experienced by isiXhosa-speaking learners in learning science. These factors included the (poor) socio-economic background of the learners, late coming and early departure from school due to problems associated with using public transport, poor learner motivation and work ethic, and lack of parental support.

The above-mentioned difficulties will be discussed in more detail in the paragraphs below.

What role did language play in the context of the difficulties?

In this study, language acted as a barrier to learning in the following ways:

English as language of learning and teaching (LOLT): IsiXhosa-speaking learners manifested difficulty in accessing knowledge, difficulty in following instructions, and difficulty in answering questions involving description, interpretation and discussion.

The Language of Science: IsiXhosa-speaking learners showed difficulty in comprehending scientific terms and concepts, difficulty with conceptualizing scientific knowledge, and a lower level in the abstraction of scientific knowledge.

Language as a barrier to learning has been identified and debated by many writers (Alexander, 1990; Department of Education, 1997b). In this study, language was found to be the key barrier to the learning of science by isiXhosa-speaking learners in Grade 6. They experienced difficulties with both the language of instruction (LOLT) and the Language of Science. This prevented them from accessing and engaging with scientific knowledge, and ultimately from constructing their own scientific knowledge. Understanding both the language of instruction and the language of science is fundamental to *scientific literacy*, which entails being able to read, interpret, and write about science and scientific phenomena (Johnson, 1998; Langenhoven, 2006; Nomlomo, 2007). Scientific literacy, in turn, facilitates the learner's scientific knowledge construction. Experiencing difficulties with language meant that the Grade 6 isiXhosa-speaking learners were rendered ineffective in their own scientific knowledge construction.

The language difficulties of the Grade 6 isiXhosa-speaking learners were exacerbated by the fact that they came from a different cultural background. As science is associated with western culture, this meant that isiXhosa-speaking learners had to cross linguistic, cultural, and cognitive barriers (borders) from their indigenous cultural background in order to access scientific knowledge (Aikenhead & Jegede, 1999; Fakudze, 2004; Ogunniyi, 1986; Ogunniyi, 2005; Po, 2006; Sutherland, 2005). Failure to integrate knowledge from their traditional social background aggravated their difficulty in learning science.

How did the teaching and learning context contribute to the difficulties?

It was found that certain factors within the teaching and learning situation impacted negatively on the leaning of science by isiXhosa-speaking learners. These were manifested in the educators' teaching methods, including the lack of integration of the learners' traditional or social background knowledge (IKS) in lessons, learning activities/projects or assessment, and their inability to use the code switching strategy (both learners and educators acknowledged that the inability of the educators to use the strategy was a disadvantage to both parties). Potentially a very powerful weapon for dealing with language barriers to learning, it was used only by the learners and only on an informal basis (Kim & Wai, 2007). Further factors were the educators' inadequate learner assessment methods or techniques, and the limiting school environment.

The functioning of educators ultimately depends on the (school) environment in which they are working, and institutional development is thus an extremely important component of capacity building (Department of Education, 1997b; Johnson, 1995). It is very important that a conducive learning environment is created. The difficulties at Tableside Primary stemmed from a school environment characterized by multilingual classes, inadequate resources, and inadequate learning support. The training of educators is therefore regarded as an important part of removing barriers to learning and creating a more conducive learning environment (Nel et al., 2011).

Educational issues are part of broader social and economic agendas or factors, such as income, employment, health, housing, crime in the living environment, and transport, and should not be divorced from them (Hughes, 2010). A poor socio-economic background, which is associated with poverty, has a negative effect on learning (including learning science) (Department of Education, 1997b; Donald et al., 2010; Du Toit, 1996; Prah, 2003; Stofile, 2008; Swart & Pettipher, 2006).

As many of the Grade 6 learners in this study came from townships or informal settlements, it is likely that poverty played a role in their poor academic performance, including science. This was manifested in their transport problems, resulting in late coming, poor academic work ethic, a general lack of motivation, and lack of parental support.

How did the learners and the educators cope with the challenges?

The coping strategies used by the learners included overdependence on their teachers and informal code switching among themselves. The strategies used by the educators, on the other hand, included using peer support, holding after-school LOLT development classes and programmes for the learners, giving remedial activities, setting projects two to three weeks before they were due, and monitoring the science projects.

What can be done to support both learners and educators in overcoming the difficulties?

Drawing on the findings of the study, Chapter 7 makes recommendations and suggestions about what could be done to support both learners and educators. These can be categorized into what could be done at classroom level, at school level, and at departmental level (i.e. at district, provincial or national levels).

The next chapter gives the summary and recommendations of the study, the significance of the findings, the limitations of the study, suggestions for further research, and the conclusion.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

7.1 INTRODUCTION

Based on the findings of the research, as well as the literature and theoretical framework on learning science (in the primary school), this chapter makes recommendations as to what could be done to assist both the learners and educators to overcome the barriers to the learning of Natural Science by Grade 6 isiXhosa-speaking learners. Further recommendations are made with regard to future research which could address related issues and contribute to the building of knowledge about the difficulties experienced by isiXhosa-speaking learners in learning Natural Science through the medium of English as LOLT.

In this study, it was argued that the opening up of all the schools following the demise of apartheid education did not constitute equality in itself or guarantee equal access to education. Consequently, the call for 'education for social justice' should be the focus of our future endeavours to 'level the playing fields', particularly with regard to the language of instruction, in order to give both historically and currently disadvantaged learners an equal opportunity to access the curriculum and achieve academically in our schools (Griffiths, 1998: 90). Griffiths (1998: 89) describes social justice as "a movement towards a fairer, less oppressive society ... the opening up, from the few to the many, chances of personal fulfilment and the rewards, prizes and enjoyments of living in a society; this is a kind of distributive justice. Education is central to it." If 'education for social justice' (Griffiths, 1998) should be achieved in the new South Africa, it will go a long way towards addressing the broader issues of (economic) equal opportunity in South African society. Resolving the difficulties experienced by learners who learn science through a second language (including isiXhosa-speaking learners) could be the starting point or launching pad for a commitment to the drive for such 'education for social justice' in South Africa.

In this study, it is argued that the burden of 'education for social justice' cannot be left to the discretion of the schools. Until such time as a concerted effort is made both to supervise closely and to support schools in implementing language of instruction (LOLT) improvement in the classroom, the disparity in academic performance along racial lines will continue, and many second-language learners will never reach the 'promised-land' (Dr. Martin Luther King). One should also bear in mind the contradiction between the demand for creative innovation and the need to keep abreast of curriculum demands (i.e. covering the syllabus) on the part of educators and schools. Mant et al. (2007: 1708) aptly highlight the pressure and contradictory demands placed on schools, with "schools being judged on outcome, measured by national test scores, and at the same time being strongly encouraged to take a more creative and imaginative approach to teaching and learning."

7.2 SUMMARY

Chapter 6 discussed the findings of this research under the following themes: Language as a key barrier to learning; the teaching and learning context; social factors as barriers to learning; how learners and educators coped with the challenges; and answering the research questions. To put the study's recommendations into perspective, the discussion on the above themes is summarized.

Language as a key barrier to learning: Under this theme, the study examined how both the language of learning and teaching (LOLT) and the Language of Science acted as barriers to the learning of Natural Science by Grade 6 isiXhosa-speaking learners. This happened both during the class teaching and learning activities and during learner assessment. Reference was made to the literature relating to barriers to learning, as well as to the theoretical framework of the study.

The teaching and learning context: This theme focused on how factors within the teaching and learning environment contributed to the difficulties experienced by the Grade 6 isiXhosa-speaking learners. These factors included teaching methods, learner assessment techniques, and the school environment (the latter including educator attitudes, learners' psycho-emotional challenges, learning support, insufficient school funding, inadequate resources, and inadequate use of resources). Reference was made to the literature and theory relating to learner scaffolding and eco-systems, underlining how these assist the learning process.

Social factors as barriers to learning: This theme examined factors in the social environment which appeared to have contributed to, or aggravated, the difficulties experienced by Grade 6 isiXhosa- speaking learners in learning science. These factors included the socio-economic background of the learners; their motivation and work ethic, and the lack of parental support. Again, reference was made to the literature and eco-systemic theory pertaining to how the web of relationships between the learner and his or her ecological environment affected or influenced the learning of science.

How learners and educators coped with the challenges: This theme examined and discussed the coping strategies employed by the learners and the educators in addressing the learning difficulties experienced by the Grade 6 isiXhosa-speaking learners. This involved the role of the teacher, code switching, and learner support interventions. Reference was made to the literature and theories relating to the overdependence of African learners on their teachers (Langhan, 1990; MacDonald, 1990a; MacDonald, 1990b; Taylor & Vinjevold, 1999). The educators' task of changing this situation primarily by focusing on developing the language skills (i.e. reading, writing and comprehension, as well as scientific literacy) of the Grade 6 isiXhosa- speaking learners to make them more self-reliant, was highlighted (Holmarsdottir, 2006; Ogunniyi, 2005; Roy-Cambell, 2001; Taylor & Vinjevold, 1999).

Answering the research questions: This theme was a review of the evidence and findings of the study in relation to its five research questions. In summary, the responses were:

What difficulties did the Grade 6 isiXhosa-speaking learners experience in learning Natural Science? The study revealed that the isiXhosa-speaking learners experienced difficulties arising from their inadequate language development, with factors within the learning and teaching environment, and with social factors emanating from their poor socio-economic home backgrounds.

