

The study from Western Cape primary classrooms reports on how language is used in teaching and learning of Natural Science in the Intermediate Phase (Grades 4–6). The focus is on the way in which isiXhosa, learners' home language, is used alongside English (the resource language and medium of teaching and learning) in mediating cognitively challenging subject content, particularly Natural Science concepts and terminology. To this end, classroom observations and interviews with teachers were done, and teaching and learning materials such as textbooks and learners' work were explored. The study concludes that the lack of materials in isiXhosa, coupled with unplanned code switching to English and the extensive use of English borrowings, affect learners' ability to understand cognitively challenging material.



UNIVERSITY OF CAPE TOWN

How scientific terms are taught and learnt in the Intermediate Phase

Zola Wababa



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Acknowledgements

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Abstract

The study seeks to investigate how language is used in teaching and learning of Natural Science in the Intermediate Phase, with specific reference to the way in which isiXhosa (learners' home language) is used alongside English (the resource language and medium of teaching and learning). My research investigated teaching and learning support materials in two classes and studied the roles of English and isiXhosa in mediating cognitively challenging subject content, particularly Natural Science concepts and terminology.

In chapter two I refer to different theoreticians to advance my argument around the use of language as a tool to promote cognitive development and conceptual understanding in areas of academic learning, in this case, Natural Science. I looked at work done internationally on cognitive development and then explored numerous research projects conducted on the same issue in an African context around the use of indigenous languages in teaching and learning. I also explored the Language in Education Policy underpinning the Natural Science curriculum statement, particularly the distinction between additive and subtractive bi/multilingualism. I will discuss the language of science and investigate how this highly specialised Natural Science jargon is used to convey understanding of science to learners who are not native speakers of English.

Classroom observations and interviews with teachers are used to gain insight into the use of both isiXhosa and English in everyday teaching and learning. Teaching and learning materials such as textbooks and learners' work are also explored to determine how Natural Science concepts and terminology are explained to learners and which language is used and for what purposes.

The study concludes that the lack of materials in isiXhosa, coupled with unplanned code switching to English and the extensive use of English borrowings, affect learners' ability to understand cognitively challenging material.

Opsomming

Hierdie studie ondersoek hoe taal gebruik word in die onderrig en leer van Natuurwetenskap in die Intermediêre fase met spesifieke verwysing na die wyse waarop isiXhosa (die leerders se huistaal) saam met Engels (die taal van hulpbronne en van onderrig-leer) gebruik word.

My navorsing het die onderrig en leer praktyke van en materiaal in twee klasse ondersoek en die rolle van isiXhosa en Engels bestudeer waar kognitief-komplekse leermateriaal, veral natuurwetenskap konsepte en terminologie, gebruik is.

In hoofstuk twee verwys ek na verskeie teoretici om my argument oor die gebruik van taal as instrument om kognitiewe ontwikkeling en konseptuele begrip van Natuurwetenskap (in hierdie geval) te bevorder, te ondersteun. Ek ondersoek internasionale perspektiewe op kognitiewe en konseptuele ontwikkeling in akademiese kontekste, in hierdie geval Natuurwetenskap, opgevolg deur 'n verskeidenheid van navorsingsprojekte op dieselfde onderwerp in die konteks van Afrika, veral wat betref die gebruik van inheemse tale in leer en onderrig. Ek neem die Taal in Onderrig Beleid onderliggend aan die Natuurwetenskap kurrikulumverklaring in ag, met spesifieke verwysing na die onderskeid tussen aanvullende en afbrekende twee- en meertaligheid. Die taal wat in die natuurwetenskappe gebruik word, word ook onder die loep geneem en die ondersoek fokus op die wyse waarop hierdie hoogs gespesialiseerde vaktaal gebruik word om Natuurwetenskap by leerders wat nie huistaalsprekers van Engels is nie, tuis te bring.

Klaskamerwaarneming en onderhoude met onderwysers is gebruik om insig te verkry in die gebruik van beide isiXhosa en Engels in daaglikse onderrig en leer. Onderrig- en leermateriaal soos handboeke en leerders se werk is ook ondersoek. Hierdie is gedoen om uit te vind hoe Natuurwetenskap konsepte en terminologie aan leerders verduidelik word en watter taal gebruik word vir watter doeleindes.

Die studie kom tot die gevolgtrekking dat 'n gebrek aan onderrig- en leermateriaal saam met onbeplande kodewisseling tussen Engels en Afrikaans en die uitgebreide gebruik van leenwoorde uit Engels die leerders se vermoë om kognitief komplekse materiaal te verstaan, beïnvloed.

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Olu phando lujolise ukuphanda ukuba ingaba ulwimi lusetyenziswa kanjani na ekufundeni nasekufundiseni kwisifundo seNzululwazi ngezeNdalo kumabanga aphakathi, lento yenziwe ngokujonga ngqo indlela ekusetyenziswa ngayo isiXhosa (nesilulwimi lwasekhaya lwabafundi) kwakunye nesiNgesi (esilulwimi olusele luphuhlisiwe nolulolona lusetyenziswayo ekufundeni nasekufundiseni). Olu phando luphanda indlela ezisetyenziswa ngayo

izixhobo zokufunda nokufundisa kumabanga amabini, luze luqwalasele inxaxheba ethi idlalwe sisiNgesi kunye nesiXhosa ekuncendiseni kuphuhliso lwengqondo kwisifundo esifuna ingqiqo, ingakumbi xa sijonga amagama anika ingqiqo kwisifundo seNzululwazi ngezeNdalo.

Kwisahluko sesibini ndixoxe ndanxulumanisa olu phando neengcali kubumbo lwengcinga, kusetyenziso kolwimi ekuphuhliseni ingqondo nokuqonda kufundo nzulu, apho singakhakanya ufundo lweNzululwazi ngezeNdalo. Ndiye ndenza uphendlo kumsebenzi opapashiweyo ngophuhliso lwengqondo kwihlabathi ngobubanzi, ndaze kwakho ndaphendla ngopapasho olwenziwe kwizwekazi laseAfrika. Ndiye ndenza nohlolo malunga nombala weelwimi kuMgaqo Nkqubo weelwimi kwezeMfundo kunye nesiBhengezo seKharityulam (National Curriculum Statement) kwisifundo seNzululwazi ngezeNdalo, ndiye ndaqwalasele umahluko phakathi kokusetyenzisa kolulwimi elongezelelweyo kunye nokungasetyenziswa kolwimi lwesibini okanye iilwimi ezininzi umntu azaziyo. Ndixoxe ndaza ndaphanda ngokusetyenziswa kolwimi lweNzululwazi/ sayensi ukuze abantwana baqonde ngcono kwakunye nendlela ekusetyenziswa ngayo isigama esingaqhelekanga nesinika ingqiqo kubantwana abangathethi siNgesi njengolwimi lwabo lwenkobe.

Ulolongo lwezifundo kunye nodliwano ndlebe nootitshala luye lwenziwa ukujonga ukuba isiXhosa kunye nesiNgesi sisetyenziswa kanjani na ekufundeni nasekufundiseni. Ndenze uphononongo lwezixhobo zokufundisa ezi njengencwadi kunye nomsebenzi obhalwa ngabantwana. Laa ibingamalinge okujonga ukuba amagama anika ingqiqo acaciswa kanjani na kwizifundo zeNzululwazi ngezeNdalo kwakunye nokuba kusetyenziswa eziphi ulwimi? Zisetyenziswa ukwenza ntoni na?

Olu phando luphetha ngokufumanisa ukuba kukho ungqongophalo kwizixhobo zokufundisa esiXhoseni kwisifundo seNzululwazi ngezeNdalo, lonto ithi ibangele ukuxutywa kwelwimi kubolekwa amagama esiNgesini, oku kubolekwa kwamagama kuthi kucaphazele ukuqonda kwabafundi umxholo wesifundo ngokuphuhlileyo lonto iqapheleka xa kusetyenziswa izixhobo zokufunda ezinika umceli mngeni.

List of acronyms

BICS	basic interpersonal communication skills
CALP	cognitive academic language proficiency
DET	Department of Education and Training
DoE	Department of Education
EMDC	Education Management and Development Centre
LiEP	Language in Education Policy
LoLT	language of learning and teaching
L1	first language
L2	second language
L3	third language
L4	fourth language
OBE	outcomes-based education
RNCS	Revised National Curriculum Statement
WCED	Western Cape Education Department
ZPD	zone of proximal development

1. How scientific terms are taught and learnt in the Intermediate Phase

1.1 Rationale for the study

Learners, especially African home-language (isiXhosa in particular) speakers, in the Intermediate Phase currently have to switch from their home language to English in the conceptual learning areas *before* they have developed sufficient language skills to be able to cope with English as their new language of learning and teaching (LoLT) across the curriculum. Such a switch results in, among other things, a high failure rate and a high number of drop-outs in the conceptual learning areas of science and mathematics. A number of studies, which have been conducted in Africa and elsewhere in the world, confirm such a finding. For example, both Macdonald's (1990) threshold study and Awoniyi (1982:1) state that the mother tongue of a child is closely associated with the child's growth and development. As a child matures, his or her language develops through the language, personality and experience expressed. A study conducted by Ramirez et al. (1991) in the USA also affirms the importance of the mother tongue for a child's cognitive and conceptual development.

1.1.1 Background to the study

Despite the fact that the African languages as media of instruction are limited to the Foundation Phase in South Africa, they play a crucial role in teaching and learning beyond that level. Although textbooks and other teaching material in Natural Science and other content subjects tend to be written only in English, the teachers concerned often use the African languages, such as isiXhosa, to explain certain concepts and terms to the learners. Such a practice often results in poor academic performance by

African language-speaking learners, particularly in the content subjects, such as the Natural Science, as most teachers tend to use isiXhosa for both oral and written work, while any assessment tends to be carried out in English alone (Plüddemann et al. 2004:31).

Most researchers link such poor performance to socio-economic problems and psychological deficiencies. However, such are not the only factors leading to poor performance. Few realise that 'the inability of these learners to pass science and mathematics and other learning areas of high conceptual thinking is due to lack of fluency in the language of instruction' (Cummins 1989:34).

After three years of primary schooling, isiXhosa-speaking learners tend to be disadvantaged by the exclusive use of English as the medium of instruction for the Natural Sciences, as they have not had sufficient opportunity to develop enough competence in that language to cope with challenges of teaching and learning. However, at this stage they are confronted with a demand for a sufficiently high level of English language use to be able to understand textbooks, learning support materials and assessment rubrics.

Such learners have low proficiency skills in English compared to those in their first language (L1)(isiXhosa), which is more suited for the purpose of learning and teaching (Heugh 2003:29). By the Intermediate Phase, the cognitive/academic language proficiency (CALP) of such learners is not yet well enough developed for them to cope with the demands of the curriculum (Baker 2001:172). Such lack of proficiency is clearly reflected in the low pass rate and the general lack of interest in the scientific learning areas, such as science and mathematics, at the upper exit level of Matric (DoE, 2001). While in office, ex-education minister Kader Asmal stated that he considered the language of instruction to be a major barrier to learning, not only in the Foundation Phase, but throughout the entire system. He was reported¹ as saying: 'Very soon, I shall announce the establishment of a ministerial committee to investigate the possibility of advancing towards the use of the indigenous languages as the medium of instruction in higher education'.

Setati (*City Press* 13th April 2008) claims that 'language became a serious barrier when learners were faced with more difficult cognitive tests' and the language impact on learner performance is most challenging in the areas of science and numeracy. Clearly, not only language issues cause problems

¹ Kader Asmal, *The Daily News* 11th June 2003.

in the teaching and learning of Natural Science, as other issues compound the problem, but the issue of language is central to such difficulties. The result is that the kind of learner who is envisaged in terms of the Natural Science curriculum statement, the Revised National Curriculum Statement (RNCS)(2002) for Natural Science, is currently unfeasible when envisaging the English language competencies of African home-language speakers (Alexander 2000).

The current study seeks to explore how scientific terminology, in the form of the concepts and terms used in the Natural Sciences, is taught and learnt in the Intermediate Phase. The study is also aimed at finding out what teachers understand about the transfer of concepts to learners during the teaching of the Natural Sciences. The investigation accordingly conducted examined the kind of teaching and learning taking place in Grade 5. This was done by means of non-participatory observation of Natural Science teaching in classes where isiXhosa (which was the L1 for most learners) and English (which formed the language of the textbooks and other teaching materials concerned) are used interchangeably in teaching and learning activities. The research involved classroom observation and interviews with teachers.

The well-known phenomenon of code-switching was found to be present in the explanations of certain Natural Science concepts and new terms in isiXhosa, which were aimed at enhancing teaching, learning and assessment. In this context, code-switching will be scrutinised at the level of lexical borrowing of words from English and their conversion to more natural sounding terms in isiXhosa through prefixing or suffixing (Skiba 1997).

Such an analysis will help in finding out whether such conversion promotes cognitive development and conceptual understanding in the teaching of Natural Science to isiXhosa-speaking learners. The study considers this practice in terms of how it relates to code-switching (Skiba 1997).

The objectives of the current study are to determine whether the use of home or L1 instruction might improve teaching practices, learning and assessment practices by allowing learners to gain an understanding of scientific concepts and terms through a language that they understand better than they do English. The Threshold Project in South Africa (Macdonald 1990:141) indicates the existence of a 'number of limiting factors in the classroom' where the learners had to learn content subjects in their second language (L2). Further mention is made that 'the global effect of these

factors is the loss of meaning. The children are likely to be alienated by what they have to learn, and only dimly perceive the implications and linkages between the concepts which they are presented with.' Awoniyi (1982:1) also points out that the mother tongue of a child is closely associated with the child's growth and development; as the child matures, his or her language develops, and he or she is able to express personality and experience through the use of that language.

1.1.2 Motivation for the study

Seepe (1992:41) points out that isiXhosa is a language used for various purposes in classes that are supposed to be English medium. Its use is operational when there is a specific need for it, such as when the teacher needs to explain a difficult point, to give a specific instruction or advice, to explain a wrong behaviour, or to enquire in a way that will render results otherwise unobtainable. IsiXhosa is used in classroom management practices, such as in greeting one another, in instructions and in teaching to explain most science concepts and terms. However, such a practice is only oral, with most Natural Science teachers usually denying that they use isiXhosa in this way (Wababa, 2004:262). Many teachers think that the teaching of the Natural Sciences can only take place in English. They believe that African languages, like isiXhosa, are incapable of being used for teaching in such areas of learning due to the lack of terminology (Bamgbose, 1997). Other arguments that have been advanced against the use of isiXhosa and other African languages as the medium of instruction in the learning of the sciences and mathematics include the following:

- i. Such languages contain portmanteau words (i.e. words that have more than one meaning), making them imprecise (Seepe 2000).
- ii. No articles, such as 'a' and 'the', exist in the African languages² (Mammimo 1992:56).
- iii. Their lack of scientific vocabulary appears to militate against their use in this context, despite O'Neil's (1980:83) finding the fact 'that certain labels (words) are absent in a particular language does not suggest that a person or particular group of people lacks the concept'.

² After all, the language used to first describe scientific concepts during the Renaissance was Latin, which also contains no articles.

The current study seeks, among others, to dispel the above-mentioned myths that no teaching of science can take place in the African languages.

Code-switching, or moving back and forth using isiXhosa in Science teaching, often happens in South African schools; for instance, if the Natural Science teaching period is 45 minutes long, a teacher will usually take 35 minutes speaking in isiXhosa, trying to disseminate knowledge in the form of concepts and terminology and to mediate teaching and learning. Ferguson (2003:95) found that 'there is evidence that teachers have evolved pragmatic strategies for coping with situations where learners have limited proficiency in the official language medium. One of these is that they alternate between languages, that is, they code-switch.' He also found that 'the problem, however, is that, despite a body of literature supporting this practice it lacks legitimacy and is consequently neglected or marginalized in teacher education'. Such a situation also prevails in South African education.

The study undertaken by Martin (1999:51–52) also indicated that 'the teacher switches from English to Malay in order to: (i) encourage and elicit learner participation; (ii) clarify the meaning of certain sections of text'. It is a process that Martin (1999:53) refers to as '(iii) unpacking the meaning' and demarcating the reading of the text. Van der Walt and Mabule (2001:257–268) also point out that one of the reasons for code-switching by teachers could be an attempt to narrow the social distance resulting from the status of the teacher and the use of English. The teacher tends to code-switch in order to initiate and invite negotiation of meaning, thereby improving comprehension of the subject.

This kind of teaching practice has two possible effects on learners: On the one hand, it benefits the learners, who come to understand more of the subject matter, as they are able to participate more freely during the lessons concerned. On the other hand, such practice can hinder the performance of learners in tests and exams, because the written assessment is conducted in English only. Many different problems contribute to the high failure rate in the Natural Sciences and other areas of high conceptual learning, though the current study focuses on the strategies employed by teachers in their teaching of Natural Science.

The low proficiency skills of most learners and teachers revealed in a study by Plüddemann et al. (2004:31) were found to result in poor performance in the Natural Sciences and other learning areas. Such poor performance has led to a steadily decreasing number of learners who are prepared

to study science in the more senior classes, which has also led to an increase in the school drop-out rate. The disjuncture between the language(s) of teaching and learning and the language of assessment has led to a multiplicity of unanswered questions by teachers. Despite this, the Department of Education (DoE), as well as the parents themselves, continue to expect good educational results.

The Constitution of the Republic of South Africa (1996) asserts:

That everyone has the right to receive education in the official language or languages of their choice in public educational institutions when that education is reasonably practicable. In order to ensure the effective access to, and implementation of, this right, the state must consider all reasonable educational alternatives.

The Department (1997:4) also states that its language policy intends:

- to promote full participation in society and the economy through equitable and meaningful access to education;
- to pursue the language policy most supportive of general conceptual growth amongst learners, and hence to establish additive multilingualism as an approach to language in education;
- to promote and develop all official languages;
- to support the teaching and learning of all other languages required by learners or used by communities in South Africa, including languages used for religious purposes, languages which are important for international trade and communication, and South African Sign Language, as well as Alternative and Augmentative Communication.

Furthermore, the RNCS for Natural Sciences and Technology (2002) lays down the use of the primary language(s) for the effective transfer of science and technology skills to learners.

1.2 Aims of the current study

The aim of the research described in this thesis is to observe the different strategies and mechanisms that teachers use in their teaching of the Natural Sciences. This study also seeks to show for what purposes such strategies are used, in order to equip teachers with innovative teaching ideas or strategies for helping to improve isiXhosa-speaking learners' understanding of science concepts. The study concludes with recommendations as to how the learn-

ers' home language(s) can help them achieve conceptual understanding and develop cognitively in their study of the Natural Sciences.

1.3 Research design

The current study looks at how scientific terms and concepts are taught and learned at the Intermediate Phase level. Two intermediate classes were chosen from two township schools, one being a less-resourced school and the other a semi-resourced school, in two different Education Management and Development Centres (EMDCs). Classroom observations and interviews were conducted at both the schools in order to investigate their teaching and learning practices in the Natural Sciences.

1.4 Data collection

The data were collected in accordance with observation schedules (see Appendix 1), which required, over the space of a week, once-daily involvement in the classroom in the form of observations specifically directed at the use of English and isiXhosa in the teaching and learning of Natural Science in Grade 5. After looking at how the content of the lesson was mediated by both teachers and learners, semi-structured interviews (see Appendix 2) were conducted with the teachers concerned. The interviews, consisting of structured open-ended questions, focused on their teaching practices and on the impact of such practices on the learners' conceptual understanding.

As well as viewing their textbooks and exercise books, due consideration was also given to the critical outcomes concerned with language issues in the Natural Science curriculum statement. In numerical terms, such an investigation entailed the following: two teachers were observed on a daily basis for one hour each at both of the schools over the course of one week. Ten teachers were interviewed for one hour each. Five teachers in the Intermediate Phase of each school were identified for the study, with one teacher undergoing observation, while the other four were interviewed for purposes of validity and reliability.

1.5 Data analysis

Leedy (1997:160) states that one of the most important aspects of data analysis is that the researcher organises, arranges, and orders the data, searching for recurring themes or patterns that represent the participant's

perspective. In the course of the current research more focus was placed on the qualitative data gleaned, in terms of which greater weight was accorded those statements made by a number of the participants.

The interpretation of data was based on the following three indicators:

- i. How language was used, as well as the purpose for which it was used, in terms of the observation schedule
- ii. How concepts and scientific terminology were explained in both English and isiXhosa in order to promote the cognitive development and conceptual understanding of the learners was explored.
- iii. Teachers' common practices in transferring concepts and terminology in the teaching and learning of Natural Science were also reviewed.

1.6 Researcher involvement in the study

In order to conduct this study, two schools based in different EMDCs within the greater Cape Town area were identified. While one school was **less-resourced** (with minimal teaching tools, having few additional teaching materials and no library, computer or science laboratory) the other was **semi-resourced** (with a relatively well-stocked, though still insufficient, library and a computer room, but no science laboratory). The research was based on the findings in one intermediate class in each school, with the focus being on plants and animals, in accordance with the Natural Science curriculum. The teaching of Natural Science across different grades in the Intermediate Phase in each school under review was considered in the course of a single week. The researcher did not participate in either the teaching or the learning, restricting his role to observing the teaching and learning practices used by the teachers involved in the study to promote cognitive development and conceptual understanding in the teaching of Natural Science concepts and terminology to isiXhosa-speaking learners. After the observation had taken place, the teachers were interviewed about their teaching practices and the methods that they used to inculcate learning.

1.7 The sampling design

Two former Department of Education and Training (DET) schools in two different EMDCs were selected on condition that the teachers were proficient in the language of the learners. For the convenience of the researcher, the schools chosen for the purposes of this study were in reasonably close proximity to each other.

1.8 The methodology employed in the study

The study looked at the scientific concepts and terms taught and learnt during the Intermediate Phase in terms of what strategies and mechanisms the teachers used to explain Natural Science terms to isiXhosa-speaking learners. Furthermore, consideration was given to how such practices either promote or hinder the conceptual understanding and cognitive development of the learners concerned.

1.8.1. The observation schedule

Field notes were collected in accordance with a standardised observation schedule. The schedule was organised around well-structured themes relating to the language distribution undertaken during teaching and learning. Particular attention was paid to the concepts and terms used in introductions, explanations and recapping, as well as to the nature of the assessment made in terms of both high and lower order written and oral questions. All such endeavours were aimed at finding out which strategies teachers tend to use in the teaching and learning of the Natural Sciences.

1.8.2 The interviews conducted with the teachers

One-on-one interviews were conducted with the 10 participating teachers, consisting of five teachers from each school. The teachers from the Intermediate Phase at both schools were asked the following questions, in the following sequence:

- i. Which language/s do you use when you teach the Natural Sciences?
- ii. Do you find that you use more than one language and switch back and forth from one language to the other during the course of a lesson?
- iii. Do you think that it is useful to use isiXhosa together with English?
- iv. Which language/s do you use most during your teaching of the Natural Sciences, and why?
- v. Explain what methods you use to ensure that the learners understand the relevant concepts and terms when teaching the Natural Sciences.
- vi. Would teaching science in isiXhosa be helpful for your learners?

The questions that were asked during the interviews were linked to the teaching and learning practices that were observed during the classroom

observations, resulting in the existence of a correlation between the issues observed (in terms of the observation schedule) and the questioning that was conducted during the interviews with the teachers.

1.8.3 An examination of the teaching and learning materials

Whether the textbooks and additional teaching materials promoted cognitive and conceptual understanding in the teaching of the Natural Sciences was explored in this study. This exploration took the form of looking at the language in which the books and documents were written in order to see whether they might, indeed, promote a high degree of conceptual thinking among the learners.

1.9 A description of the terminology used in the study

The following definitions of terms used in the study were adapted from Heugh et al.'s (1995) work on multilingual education in South Africa:

- i. 'Home language' or 'mother tongue' refers to the language that people use with greater competency, being the language that is dominant in the immediate family and community of the speaker concerned.
- ii. 'English as a second language' refers to the synonymous use of the English language with the mother tongue. Sometimes the term 'third language' is used in South Africa to indicate that the language was introduced into the education system after acquisition of the L2 had taken place. In the latter case, the learner is not expected to develop proficiency in the language equivalent to that developed in use of the L2.
- iii. 'Code-switching' means shifting from one code (i.e. a language, dialect or language variety) to another between utterances or for a section of an utterance that is at least of sentence length. All forms of code-switching presuppose a speaker's sensitivity to different social contexts and conventions.
- iv. 'Additive bilingualism' refers to the bilingualism associated with a well-developed proficiency in two languages, with positive cognitive outcomes.

- v. The term 'subtractive bilingualism' can be applied to a context in which the speakers of usually low-status languages are expected to become proficient in an L2, which is usually a dominant language of high status, such as the English or French language, as it is spoken in Africa.
- vi. 'Borrowing' involves the importation of words into a language through phonetic transcription from one language to another, during which a foreign word is integrated into the lexical system of that particular language (for example, most words that have been borrowed from the English language and incorporated into the isiXhosa vocabulary).
- vii. A 'concept' is an idea or picture of something that someone has in his or her own mind.
- viii. A 'term' is a morphological representation of a concept in writing used according to the grammatical rules of the written language.