What role did the language of learning and teaching (LOLT) play in the context of the difficulties? The evidence suggests that most isiXhosa-speaking learners had difficulties with English, both as the language of learning and teaching (LOLT) and as the Language of Science. This was exacerbated by the school's subtractive language policy.

How did the teaching and learning context contribute to the difficulties? The study revealed that the educators' teaching methods, including the lack of integration of the learners' traditional or social backgrounds, had a negative impact on their learning of science.

How did the learners and the educators cope with the challenges? The coping strategies used by the learners included dependence on the teacher, using peer support and informal code switching among themselves, while the educators used strategies such as holding after-school classes, using learner peer support, giving remedial activities, and running special language development programmes for the learners.

What could be done to support both learners and educators in overcoming the difficulties? In paragraph 7.3 of this chapter, recommendations are made, based on the findings of the study. These can be categorized into what could be done at classroom, school, and departmental levels.

7.3 RECOMMENDATIONS

In this study, it was acknowledged that learners learn best in their home language (Alexander, 1990; Brock-Utne, 2000; Heugh, 2002; Nomlomo, 2007). However, on the basis of the findings at Tableside Primary, where the learners and their parents chose English as the language of learning and teaching (LOLT), the following recommendations were made.

- The school should introduce a more flexible multilingual education policy to enable additive bilingualism to be practised (without hindrance), both by the learners and the educators when the need arises.

- The additive bilingualism approach should ultimately lead to the gradual and early introduction of isiXhosa as a Learning Area at the school as soon as possible, culminating in the use of isiXhosa as the alternative LOLT in Grade 6 Natural Science.

- Educators should use more peer support for the learners. This strategy seems to work for the educators, when they themselves cannot practice code switching and therefore cannot reach the isiXhosa-speaking learners. Also, by the educators' own admission, learners sometimes learn better from each other.

- District offices should organize workshops on how to face the challenges of teaching Natural Science to multilingual classes.

- Educators should, as far as possible, draw up an individualized *Learner Support Plan*, based on each learner's performance or achievement in assessments, or a *Group Support Plan* (for those experiencing the same or similar learning difficulties or barriers).

- Stimulating interest in science is essential and fundamental to helping the learners to understand what science is, its usefulness in their daily lives, and why it should be learned or studied.

- Educators should consider looking at their own teaching styles (and the learners' learning styles) as well as at alternative methods of assessing the learners. In some instances, the creativity of the teacher "gets blunted by the demand for more formal, traditional teaching that is geared towards good examination performance" (Gray, 1999: 265).

- Educators should adapt their lessons and methods of assessment to the learners' learning styles.

- Educators should consider 'different and creative ways' of assessing learners for whom English is not their home language. Green and Engelbrecht (2007:7) note that "Academic inclusion may sometimes involve a modified curriculum but wherever possible it should involve the same curriculum, presented and assessed in different and creative ways."

- As regards administering assessment material, in order to determine whether a learner has mastered the different learning areas certain accommodations should be made to the assessment procedures and material, namely the format, content and language (Dednam, in Landsberg et al., 2005: 376).

- Educators should also keep Bloom's Taxonomy of Educational Objectives in mind when giving tasks, projects and doing assessment, in order to ensure that these meet their learners' needs for age-appropriate levels of complexity and promote meaningful learning, as opposed to a simple recall or recognition of factual knowledge (Anderson & Krathwohl, 2001; Bloom, 1956; O-saki, 2005; Po, 2006).

- Grade 6 Natural Science Educators at this school should continue with the coping strategies (e.g. the extra English classes) that they are currently using to support learners, and in addition should compile a list or glossary of key *words/concepts/terms that matter* in Natural Science and ensure that the learners understand their meaning in each lesson. The critical question is, how can both learners and educators best be supported? In particular, given that the language of instruction (i.e. English LOLT) seemed to be the biggest barrier facing the Grade 6 isiXhosa-speaking learners, what is the best second language acquisition strategy that the educators could use to support these learners?

- More intensive integration of English and Natural Science learning programmes and activities is recommended.

- Educators are advised to devise a strategy to support learners who enter the school after what they consider to be *the critical level of entry* at the school (i.e. after Grade 4). It is suggested that such learners be subjected to a condensed and intensified Grade 4 programme or 'bridging course', including all the key elements essential to a foundation in Grade 6 Natural Science.

- With regard to reading, educators could concentrate or focus on "comprehension strategies instruction" (Norris & Phillips, 2003: 227) to develop the learners' interpretive skills as well as their scientific literacy (Norris & Phillips, 2003; Villanueva, 2010).

- In collaboration with the parents, the educators should find ways to minimize the 'time lost' by isiXhosa-speaking learners due to logistical and related transport problems.

- It is important that the school hold regular workshops for parents, to update them on the latest changes in the curriculum.

- Educators could facilitate the establishment of (Grade 6) learner support groups in LOLT and Natural Science in the areas where the isiXhosa-speaking learners live. These groups could include interested parents and could also be extended to other non-LOLT speaking learners in their areas of residence.

- There did not seem to be any clear *Bilingual Education Policy practical or implementation guideline* (for Grade 6), (Nomlomo, 2007) at the time of research. If that be the case, it would constitute a serious breach in the provision of quality "education for all" the learners in our country (Chinapah, 2000; Department of Education, 1997a; Department of Education, 1997b; Windham, 1992). It would then be strongly recommend that such an implementation guideline be developed as soon as possible.

- The apparent lack of support from parents at the school may also be due to a lack of recognition of their role in the teaching and learning process. Parents should, therefore, be recognized and empowered as primary caregivers, and their participation facilitated and encouraged in the interest of effective learning and teaching.

- The Education Department should to revisit and research its Quintile System for School Funding on a regular basis, to ensure that it serves the interests of the learners as intended.

7.4 SIGNIFICANCE OF THE STUDY'S FINDINGS

This research study has highlighted some of the difficulties experienced by Grade 6 isiXhosa-speaking learners in learning science through the medium of English at an ex-Model C school in the Western Cape. In so doing, it has pointed out the potential shortcomings in the provisions of, and practical implementation of, the Language-in-Education Policy (Department of Education, 1997b). It is therefore hoped that the findings of this study will stimulate debate and act as a springboard for further research on the difficulties experienced by isiXhosa-speaking learners (and other second language learners) in learning science through the English medium of instruction (in all schools in the Western Cape), in the context of the provision of quality education for all learners (Constitution of the Republic of South Africa, 1996; Department of Education, 1997a; Department of Education, 1997b; Department of Education, 2001). Finally, it is envisaged that this study will stimulate further research to verify or refute its findings.

The findings will be shared with the participants at the school where the study was conducted. It is hoped that they will heighten the awareness of the educators and of the other participants concerned of the difficulties experienced by isiXhosa-speaking learners in learning science through English as the medium of instruction. It is also anticipated that knowledge of these difficulties, as revealed in this research, will inform both teaching practice and the further training of the educators, particularly in dealing with multilingual and/or multicultural classes. Furthermore, it is envisaged that the study will bring a renewed focus on Language-in-Education Policy implementation issues at school, district and departmental levels, as part of the bigger picture of addressing barriers to learning.

7.5 LIMITATIONS OF THE STUDY

The scope of this study relates to the difficulties experienced by Grade 6 isiXhosa-speaking learners at one ex-Model C primary school in the Western Cape. Its findings are, therefore, limited and cannot be extended to other schools in the district or province. Each school is unique and so are the contextual circumstances under which it operates (Johnson & Green, 2007). It is hoped, however, that the study will stimulate debate on some of the issues pertaining to the provision of quality education for all learners in South Africa (Department of Education, 1997b; Green & Engelbrecht, 2007; NEPI, 1992a; NEPI, 1992b), particularly the role played by the language of learning and teaching (LOLT) in enabling or hindering access to knowledge and skills (Aikenhead & Jegede, 1999; Alexander, 1989; Cleghorn, 2005; Desai, 2012; Holmarsdottir, 2009; Nomlomo, 2007; Ogunniyi, 1986; Prah, 2003; Sutherland, 2002; Vinjevold, 1999).

7.6 FURTHER RESEARCH

In the course of this study, a number of related areas were identified and are recommended for further research. These areas include the following:

- Based on the findings of this study and those by Kieffer (2008) and October (2002), there could be a direct relationship between the (Grade 6) isiXhosa-speaking learners' initial proficiency in English at (the "critical" Grade 4 entry level) and their performance in Natural Science. This relationship needs to be researched in depth.
- Research 'words that matter' in Grade 6 Natural Science and develop a programme to enhance their meaning, both in the 'ordinary' and 'scientific' sense.
- Conduct a longitudinal research study around the academic performance of isiXhosa-speaking learners from Grade 4 to Grade 6 (even up to Grade 12).
- Research the extent of the migration of English second-language learners into ex-Model C schools and its effect on the curriculum of these schools.

The view held in this study is that, it is not for the academics to prescribe or decide what language of instruction learners or parents must choose or use. The role of academics is to provide the (empirical) facts or point out or highlight the advantages and disadvantages of every choice, so that the learners or parents can make informed decisions.