1.10 Conclusion

Given the large gap that exists between isiXhosa and English, or between the African and Western languages, in terms of their grammatical and morphological structures, learners tend to struggle with terms that the English language has adapted from the Latin and Greek languages. The use of such terms with the addition of a Xhosa prefix does not make them more understandable. In order to develop a conceptual understanding and cognitive development in the teaching of the Natural Sciences in the Intermediate Phase, a preferable practice would be to use an isiXhosa description of the English concept. Le Grange's (2000) proposal of 'the creation of new knowledge spaces in which both Western science and African indigenous knowledge could be put together', though viable, should not be achieved at the expense of the African languages.

2. The theoretical framework of the study

2.1 The theoretical concept of the study

In terms of conceptual development, Vygotsky makes a distinction between children's spontaneous concepts, which develop unsystematically through the interactions of everyday life, and scientific concepts, which form part of a system of concepts mediated through schooling. He recognises that

concept formation is a creative, rather than a mechanical passive, process; ... a concept emerges and takes shape in the course of a complex operation aimed at the solution of some problem ... memorising words and connecting them with objects does not in itself lead to concept formation; for the process to begin, a problem must arise that cannot be solved otherwise than through the formation of a new concept (Vygotsky 1962:99–100).

Cummins' Development Interdependence Hypothesis (Cummins 1991) also states that children can attain high levels of competence in their L2 if their L1 development, especially the use of certain function of language relevant to schooling and the development of vocabulary and concepts, is strongly promoted by their environment outside their schooling. Therefore, it is argued in this project that use of the English language alone cannot promote cognitive and conceptual understanding for isiXhosa-speaking learners in the teaching and learning of the Natural Sciences. However, it is acknowledged that a language develops through use, and the isiXhosa language is capable of use as an instructional medium in the areas of high conceptual learning. Even if it were not so, a range of strategies or mechanisms could be utilised to bring isiXhosa to the position that the English language currently enjoys as a high-status language. Lexical borrowing, new coinages, and the unearthing of old concepts should all be employed

to provide a meaningful education for learners and in order to convince the teachers concerned of the viability of using isiXhosa to teach the Natural Sciences.

2.2. The use of a mother tongue to address conceptual understanding

The current study also deals with the issue of additive bilingual teaching, meaning the use of the mother tongue (isiXhosa) of learners to form Natural Science concepts and terms together with English for purposes of both teaching and assessment. Studies of code-switching in the classroom also form a basis for the dual-medium approach of teaching, in which certain strategies and mechanisms to evolve Natural Science concepts and terms are employed (Bamgbose 1987:5). However, a learner's corpus goes one step further, to some extent formalising terms that teachers might or might not accept as scientific terms in a language other than English (Van der Walt 2005:245). For isiXhosa-speaking learners, the teaching and learning of science takes place in an academic setting, in which language is context-reduced (Cummins 1991:169–170). After the Foundation Phase (making up the first three years of schooling), the English language is used as the medium of teaching and learning. Nevertheless, the learners concerned are expected to take part in the process of teaching and learning of science by way of 'talking about', 'describing' and 'explaining' scientific concepts (Gee 1990:147). As a result, it is difficult for such learners to contribute their prior knowledge, reflections and life experiences to classroom discourse using English as their L2. In addition, science has its own specialised register that requires mastery.

2.3 Aspects of terminology development in the African languages

Systematic attempts to develop and expand terminology have been under way since the late 1920s, leading to the establishment of several language committees (Mahlalela et al. 2002:15). The strategies and mechanisms used in developing scientific concepts and terms in isiXhosa, despite having been in use for some time, have not yet been explored in relation to what works best in isiXhosa with specific reference to the lower educational levels. Many other languages have dedicated language academies or institutes that have been outstanding in the development of terminology.

For instance, the Académie Française, apart from its involvement with the field of science and technology, has also attempted to keep French free of foreign borrowings, particularly any from the English language. Similar in intent to such a body is the Real Academia of Spain, whose objective it is to clarify, purify, and glorify the Spanish language (Onyalo 2004).

A number of studies have been undertaken around the issue of developing scientific terminology in the African languages. Legère (2005) refers us to 'the experiences of the terminology/specialised vocabulary development project for Mbukushu (Namibian language) in which no barrier is acknowledged that can prevent the expression of scientific and mathematical concepts in an African language'. Scholars such as Carstens (1993), Bamgbose (1987), Mwanosoko (1990), Dlodlo (1999), Shembe (2000), Antia (2000), Van der Walt (2005) and Mahlalela and Heugh (2002) all share the same ideas about the use of an African language in the teaching of content subjects. None of these scholars see the issue of terminology development in an African language as problematic; rather, they regard the issue as posing a challenge that can be overcome by means of collective effort aimed at elevating the status of such languages. The LANGTAG report (1996) also recommends developing the vocabulary needed for the expansion of functions possible in terms of the new language dispensation.

2.4 Language and cognitive development

After defining language and what conceptual development means, Vygotsky's theory of language and conceptual development, as well as those of other theoreticians, are explored. What implications such theories have for the teaching and learning of the Natural Sciences in the case of isiXhosa-speaking learners, with specific reference to the intermediate and senior phase, are then also reviewed.

2.5 The meaning of language for the current study

Conventionally, language is defined as having two main functions: external communication with other people and internal representation of own thoughts (Green 1995:17). Language enables human beings to understand and interpret the universe, therefore it may be regarded as a tool that they can use for communication.

According to Whorf's (1956:23) hypothesis, the structure of a human being's language influences the way in which he or she understands reality and behaves with respect to it. Whorf asserts that language is the best show that man puts on. Other creatures have developed relatively rudimentary communication systems, but no true language.

Language is cardinal in rearing human young, in organising human communities, and in transmitting culture across the generations. Human beings are able to think rationally and act creatively because of the languages they are able to speak. Language, and, in particular, the process of naming, carries with it an implicit conceptual mechanism. Providing a common label (such as 'animal') for multiple references to various objects is, in itself, an act of classification. Likewise, providing different labels (such as 'dog' and 'horse') reveals conceptual distinctions among referents (Wax 1990:123–124). Not only is language a powerful instrument of identification and classification, but it can also be manipulated for purposes of participation and exclusion (Bamgbose 1987:29).

2.6 Cognitive development

Different views of cognitive development will now be discussed as being linked to language development. Cognitive development can be defined as the organising, handling and use of knowledge, referring to all the processes and products of the human mind that lead to the development of knowledge. Mental activities include remembering, understanding, problem-solving, relating, imagining, creating, fantasising and the use of symbols (Lee & Gupta 1995:3).

Cognitive development consists of the on-going developmental process of gaining a better understanding of the surrounding world, as well as the ability to develop an independent mind or thinking abilities, which starts in the early stages of childhood and lasts until adulthood. During such development, the learners learn to think through several different factors by exploring issues relating to their social activities, as mediated by their elders.

A child's intellectual development largely consists of the progressive socialisation of individual thought, which first occurs through resistance to adaptation to social conditions, and then becomes increasingly penetrated by surrounding adult influence (Piaget 1970:28). According to Lee and Gupta (1995:10), conceptual development also covers the acquisition and development of knowledge and cognitive processes, such as language, memory, and drawing, which only occurs if a child is raised in the presence of a vernacular language.

2.7 Vygotsky's theory

Vygotsky's aim was to integrate psychology with history, culture and sociology (Vygotsky 1962). In Vygotsky's system, the role played by culture in language and cognitive development is important. He regarded culture as being manifested in systems of symbols, such as language, science, and the media, which influence the development of mental ability. According to Vygotsky, such systems are to be seen not merely as the content of thinking, but as part of its structure and activity. The systems themselves have a dynamic structuring effect on learning and development. In this way, language provides a way of construing and constructing the world, and does not merely consist of the labels that we apply to it.

In his concept of the zone of proximal development (ZPD), Vygotsky explains the importance of mediation of a society in the development of learners by all of society, including their teachers, parents and peers. He stresses that society should let children explore things and help only where it is necessary to provide the right direction or to aid in the understanding of issues. He proceeds to define the ZPD as 'the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers' (Vygotsky 1962:86).

Vygotsky sees culture as an important factor in enhancing cognitive development. He finds that culture is a type of language. Only a thin line exists between language and culture; language goes with culture. So, for isiXhosa-speaking learners in the Intermediate and Senior Phases, isiXhosa, which is their home language, is not currently being used for the teaching of Natural Science. Therefore, the study investigated how the cognitive development and conceptual understanding of isiXhosa-speaking learners affected their conceptual learning areas in the Natural Sciences.

Vygotsky (1962) sees a language as a tool that provides a way for construing and constructing the world. However, most isiXhosa-speaking learners are forced to see the world through the lenses of the English language, which is embedded in a westernised culture.

Whorf (1956) also emphasises that all higher levels of thinking are dependent on language, and that the structure of whatever language is habitually used influences understanding of the environment. A person from a different language community may think about the world differently to an English speaker. For instance, if a race of people had the physiological defect of being able to see only the colour blue, they would hardly be able to

formulate the rule that they saw only blue. The term 'blue' would convey no meaning to them; their language would lack colour-related terms; and the words that they would use for denoting the various sensations of blue would answer to, and translate, the words 'light', 'dark', 'white', 'black', and so on, not the word 'blue' (Whorf 1956:209).

The above applies in the situation of isiXhosa-speaking learners, who grew up in a society in which isiXhosa is the major language of communication. Their experience of English is usually through the mass media, in the form of newspapers, magazines, television and certain radio stations. Such learners understand their environment in terms of their immediate environment, that which comes in the form of the isiXhosa language encapsulated in their isiXhosa culture. So, that is their mental point of departure.

Undeniably, if such an understanding is not exploited in their schooling, most such learners are doomed to fail, because their reasoning cannot develop fully in a language in which they are not conversant. Whorf (1953:25), acknowledging his debt to Sapir, stated that 'It is not so much in these special uses of language as in its constant ways of arranging data and its most ordinary everyday analysis of phenomena that we need to recognize the influence it has on other activities, cultural and personal.'

When such learners arrive at school for the first time, they come equipped with two proficiency skills in their home language: speaking and listening. The first three years of their schooling, consisting of the Foundation Phase, build on such skills by developing the other two proficiency skills: reading and writing. The four proficiency skills develop spontaneously, forming the basis of their L1 for communication purposes and their cognitive developmental process. However, abruptly, when the learners concerned progress to the Intermediate Phase, all such proficiency skills are abandoned for the English language, which is assumed to be their second or third language. IsiXhosa, the language in which they have acquired the relevant proficiency skills, is no longer used for purposes of teaching and learning, resulting in their weak grasp of both language and concept.

After the Foundation Phase, such learners have to abandon their language and culture, because the medium of teaching and learning switches to English. While English first-language learners progress in their cognitive and linguistic development, the isiXhosa-speaking learners are marginalised and cognitively delayed, because their language and cultural phenomena are neglected in the delivery of the curriculum.

The history of African languages, in particular isiXhosa, starts in the 19th century. At the time, missionaries started to codify Nguni languages. Though such languages have a rich history of development in arts and culture, they are relatively undeveloped in the field of other specialised academic domains, such as in the teaching of the Natural Sciences.

2.8 Cummins and cognitive development

Cummins' (1980) theoretical framework of language distinguishes between the following two terms:

- By basic interpersonal communication skills (BICS) he means that children should acquire a firm footing of competence in the morphological, syntactic and lexical skills of their vernacular or L1 (which is isiXhosa for most learners referred to in the current study), so that they can communicate in everyday life.
- By cognitive/academic language proficiency (CALP), which refers to the acquisition of a language outside the immediate interpersonal environment, is meant the language that is used for academic purposes, such as in teaching and learning.

According to Cummins, if no link exists between the BICS and CALP of a learner, the cognitive development and conceptual understanding skills of that learner are delayed, especially in the conceptual areas, such as the Natural Sciences. Most learners who speak African languages are in this situation. Cummins argues that BICS and CALP should be seen in the context of cognitive demand, meaning that BICS and CALP apply differently in a number of different situations.

Cummins and Swain (1986:152) argue that we should conceptualise language proficiency in such a way that the developmental interrelationships between academic performance and language proficiency in both the home language and the first additional language can be considered.

The theory of linguistic interdependence, which functions in Africa but which has, so far, been largely ignored, postulates that children are more likely to be able to acquire learning in an L2 if they are taught initially in a language that they understand (Cummins and Swain 1986:28). Furthermore, instruction that develops reading and writing in L1 not only serves to develop linguistic skills in that language, but also develops a deeper conceptual linguistic proficiency that can transfer to the L2, which is English for most isiXhosa-speaking learners (Cummins and Swain, 1986:29).

Though isiXhosa-speaking learners have limited English proficiency skills for a number of socio-economic reasons, their home language, to which they are highly exposed, is ignored in the high-level conceptual learning areas, such as science. Granted that exposure is an important prerequisite for language acquisition; it is, however, not sufficient in itself. A number of other factors that promote the development of proficiency skills should be taken into consideration in this regard (Cummins 1991:28).

Skutnabb-Kangas and Toukoma (1976) report how Finnish immigrant children in Sweden, who often appeared to educators to be fluent in both Finnish and Swedish, nevertheless showed levels of verbal academic performance in both languages that were considerably below grade/age expectations. IsiXhosa-speaking learners are similar to such learners. How concept and scientific terminology is explained in their teaching and learning of the Natural Sciences is of relevance to their cognitive development and conceptual understanding. Whether the standardised curriculum knowledge contained in the textbooks and other teaching resources takes cognisance of their socio-cultural context, which is embedded in isiXhosa, is also of interest to this study.

Leung (1996:27) observes that this context-reduced situation is a key reason why minority language learners have often failed to develop high levels of L2 academic skills. Their initial instruction has emphasised context-reduced communication, insofar as instruction has been through the medium of English and unrelated to their prior out-of-school experience. So, using the home language to support L2 acquisition could lead to a rich context for language use.

In the context of content-based English Second Language (ESL) instruction, learners actively develop their proficiency in English, while studying subject matter other than English. The teaching and learning of science in an academic setting is linguistically context-reduced for isiXhosa-speaking learners (Rosenthal 1996:140) who, after the Foundation Phase, are subjected to English as the medium of teaching and learning. Nevertheless, such learners are expected to study science by 'talking about', 'describing' and 'explaining' scientific concepts in English (Gee 1990). They are expected to contribute their prior knowledge, reflections and life experiences using English as their L2.

Often, the aspects of English learned in an ESL class differ quite radically from those language skills needed to cope with the learning of

chemistry, economics or history, when English is used as the medium of instruction and assessment (Rosenthal 1996:141). The result is rote learning (Woods 1990:192), in terms of which learners are taught to learn by heart, rather than with understanding. Such learning entails their memorising every concept or term that they learn, with no aspect of their studies being applied in context.

2.9 Cognitivism: What do other theoreticians say?

In Claassen's view (1993:830), the learner actively constructs concepts as the result of social interaction. The learner's potential for cognitive growth is limited, on the one hand, by what he or she is able to accomplish on his or her own and, on the other, by what he or she is able to accomplish with the help of a more knowledgeable individual.

Green (1998:40) agrees with Vygotsky when she recommends that instruction should be based on the development of a scientific attitude, meaning the use of a principle to solve a problem.

The teacher's role today has changed from that of instructor to facilitator, with all who are involved being allowed to participate freely. Continuous engagement and interaction with the learners might help to encourage the expression of fresh ideas necessary for constructive thinking.

Green (1998:41) urges teachers to recognise the transformative spirit of teaching and learning and to create opportunities for speech, listening, reading and writing, with the conscious awareness of how such opportunities may promote the thinking of learners.

In contrast, Piaget assigned a less important role to language, taking the view that children need to understand a concept before they can properly use the terms that refer to the concept. Piaget's 'stages' emphasise that learning occurs by means of the process of assimilation and accommodation of new information to the existing mental structures (Piaget 1970:715). Vygotsky reflected the powerful influence that language has on thought by saying: 'Piaget argues that "things do not shape a child's mind" but we have seen that in real situations when the egocentric speech of a child is connected with his practical activity, things do shape his mind. Here, by "things" we mean reality, neither as passively reflected in the child perception nor as abstractly contemplated, but reality that a child encounters in his practical activity' (Vygotsky 1962:39).

Gardner slightly differs from both Piaget and Vygotsky, expressing a belief that the stimulation encountered by the learner or child is transformed, or processed, in a number of ways by internal structures during the period in which the changes, identified as learning, take place (Gardner 1977:14). Gardner's assertion on cognitive development agrees somewhat with Vygotsky's theory, in his speaking about the internal structural circumstances that influence the critical thinking of learners.

Dennis (cited in Lee 1995:131) also agrees to a certain extent with Piaget, in his saying, 'Of course one can say words that one does not understand, but to use words appropriately one must have understanding.' Such an assertion is supported by Piaget's view that some of the isiXhosa-speaking learners attend school for the first time already knowing many words in their home language. However, that does not necessarily mean that they conceptually understand the meaning behind some of words, resulting in their need for assistance, according to Vygotsky, in gaining conceptual understanding.

Vygotsky (1962) took the view that language and thought combine at the end of the second year when the children are able to use words as symbols for thoughts. However, such is not always the case for all words, as the children need mediation sometimes to guide them in their thinking. After the end of the second year, language and thought become closely interrelated and mutually supportive. Vygotsky also points out that language is a social and cultural phenomenon that is central to the development of thinking, and that cognitive development is greatly influenced by one's cultural and social development.

Ausubel (1998:78) also agrees with Vygotsky that learning becomes more stable (i.e. more stably integrated with long-term memory structures) if it is linked in a non-arbitrary substantive fashion to the existing knowledge structures in the brain.

IsiXhosa-speaking learners, in order to organise their thinking, need to use their prior knowledge, which they acquired from their social and cultural practices. Dewey (1938), Piaget (1970) and Vygotsky (1962) all agree that learning is a process of constructing knowledge through the interaction of mind and experience.

From the point of view of the second-language learner, as with the isiXhosa-speaking learner in the mainstream classroom, the cognitive demand of any learning task is seen through the content knowledge and skills learned, such as that pertaining to the water cycle in science, as well as through elements of

the English language used to express the content meaning, such as vocabulary items, which, in this case, might, for example, be *evaporation*, and grammar and discourse organisation expressing notions, in this case, of time and causal relationships (Leung 1996:31). Leung also states that such an awareness of language can be regarded both as a means of communication and as a form of content.

Based on the above discussion, Vygotsky's theory of language and cognitive development forms the theoretical framework for the following study, in which the work of other theoreticians on language and cognitive development is also discussed. The study demonstrates why isiXhosa-speaking learners in the intermediate find it difficult to study the Natural Sciences, using English as the sole medium of teaching and learning.

Bruner also uses the term 'scaffolding' to describe the way in which parents support the acquisition of language. Similarly to Vygotsky, he believes that cognitive development is essentially a shared activity, holding that 'without instruction the child's spontaneous activities could not be transformed into rational thought'.

Contrary to the above, Piaget believes in an individually-based constructivist notion, according to which teachers are encouraged to allow learners to develop their communication and cognitive development ability.

2.10 Cognitive development: The African context

Research has been undertaken in some African countries to demonstrate that languages and cognitive development play a crucial role in the progress of children during schooling. Some of the crucial points demonstrated by such empirical studies are discussed below.

The following studies have all shown positive connections between language and cognitive development:

- the six-year Yoruba project carried out in Nigeria in the 1970s;
- the experimental school project that took place in Mali in 1985;
- the Threshold project conducted in South Africa in 1990;
- the 1999–2001 PanSALB & PRAESA project; and
- the LOITASA project carried out in South Africa and Tanzania.

Wolff (2002:134–135) articulates the results clearly as follows:

- i. Cognitive benefits can be derived when the child's home language is used as the language of instruction in early education (ADEA, 1996:10). The gains to be accrued by children from being instructed in their mother tongue fall into the following categories: cultural; affective; cognitive; socio-psychological; and pedagogic (Ife Project 1970).
- ii. Where the home language differs from the language of instruction used in the classroom, pedagogical and cognitive problems can be attributed to the choice of the language of instruction (ADAE 1996:10).
- iii. In direct comparison, children receiving mother-tongue education generally perform better than do their counterparts receiving instruction in a foreign language (Ife Project 1970). Such a finding also holds true for the core subjects, such as mathematics and science.
- iv. Mother-tongue education, in terms of which a foreign language is studied only as a subject, will not render children older than 6 years in age less proficient in, for instance, English, than those who had English as their medium of instruction throughout their primary education (Ife Project 1970).
- v. Repeating classes occurs far less in mother-tongue schools than it does in foreign language schools. In the Mali project, 48% reached Grade 6 in mother-tongue schools without having to repeat any classes, compared with only 7% in French-medium schools.

The above-mentioned findings all confirm how important mother tongue is in developing a deeper conceptual linguistic proficiency that can be transferred to the L2, as well as that instruction in the home language is crucial for cognitive development and conceptual understanding (Cummins 1986; Vygotsky 1962.). The learners were found to understand mathematical and scientific concepts better when taught them first in the mother tongue, and later in English (Ife Project 1970).

2.11 The demands of language in the science curricula

A brief look at what the RNCS of the National Department of Education (2002) says about the issue of the language will indicate its implications for the cognitive development of learners. The Natural Science curriculum intends, among other things, to develop the full potential of each learner as a citizen of a democratic South Africa, stipulating that:

Learners' home language should be used for learning and teaching wherever possible ...Where learners have to make a transition from their home language to an additional language as the language of learning and teaching, this should be carefully planned ... The home language should be used alongside the additional language for as long as possible.

Such an intention is aimed at developing tools for thinking and reasoning and at providing access to information in the language that learners understand best, which is likely to be their mother tongue or home language. So, clearly the curriculum articulates that teaching and learning not only have to scaffold the understanding of key concepts in the Natural Sciences, as well as science literacy, but have also to encourage learners to interact while absorbing such concepts.

The Language Transformation Plan of the Western Cape Education Department (WCED, 2007) also affirms the above idea, recommending the use of the mother tongue or home language from Grade R to Grade 6.

The Constitution of the Republic of South Africa (Act no. 108 of 1996) provides the basis for curriculum transformation and development in South Africa, including the rights in terms of which the Natural Science curriculum statement has been evolved. Some of the critical outcomes envisaged for learners are:

- i. Identify and solve problems and make decisions using critical and creative thinking;
- ii. Collect, analyse, organise, and critically evaluate information;
- iii. Communicate effectively using visual, symbolic and/or language skills in various modes;
- iv. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others; and
- v. Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

For African languages, including isiXhosa, the outcomes lack coherence between what is expected in terms of the science curricula and the medium of teaching and learning in the Natural Sciences. Such lack of coherence is explored in this study.

Donald (1997:106) defines curriculum development as the task of the school to meet the needs and demands of the physical, cognitive, emotional, social, and moral development of its learners.

IsiXhosa language can play a crucial role in teaching and learning in primary and secondary schooling in South Africa, based on the fact that most of the learners are proficient in the language. Although most of the textbooks and other teaching material in the Natural Sciences and other content subjects are in English, teachers often use the African languages, such as isiXhosa, to explain certain concepts and terms. IsiXhosa-speaking learners often perform poorly academically, particularly in the case of content such as that in the Natural Sciences, because the language of assessment, both orally and in writing, is solely English.

Lengthy explanations have been given for the poor academic performance of African language-speaking learners, particularly in content subjects such as Science and Mathematics. Most people link the poor performance to socio-economic problems and psychological deficiencies with which these learners are confronted. Such explanations are only partly true. However, few argue the fact that 'the inability of these learners to pass science etc, is due to lack of fluency in the language of instruction' (Cummins 1989).

After three years of primary schooling, isiXhosa-speaking learners are disadvantaged by the exclusive use of English as the medium of instruction for content subjects. They are confronted by the fact that a high level of proficiency in English is required in order for them to be able to understand the content of their textbooks, learning support materials and assessment. They have low proficiency skills in English in comparison with those that they have in their home language (isiXhosa), which might facilitate their learning of such content if it were available in their mother tongue. Their lack of mastery of the English language is clearly reflected in the low pass rate and general lack of interest expressed in scientific learning areas, such as Science and Mathematics, in the upper exit classes (DoE 2001; MoI and its Effects on Matriculation Examination Results for 2000, cited in Western Cape Secondary Schools 2002). In most classes, isiXhosa is used for various purposes, whenever there is a specific need, such as to explain a difficult point, to give a specific instruction or advice, to explain a wrong behaviour, or to enquire in a way that would otherwise be unlikely to achieve the desired results (Seepe 2000). A science learner, whose mother tongue is not used in scientific discourse, has 'very special additional difficulties of cognition and understanding' if the language of instruction is English, preventing the learner from being able to 'appeal to translation into the mother tongue for resolution of doubt or the dissipation of ignorance' (Dlodlo 1999:322).