7.7 CONCLUSION

The evidence and arguments presented in this study overwhelmingly point to the efficacy of home language instruction in teaching (including the teaching of science). It is evident from the research findings that the isiXhosa-speaking learners in Grade 6 were not sufficiently provided for (at the particular school involved in the study) to meet their *linguistic* learning needs (Brock-Utne, 2000; Obanya, 1980) in Natural Science. The LOLT was English, and the learning materials for Natural Science were all in English, which was not fully understood by the learners.

The empirical evidence presented in this study indicates, firstly, that Grade 6 isiXhosa-speaking learners experienced learning difficulties associated with both the language of learning (LOLT) and the Language of Science. This was compounded and exacerbated by socio-economic factors, such as the poor economic background of the learners, lack of parental/home support, late coming due to transport problems, tiredness and lack of interest in the lessons due to early rising, and little or no response from parents to communication by the school.

It is also clear that Grade 6 isiXhosa-speaking learners experienced major difficulties with regard to the lack of parental support. The educators were doing the best they could to support the learners through special programmes designed to develop their language (LOLT) and create opportunities for them to catch up on lost time. However, the educators themselves need support, especially with regard to developing their own bilingual or multilingual educational skills (i.e. in teaching bilingual or multilingual classes).

To address the above difficulties, both learners and educators need special support. For example, the Grade 6 isiXhosa-speaking learners at Tableside Primary needed support in developing their (English) language of learning teaching (LOLT), their Language of Science, as well as skills on *how to study*. The educators, on the other hand, needed workshops that would provide them with the skills required to deal with multilingual classes in general and specifically with supporting Grade 6 isiXhosa-speaking learners in Natural Science.

Except for generalized support for all learners (i.e. a *multilingual education policy*), there seemed to be no (subject specific) specialized programmes designed to support bilingual education (either *immersion* or *submersion* classes), especially for isiXhosa-speaking learners, in the new post-1994 diversity context of the Education Department (Department of

Education, 1997a; Department of Education, 2001). This appeared to be left to the initiative of the subject and Education Support teacher. Nor did there seem to be any *bilingual education policy practical* or *implementation guideline* for Grade 6. If that indeed be the case, the situation would constitute a serious breach in the provision of quality education for all learners in the country. Based on the research findings of this study, it would then be strongly recommend that an additive bilingualism policy be introduced and an implementation guideline be developed at the school as soon as possible.

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APPENDIX A

LETTER OF CONSENT FOR PARTICIPATION IN A RESEARCH STUDY

(Parents)

Dear parent

I am Zola, Dryfus Jonas, a Ph.D student at the University of the Western Cape. I am currently engaged in conducting a research study on *the role of language in the learning of Natural Science in Grade 6 by isiXhosa-speaking learners at one primary school in the Western Cape*. This research has two main aims, namely: (1) to investigate the difficulties experienced by these learners in learning Natural Science through the medium of English; (2) to make recommendations on how to assist both the learners and educators to address these difficulties. It is hoped that the research will benefit many schools in providing bilingual and/or multilingual instruction and dealing with diversity.

The research participants will participate voluntarily, and will be allowed to withdraw from the process at any point, without fear of intimidation or reprisals. The findings of the research will be shared with all the key participants and interest groups, if they so wish.

As the parent of ...., a Grade 6 learner at Tableside Primary school, you are hereby requested to give permission for her/his participation in this very important research. The research will take place from .... to ....

Please sign and return the attached consent form.

Yours faithfully

Z.D. Jonas.

Contact address:

EMDC South, Private Bag X2, MITCHELLS PLAIN 7785.

Tel. 370 2000; Cell. 082 353 2401; Fax. 372 1856

CONSENT FORM (Parents)

I ………………………….., being the parent of ……………………….., do/do not hereby give permission for my daughter/son to take part in the research study on *the role of language in the learning of Natural Science in Grade 6 by isiXhosa-speaking learners* at Tableside Primary School in the Western Cape.

Parent's/Guardian's signature …………………………

Date ……………………………

APPENDIX B

LETTER OF CONSENT FOR PARTICIPATION IN A RESEARCH STUDY

(Educators)

Dear educator

I am Zola, Dryfus Jonas, a PhD student at the University of the Western Cape. I am currently engaged in doing a research study on *the role of language in the learning of Natural Science in Grade 6 by isiXhosa- speaking learners at one primary schools in the Western Cape*. This research has two main aims, namely: (1) to investigate the difficulties experienced by these learners in learning Science through the medium of English; (2) to make recommendations on how to assist both the learners and educators to address the difficulties. It is hoped that the research will benefit many schools in providing bilingual and/or multilingual instruction and dealing with diversity.

The research participants will participate voluntarily, and will be allowed to withdraw from the process at any point, without fear of intimidation or reprisals. The findings of the research will be shared with all the key participants and interest groups, if they so wish.

As the educator of Grade 6 Natural Science at Tableside Primary school, you are hereby requested to participate in this very important research. The research will take place from ……………… to ……………

Please sign and return the attached consent form.

Yours faithfully

Z.D. Jonas.

Contact address:

EMDC South, Private Bag X2, MITCHELLS PLAIN 7785.

Tel. 370 2000; Cell. 082 353 2401; Fax. 372 1856

CONSENT FORM

(Educators)

I ………………………………. ,being the Natural Science educator in the Grade 6 …. Class, do/do not hereby consent to take part in the research study on *the role of language in the learning of Natural Science in Grade 6 by isiXhosa-speaking learners* at …………………. Primary School in the Western Cape.

Educator's signature …………………………

Date ……………………………

APPENDIX C

ISIMEMO SODLIWANONDLEBE NABAZALI

(INVITATION TO PARENTS FOR INTERVIEW: IsiXhosa Translation)

Bazali ababekekileyo

Njengoko nisazi ukuba ukusukela mhla kwangena inkqubo ye-democracy kweli loMzantsi Afrika ngonyaka ka 1994, abantwana bazo zonke iintlanga bavulelwa ithuba lokuba bafunde kwizikolo ezithandwa ngabo. Naxa kunjalo amaxesha amaninzi abantwana abafunda kwizikolo ezazifudula ngokubizwa ngokuba ngoo-Model C bafunda ngeelwimi zasemzini abangaziqondi kakuhle nezingasetyenziswayo kwamanye amakhaya, umzekelo, isiNgesi. Oku kuthetha ukuba abantwana abantetho isisiXhosa amathuba amaninzi bayasilela ukuphuhlisa nokucacisa ingcamango nezimvo zabo ngokuthe gca kuba bengasebenzisi ulwimi lwabo lweenkobe. Le meko ikhokelela ekubeni bambi bangaqhubi kakuhle ezifundweni zabo ezinjengeNzululwazi (Natural Science) neMatematiki (Mathematics).

Ukuzama ukukhawulelana nale meko ikhankanywe ngentla kuyafuneka ukuba kwenziwe uphando mayela neendlela ezinobuchule zokusebenzisana nokufundisa aba bantwana. Mna, njengomfundi owenza ibanga le-Ph.D kwidyunivesithi yaseNtshona-Koloni, ndikwiphulo lokwenza olu phando mayela nobunzima neengxaki abafundi abantetho isisiXhosa abathi bahlangane nazo ekufundeni iNzululwazi (Natural Science) ngolwimi lwesiNgesi kwibanga lika Grade 6. Njengoko umntwana wakho efunda kwesinye sezi zikolo zichazwe ngentla ndinomnqweno wokukhe ndincokole nawe mayela nendlela onga owakho umntwana angancediswa ngayo. Ndiyakumema ke ngoko kudliwano ndlebe lwethu sobabini ngomhla owothi ufumaneke ngawo nendawo elunge kuwe.

Ndovuyiswa kakhulu yinkxaso yakho.

Ozithobileyo

Zola D. Jonas ....

IPHEPHA LEMPENDULO YOMZALI

QAPHELA: Gcwalisa izikhewu ubeke uphawu (X) ukubonisa isigqibo sakho kule migca ingezantsi:

Mna ………………………….. (igama)

Ndiyavuma ……../andivumi …….. ukuthatha inxaxheba kudliwanondlebe mayela nezimvo zam ngendlela umntwana wam anokuncedwa ngayo kwizifundo zakhe.

Umsayino ………………….

Umhla ………………………

APPENDIX D

QUESTIONNAIRE FOR LEARNERS

SECTION A: DEMOGRAPHIC INFORMATION

1. Code: | L | | | | |

2. Age: ☐☐ years

3. Gender: | M | F |

Please answer the following questions by either ticking in the block √ next to the correct answer or filling in the space provided.

4. Where do you stay?

☐ In a township
☐ In a suburb
☐ In an informal settlement or squatter camp
☐ Other (mention ………………………………………………………..)

5. Who do you live with at home? Do you live with your

☐ Mother
☐ Father
☐ Mother and father
☐ Other (mention ………………………………..)

6. What kind of work does the person you mentioned above do for a living?

☐ Domestic worker
☐ Clerk
☐ Teacher
☐ Nurse
☐ Social worker
☐ Manager
☐ Other (mention ………………………………………………………..)

7. How do you travel to school?

☐ On foot,
☐ By your parents' car,
☐ By taxi,
☐ By Bus,
☐ By train?
☐ Other (mention..)