Although isiXhosa tends to be used for giving instructions and for explaining most science concepts, such communication is only oral. Science teachers, if asked whether they can teach Natural Science in isiXhosa, usually respond with a resounding 'No', explaining that the textbooks and other teaching materials are in English. Many teachers think that teaching can take place only in English, with languages such as isiXhosa only being used as a 'favour' to the learners (SDU & PRAESA for WCED 2002).

Multiple problems tend to compound the high failure rate in the areas of Natural Science. Although the socio-economic problems and lack of resources require investigation, the strategies and methods that teachers use for conveying subject content in areas demanding high levels of conceptual thinking need to be researched as well.

2.12 Subtractive and additive multilingualism: The requirements of the National Curriculum Statement

This section explores what subtractive and additive multilingualism means in multilingual classrooms, as well as, more specifically, what such multilingualism means for isiXhosa-speaking learners in the teaching and learning of the Natural Sciences. Discussion of the two concepts is based on what is required in terms of the RNCS.

Subtractive bilingualism refers to the limited bilingualism often associated with negative outcomes (Lambert 1975). The term is applied to a context in which speakers of usually low-status languages are expected to become proficient in an L2, which is usually a dominant language of high status, such as English or French in Africa.

Additive bilingualism refers to the bilingualism associated with a well-developed proficiency in two languages, as well as with positive cognitive outcomes (Lambert 1975). The term is applied to a context in which speakers of any language are introduced to an L2 (or even a L3) in addition to the continued educational use of the primary language as the LoLT.

Lambert (1975:89) refers to the use of subtractive multilingualism in teaching as a limited approach, which is often associated with negative cognitive outcomes. He states that it is applied to a context in which speakers of usually low-status languages (such as isiXhosa in the post-Foundation Phase) are expected to become proficient in an L2, which is usually a dominant language of high status (such as English in the post-Foundation

Phase). The current study explored whether the teaching of the Natural Sciences in the Intermediate Phase demonstrates additive or subtractive multilingualism, and, if so, what cognitive outcomes such a practice promotes for most isiXhosa-speaking learners. The study examines both teaching and learning, exploring which strategies teachers use to explain certain science concepts and most technical terminology. Whether such a practice promotes or hinders conceptual and cognitive development for most isiXhosa-speaking learners, who are L3 or L4 speakers of English, is also discussed.

Johnsen (1993:27) observes that 'sometimes learners will bring to the classroom alternative ideas, beliefs or experiences which work, but which appear to be in conflict with explanations offered by western science, engineering and technology.'

In the current study it is argued that additive multilingualism is the best teaching strategy for the promotion of conceptual and cognitive development in the teaching of the Natural Sciences in the Intermediate Phase for most isiXhosa-speaking learners. Lambert (1975) sees the additive approach of teaching, consisting of the use of two or more languages as mediums of teaching, as having positive cognitive outcomes. Such an approach to teaching applies to a context in which speakers of any language are introduced to an L2 (or even more languages) in addition to the continued educational use of the primary language as the LoLT.

2.13 Code-switching as a teaching strategy

The additive strategy of multilingualism is linked to the concept of code-switching, which is the norm in classroom practice in South Africa. Van der Walt and Mabule (2001:257–268) observe that the use of code-switching in the classroom situation is not well documented, though anecdotal evidence suggests that such use is common practice. The teaching of Natural Science in most township and rural schools is dominated by a high degree of code-switching and code-mixing in teaching strategies and practices. Heugh (2003:29) mentions that 'we find that Intermediate and Senior Phase teachers in Western Cape townships conduct most of their lessons through the medium of Xhosa, with some code-mixing (using a few English terms within a predominantly Xhosa discourse).' A clear distinction has to be drawn between the meaning of code-switching and that of code-mixing, based on the work of Kaschula and Anthonissen (1995:73).

Code-switching consists of the shifting by a speaker from a language A to a language B. For example, a teacher might switch from the English 'Vertebrate animals are animals that have internal skeleton of bones' to an isiXhosa explanation: '*Izilwanyana ezizi-vertebrathi zizilwanyana eziamathambo esikeletoni.*' However, such code-switching can do little to benefit a learner.

Obscuring of the concept can also occur, during which the speaker might 'borrow' words or phrases from an L2 in the course of a conversation conducted mainly in another language. For example, if a Grade 5 isiXhosa-speaking teacher were to teach the above lesson on vertebrates to isiXhosa-speaking learners, such code-switching might be used intermittently in an attempt to help the learners to understand conceptually what vertebrates are, such as in *Izilwanyana ezizivertebrates zizilwanyana ezine internal skeletani.*

Though borrowing and code-mixing are used to increase the scientific corpus of African languages, such borrowing of technical vocabulary can easily block the conceptual understanding and cognitive development of isiXhosa-speaking learners. Most teachers in township and rural schools where isiXhosa is the dominant language spoken tend to rely on such language practices as code-switching and code-mixing to transfer the meaning of scientific terms and concepts, unwittingly obscuring such meaning. Such practice is, in fact, not only the norm in South Africa, but also in other African countries, which rely on such strategies to achieve successful outcomes in education.

Discussion of code-mixing in the Natural Sciences and other highly conceptual learning areas is therefore imperative in coming to an understanding of the phenomenon of subtractive multilingualism in teaching. As previously stated, most learners who speak isiXhosa and other African languages find difficulty with mastering such learning areas.

The constitution, the South African Schools Act and the Language in Education Policy (LiEP) of 1997 all advocate the development and promotion of the eleven official languages. Furthermore, the LiEP gives a clear directive regarding additive bilingualism, stressing the need to encourage the home language of learners as the foundation for learning additional languages. Such a policy is clearly aligned with the constitutional stipulation that all languages are to be equally respected.

The LiEP (DoE 1997:4) aims to achieve the following:

- to promote full participation in society and the economy through equitable and meaningful access to education;

- to pursue the language policy most supportive of general conceptual growth amongst learners, and hence to establish additive multilingualism as an approach to language in education;
- to promote and develop all official languages;
- to support the teaching and learning of all other languages required by learners or used by communities in South Africa.

The curriculum also provides strong support of those learners who have to use their first additional language as the LoLT. By the end of Grade 9, such learners should be able to use their home language and first additional language effectively and with confidence for a variety of purposes, including that of learning (South African Department of Education 2002b:4).

It is recommended that the learner's home language should be used for learning and teaching wherever possible. This is particularly important in the Foundation Phase where children learn to read and write. Where learners have to make a transition from their home language to an additional language as the language of learning and teaching, this should be carefully planned ... The home language should be used alongside the additional language for as long as possible.

All the official documents quoted above promote the use of additive multilingualism. The documents emphasise the need for retaining the home language(s) of all learners as the medium of teaching for as long as possible. However, after the Foundation Phase the home language of isiXhosa-speaking learners is sacrificed for English, with the vernacular being used only on an ad hoc basis. The result is that isiXhosa is not used properly in teaching the Natural Sciences.

2.14 Devising the technical corpus in isiXhosa

Most isiXhosa-speaking teachers are faced with the challenge of having to explain, define and provide equivalent terms in isiXhosa for certain scientific text and terminologies with which they have to deal in their everyday science classes. The inferior quality of education, among other things, that was attained during the times of the apartheid government failed to equip most African language teachers with the proper language skills in either their home language or in English, their L2, for enabling them to cope with the unique proficiency skills that science teaching demands.

As a result, most teachers find difficulty in dealing with scientific English registers, which makes the teaching of Natural Science concepts and terminology in English extremely challenging. Therefore, most of the time the teachers concerned have to resort to the direct borrowing of most of the science terms that they use from the English language, which terms they then incorporate in their isiXhosa vocabulary. Such teaching practice is problematic for learning and teaching. Kishindo (2003:113) finds that many terminographers simply assume that most learners understand the concepts behind the terms, regardless of whether they are in their native language form or in English. Such an assumption is unfortunate. Despite borrowing providing an easy route out of the terminology conundrum, it does not solve the conceptual problem. Borrowing directly from the European languages by means of phonetic transcription should be avoided, since such borrowed words do not initially convey any meaning. Such methods merely tend to produce clumsy-sounding 'scientific' words in the vernacular (Dlodlo 1999:324). Most teachers tend to adapt and borrow scientific words directly from English without trying to explain them in the learners' home language, as can particularly be found in the case of teaching conducted in isiXhosa.

Such borrowing, as that alluded to by Kishindo, becomes very problematic for most isiXhosa-speaking learners, as it hinders their scientific literacy through limiting their conceptual understanding and cognitive development.

Most learners learn without fully understanding the concepts and terminology used, leading to rote learning and the likelihood of having to memorise scientific content without proper understanding of the concepts and terms involved. Heugh (2003:29) related that 'when I have asked the pupils to tell me what they understand of these sentences, they cannot. They cannot, with accuracy, relate the English sentences to the content of the lesson in which they have just participated through isiXhosa.' In the former DET schools, one can clearly detect such a lack of understanding in the Intermediate Phase. The learners in this phase come from the Foundation Phase, where the language of teaching and learning was their home language.

In the Intermediate Phase they suddenly have to adapt to English as the medium of instruction, being taught by teachers who are uncomfortable with teaching in English alone. The corollary to the unequal role allocation of the two half LoLTs is teachers' use of code-switching and code-mixing. In the study by Brock-Utne et al. (2004) the project team 'found that the

simultaneous oral use of isiXhosa and English in the Science classroom was widespread, intuitive, unsystematic, at times resourceful and yet fraught with problems' (Brock-Utne et al. 2004:159). Such a practice has resulted in the subtractive approach, in which much unsystematic alternating between the languages concerned exists, with most learners being stronger in isiXhosa than they are in English, their L2, in which they tend not to be well grounded in terms of their proficiency skills. Schutte and Orr (1992) found that the difficulties that readers of science texts face are exacerbated for those for whom English is not L1.

Apart from remarking on the unfair use of English as the medium of teaching, Rampal (1992:229) observes that most science terminology was adapted by English from other European languages in the first place: 'While the discourse of science chose to use dead words to suppress unwanted associations, it also adopted a "deadpan", or detached and disembodied, tone to obliterate any reflections of subjectivity.' Rampal states that, even though the language of science was created out of dead languages, such as Latin, 'its terminology became finely differentiated and its theory sought precise definitions for the fine-grained concepts it evolved.'

For instance, as concepts in mechanics developed, the science of 'movement' was gradually differentiated into a fine spectrum of precise, unambiguous terms, such as 'velocity', 'speed', 'momentum', 'inertia' and 'kinetic energy', with each term having a meaning quite distinct from its everyday connotations. So, the terminology which is used in the teaching of the sciences is the language with which even the native speakers of English are not familiar. The mastery of such terminology is even more difficult for African language speakers, for whom the English language, as a whole, sounds foreign.

Rampal's (1992:231) assertion that science uses the terminology of dead language(s) is correct, in that the etymology of most science terminology lies in Latin or Greek roots. However, as most teachers are not directly involved with the development of terminology they tend not to be aware of such roots.

Rampal (1992:235) further indicates that most scientific words or terminology were created to be precise in meaning and unambiguous. The question arises as to whether it is possible to teach the Natural Sciences in isiXhosa without ambiguity. This is indeed so, despite the fallacies that African languages are not capable of expressing scientific concepts, due to their lack of precision. Such fallacies lead to stereotyping of the languages

concerned, such as when Dlodlo (1999:325) points out that 'African languages as vehicle of science and technology is a goal far from being achieved'. Such a myth needs debunking, as the Natural Sciences will, indeed, be able to be taught effectively through the medium of the African languages, once the corpus has been sufficiently well developed.

Coining scientific terminology in isiXhosa for the teaching of the Natural Sciences in the Intermediate Phase would enhance the understanding of scientific concepts and terminology for most isiXhosa L1 learners. The concept of word coining entails embarking on the process of creating new isiXhosa scientific terminology to facilitate the transfer of concepts and terms to such learners. The development of terminology involves employing the principles and mechanisms of producing new terms by examining the scientific rigour of words, in terms of linguistics or phonology, speech communities, phase levels and subject specialists.

3. Methodology of the study

3.1 Method of research: Introduction

Chapter 3 contains a discussion of the research tools employed to explain how scientific terms are taught and learnt at the Intermediate Phase level. The detailed description of two schools from different situations or environments will fall under the paradigm of a case study. Case studies concentrate on the experiential knowledge present in a case and pay close attention to the influence of the case within its socio-political context (Stake 2005:444). The focus is on teaching and learning practices and on what role language plays in promoting conceptual understanding and cognitive development. The mechanisms that teachers use to explain scientific concepts and technical terminology during the teaching and learning of the Natural Sciences will be explored. How current teaching practices affect the academic performance of isiXhosa-speaking learners in this particular learning area will be revealed. The study, therefore, entails looking at how isiXhosa and English are used in the teaching of the Natural Sciences.

3.2 The research paradigm

The case study largely focuses on the processes that promote conceptual understanding and cognitive development, with the language used for teaching and learning forming the core of the research. Denscombe (1998:40) states that case studies tend mainly to focus on process rather than on measurable factors, as they tend largely to rely on qualitative data and interpretive methods, rather than on quantitative data and statistical procedures. The study employs a densely interpretive approach, which uses descriptions and the understanding of certain teaching and learning processes (Babbie & Mouton 2001:270).

Denscombe (1998:89) further mentions that the multi-method approach allows findings to be corroborated or questioned by comparing the data

produced by different methods. If, for instance, the observation of disruptive behaviour suggests one possible explanation, such an explanation might be corroborated or discarded on the basis of findings from, for example, interviews with the participants. Consequently, the study relies on different forms of data collection in the form of observations, interviews and work with the children involved.

3.3 The research method

The case study uses multiple sources of data, the use of which, in turn, facilitates the validation of data through triangulation. The study uses observation schedules, interviews, field notes and collections of the children's work (Denscombe 1998:40).

The data collection is derived from the interviewing technique, as well as from the direct observation of teacher and learner practices in the Natural Sciences (Babbie & Mouton 2001:279). The research endeavours to describe certain teaching practices in explaining Natural Science concepts and technical terminology in the Intermediate Phase, in order to find out if such practices help to promote the cognitive development and conceptual understanding of isiXhosa home language learners. The research enabled observation of how the concepts and terms used in the teaching of the Natural Sciences were being introduced to the isiXhosa-speaking learners concerned. The classroom observations (in terms of a pre-designed observation schedule) of the current Natural Science teaching practices were accompanied by the noting of concepts and technical terminology used in the Natural Sciences content that is taught in the fourth quarter of the year.

The study focuses on two Grade 5 classes from two schools (one of which is less-resourced and one semi-resourced) falling in two different Educational Management and Development Centres (EMDCs) or educational districts, as indicated above. School A is located in EMDC Metro East and school B in EMDC Metro South. After observing the lessons concerned for a week in each school, the learners' notes and other work were examined to support the argument. In the absence of tests and assignments, the study relies on what teachers had to say in their explanations of terminology and the notes and summaries given in the lessons concerned. The Natural Science textbooks and other teaching materials currently used to help the learners understand concepts and terminology in the Natural Sciences were also examined.

3.4 The instruments of research

The instruments of research consisted of the following:

- the observation schedule;
- the interviews conducted with the teachers concerned with the study; and
- the learners' worksheets and books.

Each of the instruments will now be discussed in turn.

3.4.1 The observation schedule

Classroom observations were undertaken by the researcher concerned, who took no part in the teaching and learning process, but who remained an outside observer (Babbie & Mouton 2001:293). Such a method of observation offered the opportunity to explain why certain outcomes occurred, rather than merely allowing for finding out what the outcomes were (Denscombe, 1998:30). The use of an observation schedule facilitated looking at language distribution during the teaching and learning of a science lesson. The consent of the teachers participating in the study was obtained, in order for the study to be authentic as possible and to allow for the gleaning of genuine results. Consequently, the participating teachers were encouraged not to rehearse their lessons or to change their usual teaching methods and strategies.

The observation schedule was based on the following specific indicators:

- the introduction of new concepts and explanations of the terms;
- their contextualisation;
- the use of English and isiXhosa terms;
- the questions asked about the terms;
- the use of exercises to elicit the use of the term(s);
- the provision of feedback;
- the recapping of the content of the lesson; and
- the conclusion of the lesson concerned.

The observation schedule employed was based on the assumption that the isiXhosa-speaking learners involved needed their home languages for their cognitive development and conceptual understanding of the Natural Science concepts and terminology employed in order to be able to construct their own understanding of their surroundings. All the above-mentioned

indicators served as a guideline as to what to note down and follow up on during the investigation of teaching and learning practices. The observation schedule tool was circulated among the teaching staff, facilitating discussion of the specific terms employed.

3.4.2 The interviews conducted with the teachers concerned with the study

After elucidating the nature of teaching and learning practices, the teachers were interviewed in line with a standardised questionnaire. Individual interviews were conducted, consisting of questioning of the interviewees, with the interviewee being expected to record answers on the questionnaire.

An interview is an integral part of the whole qualitative research process (Babbie & Mouton 2001:291). Furthermore, as the in-depth interview continues, more is learned about the way in which the interviewee's opinion came into being, rather than about what exactly that opinion is. Such a method of data-gathering helped to present a full picture of the phenomenon addressed in the study (Henning 2004:33).

The purpose of the questions concerned was to elicit the teachers' views and understanding of language as the medium of teaching and learning. In most schools, the likelihood is that their language policy advocates the use of the learners' home language for the first three years (the Foundation Phase), after which English is used as the medium of instruction from the Intermediate Phase onwards. Most teachers use both the home language and the first additional language.

As the interviews concerned teaching and learning practices, the first question in the interview asked which language(s) were used by that particular teacher in the teaching of the Natural Sciences. The second question aimed to elicit how much code-switching or mixing of the languages used took place during teaching and learning. If no code-switching or mixing was said to occur, the teachers concerned were asked how they explained or transferred certain concepts and terminology to their learners. However, if they stated that they did tend to code-switch, they were asked whether they found such a practice useful in terms of the learners' cognitive development and conceptual understanding of concepts and terminology. They were then asked which language they thought they used more of, and why, or whether they used both languages equally all the time during teaching and learning. The final question pertained to which teaching strategies the teachers used

so that meaningful teaching and learning could occur during their lessons. In response, the teachers were required to explain the strategies they employed or relied upon to make the learners understand the concepts and Natural Science terminology involved. The teachers had to state whether isiXhosa, as the home language of learners concerned, would help them to teach the Natural Sciences effectively.

3.4.3 The learners' worksheets and books

Consideration of the worksheets completed by learners during their class work and homework, as well as during their assignments and tests were also of interest to this study. Such work reflected their understanding of Natural Science concepts and technical vocabulary, as well as whether they used isiXhosa in their writing. The analysis looks at which language(s) the learners use for which purpose in their written work. The language used and the way in which facts were found to be organised in their textbooks was also considered. The content of the textbooks used in the Intermediate Phase was examined in order to find out whether it helped the learners concerned to think critically and to explore issues relating to science on their own. The comprehensibility of the technical language used in teaching the Natural Sciences to the learners concerned was also considered. The level of concepts and terminology used in the Intermediate Phase to promote cognitive development and conceptual understanding was explored, regarding what pedagogical implications the maintenance of such a level has for the teaching and learning of the Natural Sciences.

3.4.4 The role of the researcher in the research

The researcher took no part in the planning and teaching of lessons, as the study is a qualitative one based on observing and analysing teaching and learning practice and materials. The role of the researcher was, therefore, restricted to one of collecting data in terms of an observation schedule and interviews conducted with teachers. Such a role also entailed looking at other additional teaching resources, in the form of textbooks, charts and posters, allowing the consideration of both isiXhosa and English in the promotion of the cognitive development and conceptual understanding of the learners involved. The study was adapted to the theoretical framework on which it is based.

3.4.5 Issues of validity and reliability

The current study is based in the field of psycholinguistics, as it entails cognitive and conceptual understanding in the learning area of the Natural Sciences. The study was conducted in two schools, one less-resourced and one semi-resourced, located in two different education districts. A number of standard questions had to be drafted for use during the research, as they were to be used as a guide during the observations, as well as for the teachers' interviews. Additional field notes and an audio recording were used to close the gaps revealed during the study. Other teaching materials were also analysed in an attempt to link the use of language with that of resources. The analysis was aimed at showing how the use of such resources influences teaching and learning in the field of the Natural Sciences.

4. Findings

4.1 The interpretation of findings

Chapter 4 integrates the findings made during the observations, interviews and analysis of materials collected during the process of the study. The general trends and challenges that were observed and noted in the two schools under review fell into the following three categories:

- classroom observations;
- interviews with teachers; and
- the analysis of learning support materials.

4.1.1 Introduction

The current study investigated strategies that are used by isiXhosa-speaking teachers when they teach the Natural Sciences to learners who speak isiXhosa as their home or first language. The case study was conducted by observing the learners' conceptual understanding and cognitive development during the teaching and learning of Natural Science concepts and terminology. Tentative conclusions were drawn about the nature of their understanding. The research was intended to create an argument about how the current teaching practices affect the academic performance of isiXhosa-speaking learners in the Natural Sciences learning area.

4.1.2 The general background of both schools

Both schools share certain socio-economic challenges, such as poverty and under-resourcing, with many of the learners' parents being unemployed or self-employed. Apart from sharing such challenges, they also share the same language and culture. The isiXhosa language is dominant in both areas, with the only way of accessing the English language being through

the media and newspapers. IsiXhosa is the only language used outside the school environs, such as at religious gatherings, in playgrounds, and for other social activities. The language in which most learners are proficient in both areas is their home language, which is isiXhosa. Therefore, schooling should rely on the learners' knowledge of their home language for the transfer of concepts in teaching the Natural Sciences in particular, as well as in other learning areas.

The role of parents at both schools is not clearly defined. The governing body at both schools was reported by the teachers concerned as not functioning properly. The mission statement of both schools also indicates a lack of clarity in this regard. Parental involvement was observed to be neither clearly defined nor so well articulated as to provide a clear vision and mission for the school to be able to attain proper and meaningful goals.

Where neither the mission nor the vision is clearly articulated in school policies, the schools concerned cannot make and implement decisions that are based on educationally sound principles, as to what language to use and for which purpose, in order to facilitate and improve the teaching and learning situation. Although such schools differ in terms of resources and in the way in which they manage their everyday business, the way in which they use the isiXhosa language in school-related issues is similar.

4.2 The criteria employed when choosing the schools for this study

The two schools selected for this study were chosen on the grounds of their geographical allocation in terms of the new educational demarcation, that is, in terms of the EMDCs or districts. As indicated in the chapter on methodology (see paragraph 3.2.1), school A was located in EMDC East, while school B was located in EMDC South. While one school was less-resourced, the other was semi-resourced. The two schools were selected on the basis of such resourcing in order to see whether the difference in resources would affect the use of English and isiXhosa at the schools concerned. A formal letter was written to the Western Cape Education Department (WCED), as well as to the principals of the two schools, asking for permission to conduct such research. The necessary permission was granted by Mr R. Cornelissen of the WCED for the study to be conducted at both schools (see Appendix 3).

4.3 Classroom observations

The observations were undertaken in the second quarter of 2007 in two township schools, one each in Gugulethu and Langa. Observations of two Grade 5 classes at the schools were undertaken during the course of one week spent at each of these schools, so that, in total, two weeks were spent on the observations. The observations were geared towards answering how and for which purpose a language was used as the medium of teaching and learning in the Natural Sciences. Textbooks and other additional teaching resources, such as charts and posters, were also examined to find out how such resources were used in teaching and learning.

An observation schedule was devised to guide the observation of language distribution during teaching and learning, in order to establish which language was used orally and which for writing, and for what purpose in each case. All the issues examined formed part of either 'teacher talk' or 'learner talk' (see numbers 1 to 6 in the teachers' observation schedule, Appendix 1).

Fieldnotes were also taken during the process of observation in order to record all that was noteworthy. The lessons were also taped in order to allow for recapping of any key issues that might have been missed during the observation. The tape recordings were used in conjunction with the fieldnotes to make up for any omissions or failure in recall.

4.4 School A: Classroom observations

4.4.1 Physical structure of the school

School A is a primary school housed in permanent brick buildings, which is situated in Gugulethu townships, which is one of the areas dominated by the isiXhosa-working class community. Most families that stay in the area either do not work, work on casual jobs, or have their own small business. Most learners in the area have to depend on government social grants. Most of the teachers who teach at this school live in the same area. Most of the learners, if not all, who attend the school live in the same area. Hardly any learners at the school come from other areas.

The local community is predominantly isiXhosa-speaking, containing only a few members who speak a little English, which is a language which most seem not to have mastered. Code-mixing and code-switching are a common practice, with an increasing number of the new generation being

eager to learn English. Such eagerness is due to the current-generation parents or communities perceiving English to be a prestigious language, due to its promotion by the media, schools and other government institutions, as well as by the private sector and business. The teachers participating in the study stated that crime, gangsterism, and drug and alcohol abuse were some of the more worrying factors that posed many challenges to school management, and which militated against the promotion of an ethos of discipline and respect, as well as against the maintenance of a teaching and learning culture.