8. In what grade did you join Tableside Primary School?

☐ Grade R
☐ Grade 1
☐ Grade 2
☐ Grade 3
☐ Grade 4
☐ Grade 5
☐ Grade 6

9. In what year did you join Tableside Primary School?

☐ 2002
☐ 2003
☐ 2004
☐ 2005
☐ 2006
☐ 2007
☐ 2008

10. Where is the last school you attended before Tableside Primary School situated? In a :

☐ Township
☐ Suburb
☐ Informal settlement or squatter camp
☐ Other (mention …...)

SECTION B: LANGUAGE FOCUS

Please answer the following questions by either ticking in the box ☑ next to the correct answer or by filling in the space provided.

1. What is your home language (mother tongue)?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Zulu
☐ Sotho
☐ Other (mention ……………………………………………………………..)

2. What other languages are you able to speak?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention ……………………………………………………………..)

3. What languages do you speak in your Natural Science class?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention……………………………………………………………………)

4. What languages do you speak with your friends during break time at school?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention ……………………………………………………………..)

5. In what language is Natural Science taught in your class?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ English and Afrikaans
☐ Afrikaans and IsiXhosa
☐ English and IsiXhosa
☐ Other (mention language …..…………………………………………….)

…………………………………………………………………………………

……………………………………………………………………..........

6. In what language would you like Natural Science to be taught in your class?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ English and Afrikaans
☐ English and IsiXhosa
☐ Afrikaans and IsiXhosa
☐ Other (mention language ...………………………………………………)

7. Why? (Give reasons for your choice above)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

8. What languages do you think will make you understand Natural Science better?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention ……….. ….………………………………………………..)

8.1 Why? (Give reasons)

………………………………………………………………………………………

………………………………………………………………………………………

9. Do you find any difference between the language that is used when we speak (that is, in ordinary speech) and the language that is used in Natural Science? YES/NO (Please circle your answer).

10. If yes, what difference do you find?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

11. Does the teacher ever use code switching (i.e. changing from one language to another) during Natural Science lessons? YES/ NO (Please circle your answer).

12. If yes, what languages does the teacher use during the code switching?

☐ English and Afrikaans
☐ English and IsiXhosa
☐ Afrikaans and IsiXhosa
☐ Other (mention ………………………………………………………………….)

APPENDIX E

QUESTIONNAIRE FOR EDUCATORS

SECTION A: DEMOGRAPHIC INFORMATION

Please answer the following questions by either ticking in the block √ next to the correct answer or by filling in the space provided.

1. Code: E
2. Gender: M F
3. Academic qualifications:
4. Professional/Teaching qualifications:
5. Other qualifications:
6. Highest academic qualification in Science:
7. Number of years teaching experience years
8. Teaching experience in teaching Science: years
9. Experience in teaching Science at Tableside Primary: years
10. Experience in teaching Science in Grade 6: years
11. Have you taught Science to IsiXhosa-speaking learners before Tableside Primary? YES/NO (Please circle your answer).
12. If yes, for how many years? Years.

SECTION B: LANGUAGE FOCUS

1. What is your first language (mother tongue)?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention ……………………………………………………………………)

2. What other languages are you able to speak?

☐ Afrikaans
☐ English
☐ IsiXhosa
☐ Other (mention ……………………………………………………………………)

3. Do you think the isiXhosa-speaking learners in your Science class are sufficiently proficient in the language of instruction (English) to be able to benefit from tuition in the language? YES/NO (Please circle).

3.1 Explain

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

4. Do you ever use code switching (i.e. changing from one language to another) in your Science class? YES/NO (Please circle).

5. If yes, when or under what circumstances do you use code switching in your Science class?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

6. If you do code switching in your Science class, what languages do you use?

☐ English and Afrikaans
☐ English and IsiXhosa
☐ Afrikaans and IsiXhosa
☐ Other (mention ……………………………………………………………………)

7. How do you support learners with limited proficiency in the language of learning and teaching (LOLT) in your Science class?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

8. Is there a support programme to help you to do this at school level? YES/NO (Please circle) If yes, what kind of support?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

9. Is there a support programme to help you to do this from district level? YES/NO (Please circle) If yes, what kind of support?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

10. Is there any support to help you to do this from the parents and the community? YES/NO (Please circle) If yes, what kind of support?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

APPENDIX F

INDIVIDUAL INTERVIEWS FOR LEARNERS

Please answer the following questions:

1. What makes it easy for you to learn Natural Science?
2. What difficulties do you find in learning Natural Science at school?
3. What, do you think, causes Natural Science to be difficult to learn?
4. What, do you think, causes the difficulties that you find in learning Natural Science?
5. What do you do to deal/cope with the difficulties that you find in learning Natural Science?
6. What would you change to make Natural Science easier to learn?
    a. In class?
    b. At the school?
    c. Elsewhere? (state where)
7. Is code switching (i.e., changing from one language to another) used in your Natural Science class? YES/NO.
    a. Is code switching used by the teacher in your Natural Science class?
    b. Is code switching used by the learners in your Natural Science class?
8. If code switching is used by the teacher in your Natural Science class, when does this happen?
    a. If code switching is used by the learners in your Natural Science class, which learners use it? And,
    b. When does this happen?
9. What kind of help or support do you need to make the learning of Natural Science easier?

(TRANSLATED) ISIXHOSA INTERVIEW QUESTIONS

INDIVIDUAL INTERVIEW QUESTIONS FOR LEARNERS

Nceda uphendule le mibuzo ilandelayo:

1. Yintoni eyenza ukuba kubelula kuwe ukufunda i-Natural Science?
2. Bobuphi ubunzima obufumanayo ekufundeni i-Natural Science?
3. Ngokokucinga kwakho, yintoni ebangela ukuba kubenzima ukufunda i-Natural Science?
4. Ekucingeni kwakho ziintoni ezibangela obu bunzima ubufumana ekufundeni i-Natural Science?
5. Yintoni oyenzayo ukuhlangabezana nobunzima obufumanayo ekufundeni I-Natural Science?
6. Yintoni onokuyitshintsha ukuze kubelula kuwe ukufunda i-Natural Science?
   a. eklasini?
   b. (apha) esikolweni?
   c. kwenye indawo? (chaza indawo leyo)
7. Ingaba inguqulelo yolwimi olusetyenziswayo (code switching) iyenziwa eklasini yakho ye-Natural Science? EWE/HAYI
   a. Ingaba inguqulelo yolwimi olusetyenziswayo iyenziwa ngutishala wakho we-Natural Science?
   b. Ingaba inguqulelo yolwimi olusetyenziswayo iyenziwa ngabafundi eklasini yakho ye-Natural Science?
8. Ukuba inguqulelo yolwimi olusetyenziswayo iyenziwa eklasini yakho ye-Natural Science, loo nto yenziwa xa kutheni?
   a. Ukuba inguqulelo yolwimi iyenziwa ngabafundi eklasini yakho ye-Natural Science, ngabaphi abafundi abayenzayo loo nto? Yaye,
   b. Beyenza xa kutheni?
9. Loluphi uncedo okanye inkxaso oyidingayo okanye oyifunayo ukuze kube lula kuwe ukufunda i-Natural Science?

APPENDIX G

INDIVIDUAL INTERVIEWS FOR EDUCATORS

Please answer the following questions:

1. What difficulties do you find in teaching Natural Science to isiXhosa-speaking learners in Grade 6 at the school?
2. What factors within the teaching and learning situation contribute to the difficulties you mentioned above?
3. What do you think are the barriers to learning Natural Science through the medium of English (as LOLT) for Grade 6 isiXhosa-speaking learners?
4. What strategies do you use to deal or cope with the difficulties you mentioned (in questions 1 – 3) above?
    a. What support systems are there in the school to help learners who experience learning barriers?
    b. How are these systems used to support isiXhosa-speaking learners who experience barriers to learning Natural Science in Grade 6?
    c. Does the school have an ILST/TST?
    d. If yes, what role does the ILST/TST play?
5. What do you think makes teaching Natural Science to isiXhosa-speaking learners more effective?
6. What would you change to promote the learning of Natural Science by isiXhosa-speaking learners in your class?
7. What would you change to promote the learning of Natural Science by isiXhosa-speaking learners in the school?
8. How is the learning of Natural Science promoted in the school?
9. What kind of support do you need to make the teaching of Natural Science to isiXhosa-speaking learners more effective?

a. at class level

b. at school level

c. district level

APPENDIX H

FOCUS GROUP INTERVIEWS FOR LEARNERS

Please answer the following questions as much as you can:

1. What difficulties do you find in learning Natural Science through the medium of English?
2. What factors within the teaching and learning situation contribute to the learning difficulties that you experience in learning Natural Science through the medium of English?
3. What role does language or medium of instruction play with regard to the difficulties (in learning Natural Science through the medium of English)?
4. How do you cope with the difficulties that you find in learning Natural Science through the medium of English?
5. What does your science teacher do to help you cope with the difficulties that you find in learning Natural Science through the medium of English?
6. What, do you think, should or must be done to help you to overcome the difficulties that you find in learning Natural Science through the medium of English?