4.4.2 Language distribution

The school practises a transitional model of teaching. During the first three years of the Foundation Phase, from Grade 1 to Grade 3, the medium of teaching and learning is isiXhosa in all learning areas. English is used as medium of teaching from Grade 4 to Grade 7. According to the teachers at the school, most of the learners are isiXhosa-speaking, with the few seSotho- and seTswana-speaking learners seeming to be proficient in isiXhosa as well, due to few speaking seSotho and seTswana in the surrounding community. All of the teachers at the school are also first-language isiXhosa speakers, with only two or three teachers understanding the seSotho language. However, the community in which the school is based is predominantly isiXhosa. In the classes that were placed under observation, the teacher–learner ratio was 1:50. Therefore, the classes are exceptionally large, because the Education Department strives for a teacher–learner ratio of 1:35. The language composition in most of the classes observed was predominantly isiXhosa. English was seen to be marginalising isiXhosa. English was found to be used at the expense of the L1 of most isiXhosa-speaking learners. Most learners and teachers tended to be more comfortable with the use of their L1 than with that of their L2.

4.4.3 The description of the classroom

Of the approximately 50 learners in each class, about 30 were girls and 20 boys. The desks in the classroom were arranged so that the learners were able to work in mixed-gender groups. The congestion due to the large numbers was a problem with which most teachers had to contend.

4.4.4 The language profile of the teachers and learners involved in the study

The teacher of the class observed was a first-language isiXhosa and second-language English speaker. The fluency of the teacher was, therefore, at different levels for each language. The medium of teaching and learning for the content subjects was meant to be English only, as is the case for most former DET schools. However, in practice the situation was observed as being totally different. With the teacher coming from a society that uses mainly isiXhosa in all communication, he was found to be highly proficient in isiXhosa as his home language, although he was able to read and write both languages.

The learners were found to speak the same language (isiXhosa) as their teacher, so it meant that there was no teacher–learner mismatch in respect of the L1. English was found to be regarded as the L2 of all the learners, who were all found to speak an African language as their home language. Most of the learners who were found to speak isiXhosa had not been exposed at an early age to English, so that their proficiency skills were not well developed in the latter language. They tended to regard English as their L2, which was being used as their medium of instruction from the Intermediate Phase up to the higher learning levels. The learners concerned, therefore, had to make do with the use of English throughout their schooling.

4.4.5 Talk and general conversation in the classroom

IsiXhosa was the only language that was observed to be used by the learners before the lesson commenced. By moving around in between their desks, the researcher noted that they spoke more in isiXhosa throughout the lesson. Most of the time, the teacher gave instructions, and insisted on discipline, in the home language of the learner in order to make sure that he was understood. Accordingly, starting with the L1 was seen to provide a sense of security that validated the learners' lived experiences, allowing them to express themselves 'while at the same time providing meaningful written material to work with' (Ausubel 1993).

Whenever the teacher started to talk in English, the learners would start whispering to one another, resulting in the classroom becoming noisy. If the teacher spoke in their home language (that of isiXhosa), the learners appeared willing to participate by talking in their home language. As soon as

the teacher switched to English most learners started to look down to avoid eye contact with the former. Those who kept eye contact looked as though they were in despair, placing their hands on the side of their face, as though they were wondering about what was going to happen next. Judging by such gestures, behaviour and attitudes, most of the learners appeared to appreciate being addressed by their teacher in their home language, isiXhosa, rather than in English.

4.5 The lesson topic: Life and living: The process of photosynthesis

The observation schedule was designed to assist with the capturing of data related to teacher and learner language distribution and practices during teaching and learning. The data concerned fell into one of the following rubrics:

- the introduction of the lesson;
- the explanation of a term;
- the asking of questions;
- the provision of exercises;
- the provision of feedback;
- recapping; and
- the conclusion.

4.5.1 The introduction of the lesson

The introduction of the lesson took place in English, with the teacher starting by asking a question, in response to which the whole class was silent. The teacher kept on talking for a few minutes. The teacher wanted to find out whether the learners remembered what they had been taught a few days previously. Due to the lack of response, the teacher clearly felt obliged quickly to translate the introductory question into isiXhosa: *'Ingaba izityalo ziyazenzela ukutya?'* At once, a few learners raised their hands. With some of the learners' hands being only half up, most of the learners showed some uncertainty about whether they were going to give the right answer. They seemed to doubt whether they understood a question correctly, though there was some attempt to answer the question that was asked. Their chorused response consisted of only one word, 'Yes'. The lesson then proceeded.

In the lesson observed, the teacher focused on the theme of 'Life and Living'. In terms of outcomes-based education (OBE), teachers are expected to engage with learners on projects in which the latter are expected to work in groups, with the teacher acting as facilitator. Ongoing assessment was seen to be taking place around the theme. During the whole lesson, all the writing, whether on the blackboard or in books, took place in English only. However, the verbal interchange between the teachers and learners was an ad hoc mixture of English and isiXhosa. A description of the observation that took place is followed by a transcription of the recording made during the lesson.

The teacher wrote the following statement on the blackboard: Plants make their own food through the process of photosynthesis. He continued:

Teacher:

Thabiso [a learner in the class] has asked an important question. The oxygen in the atmosphere does not get used up, because plants make oxygen. Plants use up carbon dioxide, water, mineral salts and sun to make their own food. When plants make food during the process of photosynthesis, they also make oxygen. The oxygen is released from the leaves of plants and goes back into the air. In this way, fresh oxygen is always in the air for people, animals and plants to use.

[All the teachers' writing was in English only. He then asked the following question to find out whether the learners had been following what was written on the board.

1. T: Do plants make food?
[The same question translated into isiXhosa follows.]
2. T: *Ingaba izityalo ziyakwazi ukuzenzela ukutya?*
3. Ls: Yes, teacher [a one-word response, in English]
4. T: *Zikwenja njani izityalo ukutya?* [How do plants make their food?]
5. Ls: *Zisebenzi amanzi neeminerali salts* [Plants use water and mineral salts]
6. T: What else do they use?
7. Ls: *neCarbon dioxide kunye nelanga*
8. T: OK, what do we call the process when plants make their food? [This question had to be repeated in isiXhosa: *'Sithi yintoni loo prosesisi xa izityalo zizenzela ukutya?'* (Teacher translation)]
9. Ls: *yiFotosyntesis* [It is photosynthesis]

10. T: *Sithetha ukuthini xa sithi yiFotosyntesisi* [What do we mean by photosynthesis?]
11. Ls: *Ithetha ukwenza ukutya* [It means making food]
12. T: Can photosynthesis happen without light?
13. Ls: No [a one-word answer]

4.5.2 Analysis of the lesson

When the teacher asked the learners' about their understanding of how plants make food (see line 8), although the question was translated into isiXhosa, he did not provide the proper isiXhosa equivalent term for the word 'process'. The word that he used was borrowed directly from the English (process = *i-prosesi*). As there is an equivalent term for the word in isiXhosa (process = *inkqubo*), the researcher expected the teacher to use that word instead. The practice of direct borrowing appears to block the cognitive and conceptual understanding of the Natural Sciences by the learners.

In the learners' response to the teacher's question (see line 9) a direct borrowing of the word 'yifotosyntesisi' from English was seen to have been incorporated into the isiXhosa vocabulary, with the term being Xhosalised. The stem of the word 'photosynthesis' was left unpacked in the learners' home language. The process of photosynthesis is used to illustrate the arguments made in the following subsections. Borrowing (by means of code-switching) technical words from English shows that such tendencies can disadvantage isiXhosa-speaking learners in regard to their cognitive development and conceptual understanding of the Natural Sciences.

4.5.3 Content of the lesson: Learner and teacher talk

Whenever the teacher unsuccessfully tried to interact with the learners in English only, he resorted to using their home language, isiXhosa. The whole lesson concerned photosynthesis, which is one of the most important concepts relating to plants in the Natural Sciences theme: life and living. At the beginning of the lesson, as already indicated, a number of questions were asked to ascertain how much the learners knew about the theme. Constant alternation occurred between English and isiXhosa (see lines 1, 2 and 8) in order to move the lesson forward.

The interaction with learners engaged in by way of alternating the languages at certain points of the lesson was vague and unclear for the learners involved. Some of the words used in the lesson were introduced,

but went unexplained in both English (the medium of instruction) and Xhosa (the learners' home language). For instance (see lines 5 and 7), how plants use water, mineral salts, carbon dioxide and sunlight during the photosynthesis remained unclear. Instead of unpacking the word 'photosynthesis', so that the learners might better understand the concept as consisting of photo, meaning 'light', and synthesis, meaning 'the manufacture of something', the teacher jumped straight to the process. The question 'What do we call a process where plants make their own food?' was responded to by the learners in a chorus. During the content delivery, most teachers who were observed dominated their lessons, with their teaching being more teacher-centred than learner participatory. They were seen to strictly follow what the textbook said, without any further elaboration or explanation.

4.5.4 The learners' responses to questioning

The learners seemed not to be taught in a way that freed them to ask questions about the content of the lesson. Despite their struggling to attend to English as the medium of teaching, they also seemed to live in fear that a question could be posed at any time, which they would be expected to answer in English. The way in which the questions were formulated elicited only one-word answers (see lines 1, 7 and 13). There was no digging or asking of higher order questions. Questions such as 'What?' or 'How?' were posed. Each time the teacher asked a question, he would give the learners a mandate to answer in Xhosa if they wanted to. He would also often translate the questions from low conceptual English to low conceptual Xhosa. Such questions were only set to elicit one-word answers without elaboration to show that the learners had actually conceptually understood the questions posed. The learners struggled or were doubtful about responding to the low-order questions, no matter whether they were asked in their home language or in English, because of the way in which both languages were used during teaching, learning and assessment, including both oral and written form. No clear roles existed for the use of isiXhosa and English. The above-mentioned examples clearly demonstrate the kinds of questions that were asked during the lesson under review.

Learners' conceptual understanding would be likely to benefit from questions being posed only in English or isiXhosa, instead of a mixture of the two languages. Most of the time, the oral questions were asked in a mixture of the two languages, while IsiXhosa was used more in the

oral form for clarification purposes, but in an unplanned way. The way in which English and isiXhosa was used alternatively or interchangeably was totally inconsistent.

The learners were expected to write in English, which is how the teachers concerned delivered their lessons. The worksheets of most of the learners clearly showed that they were mixing the two languages (see lines 5, 7 and 9) when answering their questions and that they sometimes mixed their writing system.

For learners to be taught in their L2, as was the case with the IsiXhosa-speaking learners in the study, is problematic for the understanding of content. However, learners can also be challenged by content, even when it is taught in their home language, if it is not conveyed in a planned and meaningful way.

4.6 School B: Classroom observations

School B is a semi-resourced primary school situated in Langa, which is one of the oldest townships in the greater Cape Town area. Langa is regarded by most people as being the only isiXhosa-dominated township close to the central business district, resulting in the school in question offering a number of intervention projects related to teaching and learning. The school has a state-of-the-art functional computer laboratory, as well as a steadily expanding science laboratory. In addition, the school receives offers of a variety of books from different companies. The good management of the school also plays a role in attracting projects that contribute to the innovative development of its environment. The school is, consequently, well resourced, in comparison with other townships schools, offering its learners a quality education far surpassing that offered by other schools in the township, which lack such resources. Almost all the 48 educators on the staff were employed by the government at the time of the study. The teacher-learner ratio is about 1:48 in some classes.

The school also uses the transitional teaching model, in terms of which the medium of teaching and learning during the first three years of the Foundation Phase is isiXhosa in all the learning areas, while English is used as the medium of instruction from Grade 4 to Grade 7. Most of the learners and teachers at the school were found to speak isiXhosa as their home language. They tended to be much more proficient in isiXhosa than they were in the English language, which is used as the medium of teaching and learning beyond the Foundation Phase, from Intermediate Phase up.

Members of the community surrounding the school are virtually all isiXhosa-speaking, with some being able to communicate in other Sotho languages, such as seSotho and seTswana. Most learners who attend School B, similarly to those who attend school A, come from poor families, with most of their parents being self-employed or working as casual labourers. Therefore, the socio-economic surroundings of both the schools under review are similar in many ways.

4.6.1 The description of the classroom

The classroom used in the study conducted at this school contained 50 learners, with there being more girls (29) than boys (21). The learners' desks were arranged in such a way that the learners could easily hold discussions, with their tables being placed together to allow them to work in groups. The groups tended to be dominated by the girls, who formed the majority of the class. There were passages in between the desks, so that their teacher could walk around while facilitating the lesson.