(TRANSLATED) FOCUS GROUP INTERVIEW QUESTIONS FOR LEARNERS

Nceda uphendule le mibuzo ilandelayo kangangoko unako:

1. Bobuphi ubunzima obufumanayo ekufundeni i-Natural Science ngolwimi lwesiNgesi (English)?
2. Ziziphi iimeko mayela nokufundiswa nasekufundeni ezinegalelo kubunzima ubufumanayo ekufundeni i-Natural Science ngulwimi lwesiNgesi?
3. Yeyiphi indima edlalwa lulwimi lokufunda kubunzima obufumanayo (ekufundeni i-Natural Science ngolwimi lwesiNgesi)?
4. Uhlangabezana njani nobunzima bokufunda i-Natural Science ngolwimi lwesiNgesi (English)?
5. Ngawaphi amacebo asetyenziswa ngutishala wakho we-Natural Science ukukunceda ukuba uhlangabezane nobunzima obufumanayo ekufundeni i-Natural Science ngolwimi lwesiNgesi?
6. Ngokokucinga kwakho, yintoni enokwenziwa ukukunceda ukuba woyise ubunzima obufumanayo ekufundeni i-Natural Science ngolwimi lwesiNgesi (English)?

APPENDIX I

FOCUS GROUP INTERVIEWS FOR EDUCATORS

Please answer the following questions as much as you can:

1. What difficulties do you find in teaching Natural Science to isiXhosa-speaking learners in Grade 6 at the school?
2. What role does the LOLT play with respect to these difficulties?
3. What role does the 'Language of Science' play with respect to these difficulties?
4. What strategies do you use to deal with or cope with the difficulties you mentioned above?
5. What structures/systems do you use in the school to support learners who experience learning difficulties?
    a. How are these structures used to support isiXhosa-speaking learners in Natural Science in Grade 6?
    b. What role does it play to support isiXhosa-speaking learners in Natural Science in Grade 6?
    c. Does the school have an ILST/TST?
    d. What role does it play?
6. What, do you think, should be done to facilitate the teaching and learning of Natural Science to isiXhosa-speaking learners in Grade 6?

APPENDIX J

CLASSROOM OBSERVATION CHECKLIST

CLASS: …………………………………………...

DATE: …………………………………………….

1. Identifying learning difficulties

Nature of LD	**Coping Strategy**	**How is it addressed?**	**Remarks**

2. Classroom interaction and language use (LOLT)

Interaction	**Language/s used**	**For what purpose?**	**Remarks**
Teacher-Learner			
Learner-Learner			
Learner-in group			

3. Classroom interaction and Science lesson

Interaction	Yes	No	Remarks
Teacher-Learner: • Does teacher give clear instructions? • Does learner respond to teacher instructions/questions? • Does learner express her/his needs? • Does teacher respond to learner needs?			
Learner-Learner: • Does learner co-operate? • Is learner willing to share ideas? • Is learner willing to lead discussion?			
Learner-in group: • Does learner co-operate? • Is learner willing to share ideas? • Is learner willing to lead discussion? • Is learner willing to report or perform task on behalf of the group?			

4. Teaching strategies (mediating learning)

Common strategies used	Sequence (of events)	Remarks

5. Classroom environment & Teaching and Learning resources

Category	Manifestation	For what purpose	Remarks
• Culture of science teaching			
• science projects			
• science resources/ equipment			

APPENDIX K

GROUP INTERVIEWS

SCHOOL MANAGEMENT TEAM (PRINCIPAL, DEPUTY, AND HODs)

1. What does the SMT do to promote the learning of Natural Science in Grade 6 at the school?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

2. What does the SMT do to support Grade 6 Natural Science educators/teachers?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………

3. What difficulties does the SMT encounter in giving this support?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………

4. What does the SMT do to support Grade 6 isiXhosa-speaking learners in Natural Science?

……………………………………………………………………………………………………

……………………………………………………………………………………………

5. What difficulties does Management encounter in giving this support?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………

6. What support does the SMT get in Natural Science from the District?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

7. What further support would the SMT like to get from the District?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

8. What support would the SMT like to get from parents of Grade 6 isiXhosa-speaking learners in Natural Science?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

9. What does the SMT do to encourage parents of isiXhosa-speaking learners to support their children in Natural Science?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

10. What difficulties does the SMT encounter in getting this support?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………

11. What role does the SGB play in this regard?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

12. Are there any further comments with regard to all of the above?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

APPENDIX L

INDIVIDUAL INTERVIEWS: PARENTS

1. What do you, as a parent, do to support your child in learning Natural Science?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………

2. What difficulties do you find in supporting your child to learn Natural Science?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

3. What do you do to address these difficulties?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………

4. What suggestions would you like to make with regard to the difficulties you experienced?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………

5. What do you, as a parent, do to support the school in teaching your child Natural Science?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………

6. What difficulties do you find in supporting the school in teaching your child Natural Science?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

7. What suggestions would you like to make with regard to the difficulties you find in supporting the school?

………

………

………

………

………

………

………

………

………

………

APPENDIX M

SAMPLES OF LEARNERS' ASSESSMENT

MEMORANDUM!

GRADE 6 NATURAL SCIENCES MARCH 2008

NAME & SURNAME : ______________ MARKS : 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMEN IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	• humus	snakes
1.2 They are important for the soil.	• photosynthesis	earthworms
1.3 This is a mixture of rotten plants and animals.	• incisors	humus
1.4 The process when plants make food.	• canines	photosynthe:
1.5 This type of teeth is for tearing.	• snakes	canines
1.6 This type of teeth is for biting off food.	• earthworms	incissors

(6)

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of (enamel ; [✓ ivory]).

2.2 A set of milk teeth consists of (32 ; [✓ 20]) teeth.

2.3 You can choke when food slips down your ([✓ windpipe] ; oesophagus).

2.4 ([✓ Vultures] ; cows) are called scavengers.

2.5 ([✓ Mushrooms] ; fruit) are decomposers.

2.6 Birds store their food in the (gizzard ; [✓ crop]) before it is digested

(6)

3. ANSWER THE FOLLOWING QUESTIONS :

3.1-3.2 Name 2 reasons why trees are important.

beautify area / provide shelter / oxygen, shade / it is the home for certain animals / provide wood for furniture or fuel

3.3 Where does oxygen come from?

plants

+-3.6 Name 3 things elephants use their tusks for.

dig up water

tear bark from trees

defend themselves

(6

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the leafs.

4.2 Cows' food is digested in the rumen.

4.3 Our teeth are coated with enamel.

4.4 The process when the food which we eat is broken down, is called digestion.

4.5 The indigestible food which birds cough up is called pellets.

4.6 A bird's stomach is called the gizzard.

(6)

5. TRUE OR FALSE :

5.1 Saliva makes it easier for us to swallow food.	true
5.2 Snake venom helps snakes to digest their food.	true
5.3 There are plants on the moon.	false
5.4 Elephants have 2 sets of teeth in their entire life.	false
5.5 The jaws of snakes can unhinge.	true
5.6 Earthworms move minerals to the surface of the soil	true

(6)

---

1 = 3,3%
2 = 6,6%
3 = 10%
4 = 13,3%
5 = 16,7%
6 = 20%
7 = 23,3%
8 = 26,7%
9 = 30%
10 = 33,3%

11 = 36,7%
12 = 40%
13 = 43,3%
14 = 46,7%

15 = 50%
16 = 53,3%
17 = 56,7%
18 = 60%
19 = 63,3%
20 = 66,7%

21 = 70%
22 = 73,3%
23 = 76,7%
24 = 80%
25 = 83,3%
26 = 86,7%
27 = 90%
28 = 93,3%
29 = [illegible]
30 = [illegible]

GRADE 6 NATURAL SCIENCES $\frac{19}{30}$ = 63,3% = 3 /MARCH 2008

NAME & SURNAME : S LEARNER RESPONCE 1 MARKS : 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMEN IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	• humus	Snakes ✓
1.2 They are important for the soil.	• photosynthesis	earthworms
1.3 This is a mixture of rotten plants and animals.	• incisors	humus ✓
1.4 The process when plants make food.	• Canines	photosynthesis
1.5 This type of teeth is for tearing.	• snakes	incisors X
1.6 This type of teeth is for biting off food.	• earthworms	canines X

(6)

4

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of (enamel ; [✓ ivory]). ✓

2.2 A set of milk teeth consists of (32 ; [✓ 20]) teeth.

2.3 You can choke when food slips down your ([✓ windpipe] ; oesophagus). ✓

2.4 (Vultures ; [✓ cows]) are called scavengers. X

2.5 ([✓ Mushrooms] ; fruit) are decomposers. ✓

2.6 Birds store their food in the (gizzard ; [✓ crop]) before it is digested

(6)

5

3. ANSWER THE FOLLOWING QUESTIONS :

3.1-3.2 Name 2 reasons why trees are important.

tress give us oxygen.

tress give us food.

3.3 Where does oxygen come from?

Trees. ✓

4 -3.6 Name 3 things elephants use their tusks for.

to bite food X

2

to drink water. ✗

and to chew. ✗

(6

4. FILL IN THE MISSING WORDS:

4.1 Plants make their food in the ______. ✗

4.2 Cows' food is digested in the rumen ✓.

4.3 Our teeth are coated with milk ✗.

4.4 The process when the food which we eat is broken down, is called digestible. ✓

4.5 The indigestible food which birds cough up is called ✗ ______.

4.6 A bird's stomach is called the gizzard. ✓

3

(6)

5. TRUE OR FALSE:

5.1 Saliva makes it easier for us to swallow food.	False
5.2 Snake venom helps snakes to digest their food.	True ✓
5.3 There are plants on the moon.	False ✓
5.4 Elephants have 2 sets of teeth in their entire life.	False
5.5 The jaws of snakes can unhinge.	True ✓
5.6 Earthworms move minerals to the surface of the soil	True ✓

5 (6)

GRADE 6 NATURAL SCIENCES $\frac{16}{30}$ = 53,3% = 3 MARCH 2008

NAME & SURNAME : LEARNER RESPONSE 2 MARKS : 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	• humus	Snake
1.2 They are important for the soil.	• photosynthesis	eculhworm
1.3 This is a mixture of rotten plants and animals.	• incisors	humus
1.4 The process when plants make food.	• canines	photosynth
1.5 This type of teeth is for tearing.	• snakes	canines ~~[illegible]~~
1.6 This type of teeth is for biting off food.	• earthworms	~~[illegible]~~ ~~[illegible]~~ (rvci

(6)

5

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of ([✓ enamel]; ivory). X

2.2 A set of milk teeth consists of ([✓ 32]; 20) teeth. X

2.3 You can choke when food slips down your ([✓ windpipe]; oesophagus).

2.4 (Vultures; [✓ cows]) are called scavengers. X

2.5 ([✓ Mushrooms]; fruit) are decomposers. ✓

2.6 Birds store their food in the (gizzard, [✓ crop]) before it is digested.

3 (6)

3. ANSWER THE FOLLOWING QUESTIONS :

3.1-3.2 Name 2 reasons why trees are important.

Trees is important because it gives us oxgern ✓

and it give us shade ✓

3.3 Where does oxygen come from?

form trees ✓

3.4-3.6 Name 3 things elephants use their tusks for. Che 3

~~eating food elephants are two digs for small nize~~

4H 12/3 when Chey want to eat food they use the trusks

Elaphant is too Baig for the small natre
when Elaphant have a small tusk Elephant cannot eat fo
(6)

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the moning X .

4.2 Cows' food is digested in the pot X .

4.3 Our teeth are coated with our skin X .

4.4 The process when the food which we eat is broken down, is called eaten food X

4.5 The indigestible food which birds cough up is called wtmm .

4.6 A bird's stomach is called the crop . X

(6)

5. TRUE OR FALSE :

5.1 Saliva makes it easier for us to swallow food.	false
.2 Snake venom helps snakes to digest their food.	True ✓
5.3 There are plants on the moon.	false ✓
4 Elephants have 2 sets of teeth in their entire life.	false ✓
.5 The jaws of snakes can unhinge.	True ✓
.6 Earthworms move minerals to the surface of the soil	True ✓

5 (6)

GRADE 6 NATURAL SCIENCES $\frac{7}{30}$ = 23,3% = 1 MARCH 2008

NAME & SURNAME: 1 LEARNER RESPONSE 3 MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A:

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole.	• humus	Snakes ✓
1.2 They are important for the soil.	• photosynthesis	humus X
1.3 This is a mixture of rotten plants and animals.	• incisors	earthworms X
1.4 The process when plants make food.	• Canines	photosyntesi ✓
1.5 This type of teeth is for tearing.	• snakes	incisors X
1.6 This type of teeth is for biting off food.	• earthworms	canines X

(6)

2

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS:

2.1 The teeth of elephants consist of (enamel, [✓ ivory]) X

2.2 A set of milk teeth consists of ([✓ 32], 20) teeth.

2.3 You can choke when food slips down your (windpipe, [✓ oesophagus]). X

2.4 ([✓ Vultures], cows) are called scavengers. X

2.5 (Mushrooms, [✓ fruit]) are decomposers. ✓

2.6 Birds store their food in the (gizzard, [✓ crop]) before it is digested. ✓

(6)

3

3. ANSWER THE FOLLOWING QUESTIONS:

3.1-3.2 Name 2 reasons why trees are important.

Is cakt a oxygen X

Is a tree are important X

3.3 Where does oxygen come from?

important X

3.4-3.6 Name 3 things elephants use their tusks for.

Is a tusks dig a Use Scavengers.

one day a teeth come up X of a miant it.
a tree hif a leefis. X

(6.

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the oxygen X.

4.2 Cows' food is digested in the miant X.

4.3 Our teeth are coated with 20 teeth X.

4.4 The process when the food which we eat is broken down, is called bired. X

4.5 The indigestible food which birds cough up is called gizzard

4.6 A bird's stomach is called the ~~t~~ment X.

(6)

5. TRUE OR FALSE :

5.1 Saliva makes it easier for us to swallow food. Irtie

5.2 Snake venom helps snakes to digest their food. false X

5.3 There are plants on the moon. True X

5.4 Elephants have 2 sets of teeth in their entire life. True X

5.5 The jaws of snakes can unhinge. false X

5.6 Earthworms move minerals to the surface of the soil True ✓

2 (6

GRADE 6 NATURAL SCIENCES $\frac{18}{30}$ = 60% = 3 MARCH 2008

NAME & SURNAME : LEARNER RESPONSE 4 aFa MARKS : 30

---

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	. humus	snakes
1.2 They are important for the soil.	. photosynthesis	earthwor
1.3 This is a mixture of rotten plants and animals.	. incisors	humus
1.4 The process when plants make food.	. Canines	Photosynthesis ✓
1.5 This type of teeth is for tearing.	. snakes	CANINES
1.6 This type of teeth is for biting off food.	. earthworms	INCISORS

(6)

6

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of ([✓ enamel]; ivory).

2.2 A set of milk teeth consists of (32 ; [✓ 20]) teeth.

2.3 You can choke when food slips down your ([✓ windpipe]; oesophagus).

2.4 (Vultures ; [✓ cows]) are called scavengers X

2.5 (Mushrooms ; [✓ fruit]) are decomposers. X

2.6 Birds store their food in the (gizzard ; [✓ crop]) before it is digested.

(6)

3

3. ANSWER THE FOLLOWING QUESTIONS :

.1-3.2 Name 2 reasons why trees are important.

It give us shelter

And protection X

3.3 Where does oxygen come from ?

Plant and trees ✓

3.6 Name 3 things elephants use their tusks for.

water, food and eat

2

(6

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the humus ✗.
4.2 Cows' food is digested in the rumen. ✓
4.3 Our teeth are coated with ivory ✗.
4.4 The process when the food which we eat is broken down, is called oesophagus ✗
4.5 The indigestible food which birds cough up is called pellet ✓ .
.6 A bird's stomach is called the crop. ✗

2 (6)

5. TRUE OR FALSE :

.1 Saliva makes it easier for us to swallow food. true ✓
5.2 Snake venom helps snakes to digest their food. true ✓
3 There are plants on the moon. false ✓
5.4 Elephants have 2 sets of teeth in their entire life. false ✓
.5 The jaws of snakes can unhinge. fals ✗
.6 Earthworms move minerals to the surface of the soil true ✓

5 (6)

GRADE 6 NATURAL SCIENCES 19/30 = 63,3% = 3 MARCH 2008

NAME & SURNAME : Z LEARNER RESPONSE 5 Rane MARKS : 30

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1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	• humus	snake. ✓
1.2 They are important for the soil.	• photosynthesis	earthworms ✓
1.3 This is a mixture of rotten plants and animals.	• incisors	humus. ✓
1.4 The process when plants make food.	• Canines	photosynthes ✓
1.5 This type of teeth is for tearing.	• snakes	Canines. ✓
1.6 This type of teeth is for biting off food.	• earthworms	incisors. ✓

(6)
6

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of (enamel; [✓ ivory]) ✓

2.2 A set of milk teeth consists of (32 ; [✓ 20]) teeth. ✓

2.3 You can choke when food slips down your (windpipe; [✓ oesophagus]). ✗

2.4 (Vultures ; [✓ cows]) are called scavengers. ✗

2.5 ([✓ Mushrooms]; fruit) are decomposers. ✓

2.6 Birds store their food in the (gizzard, [✓ crop]) before it is digested ✓

(6)
4

3. ANSWER THE FOLLOWING QUESTIONS :

3.1-3.2 Name 2 reasons why trees are important.

Trees are important because they give us ~~sunlight~~ shade ✓
and they give us food.

3.3 Where does oxygen come from?

air ✗

3.4-3.6 Name 3 things elephants use their tusks for.

[illegible] ✗ /

— — to wash themselves ✓

and they use their tusk for X

(6

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the soil X .

.2 Cows' food is digested in the ~~grass~~ X .

4.3 Our teeth are coated with enamal ✓.

.4 The process when the food which we eat is broken down, is called ~~stomach~~. X

4.5 The indigestible food which birds cough up is called gizzard. X

4.6 A bird's stomach is called the gizzard ✓

2 (6)

5. TRUE OR FALSE :

5.1 Saliva makes it easier for us to swallow food. true ✓

5.2 Snake venom helps snakes to digest their food. true ✓

.3 There are plants on the moon. false ✓

.4 Elephants have 2 sets of teeth in their entire life. false ✓

.5 The jaws of snakes can unhinge. true ✓

5.6 Earthworms move minerals to the surface of the soil true ✓

6 (6)

15/30 = 50% = 3

GRADE 6ª NATURAL SCIENCES MARCH 2008

NAME & SURNAME : LEARNER RESPONSE 6 MARKS : 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMEN IN COLUMN A :

COLUMN A	COLUMN B	ANSWER
1.1 These animals swallow their prey whole	• humus	Snakes ✓
1.2 They are important for the soil.	• photosynthesis	Earthworms ✓
1.3 This is a mixture of rotten plants and animals.	• incisors	humus ✓
1.4 The process when plants make food.	• Canines	Photosynthesis ✓
1.5 This type of teeth is for tearing	• snakes	incisors ✗
1.6 This type of teeth is for biting off food.	• earthworms	canines ✗

4 (6)

2. CHOOSE THE CORRECT WORD WITHIN BRACKETS :

2.1 The teeth of elephants consist of (enamel ; [✓ ivory]) ✓

2.2 A set of milk teeth consists of (32 ; [✓ 20]) teeth.

2.3 You can choke when food slips down your ([✓ windpipe] ; oesophagus).

2.4 (Vultures ; [✓ cows]) are called scavengers. ✗

2.5 ([✓ Mushrooms] ; fruit) are decomposers. ✓

2.6 Birds store their food in the ([✓ gizzard] ; crop) before it is digested ✗

4 (6)

3. ANSWER THE FOLLOWING QUESTIONS :

3.1-3.2 Name 2 reasons why trees are important.

They give us paper to ~~write~~ on

They give us houses

3.3 Where does oxygen come from ?

Plants ✓

/

-3.6 Name 3 things elephants use their tusks for.

Water ✗

trees ✓

Leves ✓

(6)

4. FILL IN THE MISSING WORDS :

4.1 Plants make their food in the Soil ✗.

.2 Cows' Food is digested in the gizzard ✗.

4.3 Our teeth are coated with 28 ✗.

.4 The process when the food which we eat is broken down, is called Pellet. ✓

4.5 The indigestible food which birds cough up is called Pellets.

.6 A bird's stomach is called the crop ✗.

1 (6)

5. TRUE OR FALSE :

5.1 Saliva makes it easier for us to swallow food. True ✓

5.2 Snake venom helps snakes to digest their food. False ✗

5.3 There are plants on the moon. False ✓

5.4 Elephants have 2 sets of teeth in their entire life. False ✓

5.5 The jaws of snakes can unhinge. True ✓

5.6 Earthworms move minerals to the surface of the soil True ✓

5 (6)

MEMORANDUM 2

GRADE 6 NATURAL SCIENCES JUNE 2008

NAME & SURNAME : MARKS : 30

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1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. Coal	Sun
1.2	It is used to generate electricity.	. static electricity	Coal
1.3	Animals get their energy from this.	. oil	food
1.4	It is used to generate hydro-electricity	. sun	Water
1.5	It is present in a woolen jersey.	. water	static electr
1.6	It is supplied by living things which died in the oceans.	. food	Oil

(6)

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS :

2.1 (Electricity; natural gas) is a fossil fuel.

2.2 Energy sources that we use directly, are called (primary ; secondary-energy sources.

2.3 (Coal ; oil) comes from plants and animals which lived millions of years

2.4 (Thunder ; lightning) is dangerous.

2.5 Only (positive ; negative) charges can move during a storm.

2.6 Our bodies are (weak ; good) conductors of electricity.

(6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The Sun is our main source of energy.

3.2 Most electricity in South Africa is generated in power stations

3.3 Oil, petrol and gas are manufactured at the SASOL plants

3.4-3.5 Clouds are made up of ice and water.

3.6 Due to the lack of other energy sources, people in the rural areas still use Wood as an energy source.

(6)

4. ANSWER THE FOLLOWING QUESTIONS :

4.1 - 4.3 Name 3 ways how we can stay safe during a storm.

Don't sit in a small boat / swim.

Don't stand under a tree.

Don't lie flat or sit in an open area.

4.4 What do we call the loud bang that we hear during a storm?

thunder

4.5 What is bio-fuel manufactured of?

mealies / maize

4.6 Where are the SASOL plants?

Secunda (6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME. (6)

Don't place an electric cord under a mat/ carpet. When bare wires touch each other it causes a short circuit which could start a fire. Don't push objects, especially not your fingers or metal objects, into electric sockets. Dont pull on an electric cord when you want to unplug an appliance. Switch off lights when you change a light bulb. Don't plug too many appliances into a socket. Never plug electrical appliances into a light socket. Don't repair broken electrical cords → replace them and Don't keep electrical appliances in the bathroom when you bath. Don't play near power stations Don't touch electrical appliances that are switched on with wet hands.

1 = 3,3 %
2 = 6,7
3 = 10
4 = 13,3
5 = 16,7
6 = 20
7 = 23,3
8 = 26,7
9 = 30
[illegible]

11 = 36,7 %
12 = 40
13 = 43,3
14 = 46,7

15 = 50 %
16 = 53,3
17 = 56,7
18 = 60
19 = 63,3
20 = 66,7

21 = 70 %
22 = 73,3
23 = 76,7
24 = 80
25 = 83,3
26 = 86,7
27 = 90
28 = 93,3
29 = 96,7
[illegible]

13/30 = 43,3 10 = 2

GRADE 6^A NATURAL SCIENCES JUNE 2003

NAME & SURNAME : Sik LEARNER RESPONSE 1 WG MARKS : 30

---

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. coal	Sun ✓
1.2	It is used to generate electricity.	. static electricity	oil X
1.3	Animals get their energy from this.	. oil	Food ✓
1.4	It is used to generate hydro-electricity	. sun	water ✓
1.5	It is present in a woolen jersey.	. water	Static electricity ✓
1.6	It is supplied by living things which died in the oceans.	. food	Coal X

4 (6)

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS :

2.1 (Electricity ; natural X gas) is a fossil fuel.

2.2 Energy sources that we use directly, are called (primary X ; [✓ secondary]) energy sources. ✓

2.3 ([✓ Coal], oil) comes from plants and animals which lived millions of years ago. ✓

2.4 (Thunder ; [✓ lightning]) is dangerous. ✓

2.5 Only ([✓ positive], negative X) charges can move during a storm.

2.6 Our bodies are (weak ; [✓ good]) conductors of electricity. ✓

3 (6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The water X is our main source of energy.

3.2 Most electricity in South Africa is generated in power station ✓.

3.3 Oil, petrol and gas are manufactured at the Secondary plants.

3.4 - 3.5 Clouds are made up of ________ X and ________ X.

3.6 Due to the lack of other energy sources, people in the rural areas still use Sun X as an energy source.

4/7/6

1 (6)

GRADE 6
NAME:

4. ANSWER THE FOLLOWING QUESTIONS :

4.1 - 4.3 Name 3 ways how we can stay safe during a storm.

~~5~~ Do not stand under the tree ~~~~ during storm

Do not swim ~~~~ during storm. ✓

Do not sit flat on a ~~open~~ area.

4.4 What do we call the loud bang that we hear during a storm?

Thunder ✓

4.5 What is bio-fuel manufactured of?

Plants. ✗

4.6 Where are the SASOL plants?

Secondary ✗

4

(6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME. (6)

1 Do not put on radio ~~in~~ the bathroom.
2 ✗
3 ✗
4 Do not put to many plugs ✗
5
6. -

1

$\frac{10}{30}$ = 33,3 6 = 1

GRADE 6 NATURAL SCIENCES LEARNER RESPONSE 2 =1 JUNE 2008

NAME & SURNAME: MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. coal	Sun ~~Water~~ ✓
1.2	It is used to generate electricity.	. static electricity	Coal ✓ ~~static electr~~
1.3	Animals get their energy from this.	. oil	Water X
1.4	It is used to generate hydro-electricity	. sun	Static electr
1.5	It is present in a woolen jersey.	. water	city X
1.6	It is supplied by living things which died in the oceans.	. food	oil ✓

(6) 3

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS:

2.1 (Electricity; [✓ natural gas]) is a fossil fuel.

2.2 Energy sources that we use directly, are called (primary; [✓ secondary]) X energy sources.

2.3 ([✓ Coal]; oil) comes from plants and animals which lived millions of years ago

2.4 (Thunder; [✓ lightning]) is dangerous.

2.5 Only (positive; [✓ negative]) charges can move during a storm.

2.6 Our bodies are ([✓ weak]; good) conductors of electricity.

4

(6)

3. COMPLETE THE FOLLOWING SENTENCES

3.1 The Sun ✓ is our main source of energy.

3.2 Most electricity in South Africa is generated in static electricity X

3.3 Oil, petrol and gas are manufactured at the city X plants.

3.4 - 3.5 Clouds are made up of coal X and oil X.

3.6 Due to the lack of other energy sources, people in the rural areas still use Sun X as an energy source

(6) 1

4|7|6

4. ANSWER THE FOLLOWING QUESTIONS :

4.1 - 4.3 Name 3 ways how we can stay safe during a storm.

stay in your house

stay in your shop ~~cupboard~~

stay in your cupboard

4.4 What do we call the loud bang that we hear during a storm?

We call it thunder

4.5 What is bio-fuel manufactured of?

it is bio fuel manufactured of coal

4.6 Where are the SASOL plants?

down in the soil

2 (6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME. (6)

1 ~~you must~~ when you finished using your stove you must make sho
your stove is off

2 you must not touch water and then touch electricity

3 you must not light the jug and open the jug and touch the wate
inside the jug

4 you must not play with electricity

5 you must not touch the Glob when its on

6 Do not play with lights

$\frac{6}{30}$ = 20% = 1

GRADE 6 NATURAL SCIENCES JUNE 2008

NAME & SURNAME: 1(a) LEARNER RESPONSE 3

MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. coal	oil ✗
1.2	It is used to generate electricity.	. static electricity	water ✗
1.3	Animals get their energy from this.	. oil	sun ✗
1.4	It is used to generate hydro-electricity	. sun	coal ✗
1.5	It is present in a woolen jersey.	. water	food ✗
1.6	It is supplied by living things which died in the oceans.	. food	static electricity ✗

(6)

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS:

2.1 ([✓ Electricity], natural gas) is a fossil fuel.
2.2 Energy sources that we use directly, are called ([✓ primary], secondary) energy sources.
2.3 ([✓ Coal], oil) comes from plants and animals which lived millions of years ago.
2.4 (Thunder, [✓ lightning]) is dangerous.
2.5 Only (positive, [✓ negative]) charges can move during a storm.
2.6 Our bodies are (weak, [✓ good]) conductors of electricity.

5

(6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The food is our main source of energy.
3.2 Most electricity in South Africa is generated in weak ✗.
3.3 Oil, petrol and gas are manufactured at the coal ✗ plants.
3.4 - 3.5 Clouds are made up of ~~water~~ coal ✗ and oil ✗.
3.6 Due to the lack of other energy sources, people in the rural areas still use water ✗ as an energy source.

(6)

4. ANSWER THE FOLLOWING QUESTIONS :

4.3 Name 3 ways how we can stay safe during a storm. ✓

stay ~~of~~ out home

they kill birds and bats X

clean

4.4 What do we call the loud bang that we hear during a storm?

Coal X

4.5 What is bio-fuel manufactured of?

Nuclear X

4.6 Where are the SASOL plants?

Electricity X

1 (6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME. (6)

~~[illegible]~~

1) ~~do~~ not seal on the coal wold you sleep

2) yields only small amounts of electricity

3) ~~pe~~ Therquires ~~big~~ land areas

4) people safely your electricity at home

5) and do not ~~op~~ open your water

GRADE 6^S $\frac{18}{30}$ = 60% = 3 NATURAL SCIENCES JUNE 2008

NAME & SURNAME LEARNER RESPONSE 4 9Fa MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

COLUMN A	COLUMN B	ANSWER
1.1 Plants get their energy from this.	. Coal	Sun ✓
1.2 It is used to generate electricity.	. static electricity	coal ✓
1.3 Animals get their energy from this.	. oil	WaterA
1.4 It is used to generate hydro-electricity	. sun	static electricit.
1.5 It is present in a woolen jersey.	. water	food A
1.6 It is supplied by living things which died in the oceans.	. food	oil ✓

3

(6)

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS:

2.1 ((Electricity), natural gas) is a fossil fuel. X

2.2 Energy sources that we use directly, are called (primary ✓, secondary) energy sources.

2.3 ((Coal) ✓, oil) comes from plants and animals which lived millions of years ago.

2.4 (Thunder, (lightning) ✓) is dangerous.

2.5 Only (positive, (negative) ✓) charges can move during a storm.

2.6 Our bodies are (weak ; (good) ✓) conductors of electricity.

5

(6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The food X is our main source of energy.

3.2 Most electricity in South Africa is generated in power station.

3.3 Oil, petrol and gas are manufactured at the Coak plants.

.4 - 3.5 Clouds are made up of air X and water ✓

3.6 Due to the lack of other energy sources, people in the rural areas still use generator as an energy source.

2(6)

4. ANSWER THE FOLLOWING QUESTIONS :

4.3 Name 3 ways how we can stay safe during a storm.

don't sit or lie in a open ~~area~~.

don't stand under a tree. ✓

don't use a small boat. ✓

4.4 What do we call the loud bang that we hear during a storm?

thunder ✓

4.5 What is bio-fuel manufactured of?

gas ✗

4.6 Where are the SASOL plants?

SEcunda ✓

5 (6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME.

(6)

① You must make sure you dont touch a electrica thing with wet head or put it ~~in~~ some where wet.

② Don't salotape any electrical use.

③ Don't blow dry your hair when you take a bath

④ The wire must be inside the plag

⑤ Do not play around a danger of electricity.

⑥ Do not put your finger in a plag. ✓

3

GRADE 6ᴬ $\frac{13}{30}$ = 43,3 10 = 4 NATURAL SCIENCES 17 JUNE 2008

NAME & SURNAME: Z LEARNER RESPONSE **5** MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. coal	sun ✓
1.2	It is used to generate electricity.	. static electricity	~~sat~~ static electricity X
1.3	Animals get their energy from this.	. oil	oil X
1.4	It is used to generate hydro-electricity	. sun	coal X
1.5	It is present in a woolen jersey.	. water	food X
1.6	It is supplied by living things which died in the oceans.	. food	water X.

(6) 1

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS :

2.1 (Electricity; [✓ natural gas]) is a fossil fuel.

2.2 Energy sources that we use directly, are called (primary; [✓ secondary]) energy sources. ✓ X

2.3 ([✓ Coal]; oil) comes from plants and animals which lived millions of years ago X

2.4 ([✓ Thunder]; lightning) is dangerous. X

2.5 Only ([✓ positive]; negative) charges can move during a storm. X

2.6 Our bodies are ([✓ weak]; good) conductors of electricity.

2 (6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The food X is our main source of energy.

3.2 Most electricity in South Africa is generated in ______ X.

3.3 Oil, petrol and gas are manufactured at the coal X plants.

3.5 Clouds are made up of water ✓ and air X.

3.6 Due to the lack of other energy sources, people in the rural areas still use generator as an energy source.

1 (6)

4. ANSWER THE FOLLOWING QUESTIONS :

4.1 - 4.3 Name 3 ways how we can stay safe during a storm.

Don't sit in a small boat.

Do not stand under a tree.

Do not sit in an open place.

4.4 What do we call the loud bang that we hear during a storm?

thunder ✓

4.5 What is bio-fuel manufactured of?

oil ✗

4.6 Where are the SASOL plants?

✗

4

(6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME.

(6)

1. Make sure all light are switched off after you change the ~~t~~ bulb light
2. Do not touch the wires or the appliance withs wet hands. ✓
3. Do not put an appliance under a mat cause ~~people~~ when people walk in it can wear thorough
4. Do not mix water with electricity.
5. Do not plug too many appliance into a socket. ✓
6. Never plug electrical appliance into light switch socket.

5

$\frac{16}{30}$ = 53,3 / 6 = 3

GRADE 6 NATURAL SCIENCES JUNE 2008

NAME & SURNAME LEARNER RESPONSE 6 MARKS: 30

1. CHOOSE THE CORRECT ANSWER FROM COLUMN B TO MATCH THE STATEMENT IN COLUMN A.

	COLUMN A	COLUMN B	ANSWER
1.1	Plants get their energy from this.	. coal	Sun ✓
1.2	It is used to generate electricity.	. static electricity	oil X
1.3	Animals get their energy from this.	. oil	water X
1.4	It is used to generate hydro-electricity	. sun	food X
1.5	It is present in a woolen jersey.	. water	Static eletricity
1.6	It is supplied by living things which died in the oceans.	. food	coal X

2

(6)

2. CHOOSE THE CORRECT ANSWER WITHIN BRACKETS:

2.1 (Electricity; natural X gas) is a fossil fuel.

2.2 Energy sources that we use directly, are called (primary X; [✓ secondary]) energy sources ✓

2.3 ([✓ Coal]; oil) comes from plants and animals which lived millions of years ago.

2.4 (Thunder; [✓ lightning]) is dangerous.

2.5 Only (positive; [✓ negative]) charges can move during a storm.

2.6 Our bodies are (weak; [✓ good]) conductors of electricity.

4

(6)

3 COMPLETE THE FOLLOWING SENTENCES

3.1 The Sun. ✓ is our main source of energy.

3.2 Most electricity in South Africa is generated in power station ✓.

3.3 Oil, petrol and gas are manufactured at the Secunda X plants.

3.4 - 3.5 Clouds are made up of Coal X and gas X.

3.6 Due to the lack of other energy sources, people in the rural areas still use gas X as an energy source

2

(6)

4. ANSWER THE FOLLOWING QUESTIONS:

4.3 Name 3 ways how we can stay safe during a storm.

Staying at home ✓

Not playing outside ✗

Not watching televition.

4.4 What do we call the loud bang that we hear during a storm?

lightning ✗

4.5 What is bio-fuel manufactured of?

Plants. ✗

4.6 Where are the SASOL plants?

Secunda ✓

2 (6)

5. WRITE A PARAGRAPH OF ± 6 SENTENCES ABOUT HOW TO USE ELECTRICITY SAFELY AT HOME. (6)

① You should never touch an electrical appliance when your hands are wet ~~and never use~~

② You should never use any appliance ~~while~~ you in the bath.

③ You should never over loud ~~lout~~ plugs

④ Do not try to repair broken electrical cords with electric tape.

⑤ Never plug electrical appliance into light switch sockets

⑥ Make sure lights are switched off when you change a light bulb ✓

6