The posters and charts on the wall were all in English, with not a single picture being labelled in isiXhosa, the learners' home language. At the front of the classroom was a small cupboard containing a few books that are used for literacy for an hour at a time. The teacher had his own table and chair in front of the learners' desks. Given the number of learners in the classroom, the arrangement seemed to suit the teaching and learning environment.

4.6.2 Language distribution

As indicated above, the school follows the transitional model of teaching, with isiXhosa being used as the medium of teaching and learning in the Foundation Phase, after which there is a switch to English in the Intermediate Phase throughout the learners' primary schooling.

All the learners at the school are fully proficient in their mother tongue, which is largely that of isiXhosa, except for the few who speak one or other of the Sotho languages. The only time that the learners were obliged to speak English was during teaching and learning. Most of their teachers share isiXhosa with them as their home language, so that most of the communication during teaching and learning took place in isiXhosa. The researcher considered the variety used to be acceptable, because he could understand and relate to what they said. The books, especially in the content learning areas, were mainly in English, with all other official documents, such as the national curriculum statements, being written in English only.

The teachers and learners had a common or natural understanding that they could code-switch more in isiXhosa, with a few doing so in English, during teaching and learning. Most teachers were found to be bilingual, with isiXhosa being their home language and English their L2. The English language is used as the medium of teaching in the areas of high conceptual thinking, such as the Natural Sciences and mathematics. IsiXhosa is the dominant language for communication both informally and formally and both in and outside the classroom.

4.6.3 The language profile of the teachers and learners involved in the study

The teachers at the school were found to be primarily L1 isiXhosa and ESL speakers, as is always assumed for all African language speaking teachers. So, as is the case with the learners, the proficiency of most teachers in both isiXhosa and English was at different levels. English was being used as the medium of teaching for the content subjects, including the Natural Sciences, which was the L2 language for most of the teachers. The teachers seemed less proficient in English, which is often the case with L2 speakers. The language, isiXhosa, in which most teachers were highly proficient, tended only to be used by most teachers when there was a deadlock in communication during the presentation of their lessons (see subsection 5.2 below).

Most teachers came from the same linguistic social background as that of the learners, meaning that there was no language mismatch at the school, as the language of high proficiency for both the teachers and learners was IsiXhosa, their vernacular. Most learners were also found to speak English as their L2. However, the learners were not necessarily conversant in the language, especially when it was used as the medium of teaching. So, the only language in which the learners had high proficiency skills was their home language, isiXhosa. A few of the learners were also able to speak the seSotho languages as well.

4.7 Talk and general communication in the classroom

The only language that was used by the learners before the lesson commenced was isiXhosa, their mother tongue. Most of the time, a teacher would give instructions and insist on discipline in the home language of the learners to ensure understanding. Whenever the teacher started to talk in

English, which was the L2 of the learners, most of the learners would start to whisper to one another in their home language, isiXhosa. If the teacher switched to their mother tongue, they would immediately stop talking and listen attentively.

Once their teacher switched back to English, the learners were observed talking quietly and softly to one another in isiXhosa. Not one attempted to speak in English. Their facial expressions reflected their wonder at the whole process of teaching and learning. The learners seemed more relaxed when their teachers spoke in their home language, but when English was used the mood of the class seemed to change immediately.

4.8 The lesson topic: Matter and materials

4.8.1 The introduction of the lesson

The teachers who were observed at both the schools involved in the current study appeared to share some of the teaching styles, in their presentation of lessons. Whether such commonality related to the methods or strategies employed was uncertain, but might warrant further investigation in future. The phenomenon might have to do with teacher training.³

The lesson introduction was in English alone, during which the whole class remained silent. After continuing to talk for a few minutes, she tried to find out whether the learners still remembered what they had learned in earlier lessons. When the questions were translated into the learners' home language, some learners immediately started to raise their hands, though they appeared doubtful as to whether to raise their hands or not, as they seemed unsure as to whether they had understood the question correctly.

The following was observed during a lesson on the theme matter and materials. The teacher began by stating:

Matter is anything that takes up space and has mass. Each state of matter is different from the others. Everything that you can see and feel is made up of matter.

The above paragraph was written on the board in English only. The teacher then switched to isiXhosa to ask the following:

³ Though it might seem as though this is merely a repetition of the lesson observation, this is not the case. This is what was observed, among other teaching that occurred during the same week. The lesson concerned, as with the lesson observed at school A, was introduced, with questions being posed right from the start. The similarities between the two schools are obvious.

1. T: *Yintoni imatter?* [What is matter?]
2. Ls: *iMatter yinto okwaziyo ukuyibamba* [Matter is something that you can touch]
3. T: What does matter contain?
4. Ls: *iMatter yenziwe zizinto ezincinci* [Matter is made up of small things]
5. T: Can you give me any examples of matter?
6. Ls: Wool that makes clothing
7. T: *Yintoni enye?* [What else?]
8. Ls: *Isonka senziwe ngengolowa* [Bread is made up of wheat]
9. T: What is the difference between matter and materials? [*Yintoni I umahluko phakathi kwematter neematerials?*] *Teacher translation in isiXhosa*
10. Ls: *Ziyafana* [Matter and materials are the same]
11. T: *Nika umzekelo weematerials?* [Give the examples of materials]
12. Ls: A pen, and a ruler
13. T: What is a difference between a pen and a ruler? [then the teacher switches to isiXhosa to explain the question: *yintoni umahluko phakathi kwe-pen nerula?*]
14. Ls: *Enye yenziwe ngeplastiki enye ngomthi* [It means a pen is made of plastic and then, referring to a ruler, is made out of wood]
15. T: How do we know that?
16. Ls: *Kungenxa yokuba siyayibona lonto* [The reason why we say so is that we can see that]
17. T: OK

4.8.2 Analysis of the lesson

Whether the learners concerned conceptually understood the teacher's definition of the word 'matter' is uncertain. The learners' response to the teacher's question in line 1 indicates gaps in conceptual understanding. The learners' response (see line 2) to the initial question asked by the teacher (see line 1) was that 'matter' is something that can be felt or touched, while some 'matters', such as a virus, atom and certain cells, cannot be seen or touched, though other means can be used to see or feel them. A misunderstanding was, therefore, seen to occur between the questions asked by the teacher

(see lines 3 and 9) and the responses given by the learners (see lines 4 and 10). Both the questions and answers reflected certain inaccuracies. Both languages were used inaccurately (entailing code-switching on an ad hoc basis, with nothing being done in a structured way) to promote the cognitive development and conceptual understanding of the learners.

4.9 The learners' responses to questioning

During the lesson a number of questions were asked in such a way that a teacher would receive a one-word answer, without digging or follow-up high-order questions being posed. The same tendency of learners to answer in chorus was evident at School B as well. Questions such as 'What?' and/or 'Is it correct or true?' (see lines 1, 2, 7, 9 and 13) were posed. Each time a teacher asked a question s/he would give the learners a mandate to answer in Xhosa if they wanted to, so that the low-order English questions were translated into low-order isiXhosa questions throughout. The learners were seen to struggle with answering the questions even in their home language, isiXhosa, because of the unplanned and ad hoc way in which the two languages were used during the teaching, learning, and oral assessment. The learners found difficulty with answering questions, being unsure as to which language to use, resulting in their being confused about the content, too. The researcher could only recall one higher-order question being asked, that being 'how' (see line 15). However, the way in which it was posed appeared to be redundant.

The learners gave a one-word answer to the question 'How do you know that a pen is made of plastic and a ruler out of a wood?' saying that 'It is because we see that'. The teacher should have followed-up on the question, or at least used a more probing question. As indicated above, such asking of questions might be related to the teaching methodology, or to the lack of modified and integrated language teaching strategies.

The formulation of the other simple question that was asked is now considered. In this case, two languages were asked in the same sentence, which referred to 'matter'. First, the teacher asked: 'What is the difference between matter and materials?' (see line 9). Then the teacher translated the same question into isiXhosa: '*Yintoni umahluko phakathi kwemata neematerials?*' Such questioning revealed inconsistency in the use of language.

The way in which the question was asked appeared to be confusing. The question should have been asked either in English or isiXhosa, instead of code-mixing. The result was that the concept of 'matter' was left

unexplained, with the teacher clearly thinking that it was enough just to translate, which showed that she did not understand that it was not only the language that the learners did not understand – they needed to understand the concept behind the term as well. Most of the time the oral questions contained a mixture of isiXhosa and English, with isiXhosa being used more in an oral form for clarification purposes, but in an unplanned and unsystematic way, as well as in a way that translated the question without explaining the terms involved.

The learners were expected to write in English, which was how the teachers measured the delivery of the content of the lessons that they presented. The learners' worksheets clearly showed that most learners also mixed isiXhosa with English in their answers. Most of what they wrote in isiXhosa consisted of those correct answers that were expected from them. The learners appeared not only to be having problems with the content of the lessons, but also with the way in which the questions were asked.

4.10 General talking among the learners and teachers at both schools

4.10.1 Talk among the learners

Most of the learners were observed talking to one another in their home language, which is isiXhosa, even during the time dedicated to teaching and learning time. They whispered to one another in isiXhosa during class. English was only used when they read something from their notebooks or textbooks. They only attempted to switch to English in their responses to their teacher. The teacher expected them to answer in English, unless she said that 'if they wish, they can give the answer in their home language'. Accordingly, the learners would wait for instructions from their teacher as to which language to use in their answers.

4.10.2 Talk among the teachers

Apart from when they were conducting their lessons, the teachers from both schools were observed speaking to one another in isiXhosa. They appeared not to use English at all during their informal talk. When the teachers consulted one another about work-related issues, they asked about such issues in the vernacular.

4.11 The interviews conducted with the teachers

The current study was conducted during the second quarter of the 2007 school year. Teachers were interviewed at both School A and School B. Five teachers at each school were interviewed about their teaching and learning practices and tendencies.

The types of questions that the teachers were expected to answer consisted of the following:

- i. A language medium question.
- ii. Whether the teachers code-mix and code-switch.
- iii. Whether the teachers find it helpful to use isiXhosa alongside English.
- iv. Which language they use more often.
- v. Which methods they use to explain concepts and technical terminology.
- vi. Whether teaching the Natural Sciences in isiXhosa is useful or not.

The above questions guided the interviews, enabling the teachers to gain perspective on the use of isiXhosa along with English in teaching.

At both School A and School B, the interviews were conducted on the last day of the school visit. The interviews were conducted on a one-on-one basis in a separate classroom in after-school hours to avoid interruption of the school day. A tape recorder was used to record the conversation before and after the interviews. Standard questions were drafted for all participating teachers at both schools.

4.11.1 The medium of language

Table 4.1, over, lists the responses received to the question: Which language/s do you use when you teach Natural Science?

Table 4.1 shows the responses received to the question: In which language(s) do you teach Natural Science? The question was open-ended, although the teachers were not asked to elaborate in their responses. As can be seen in Table 4.1, the majority of the teachers interviewed indicated that they used both isiXhosa and English in their everyday teaching of Natural Science. Few indicated that they tended to speak more isiXhosa, with the use of some isiXhosa in their teaching. Not one teacher indicated sole use of English in their teaching and learning.

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	isiXhosa
Teacher 2 (T2)	L1 isiXhosa	School A	isiXhosa and English
Teacher 3 (T3)	L1 isiXhosa	School A	English and isiXhosa
Teacher 4 (T4)	L1 isiXhosa	School A	English and isiXhosa
Teacher 5 (T5)	L1 isiXhosa	School A	isiXhosa
Teacher 6 (T6)	L1 isiXhosa	School B	English and isiXhosa
Teacher 7 (T7)	L1 isiXhosa	School B	isiXhosa
Teacher 8 (T8)	L1 isiXhosa	School B	isiXhosa
Teacher 9 (T9)	L1 isiXhosa	School B	English and isiXhosa
Teacher 10 (T10)	L1 isiXhosa	School B	English and isiXhosa

Table 4.1: Responses received to the question: Which language/s do you use when you teach Natural Science?

What such responses imply for pedagogy, cognitive development and conceptual understanding in the field of the Natural Sciences as taught at the schools participating in the study requires some consideration. The learners at the schools were assessed in English only, in both their oral and written tasks. Most teaching in the Natural Sciences learning area is done in both languages, though whether such use of the languages concerned is done in planned and systematic way is questionable. What was seen to occur at grassroots level was not what was intended by the language policy in education. According to the language policy, teachers would be expected to use English as the medium of teaching. Instead, they indicated that they were doing the opposite. Teaching in isiXhosa alternated with teaching in English in the learning area under discussion.

4.11.2 Code-mixing and code-switching

The second question attempted to find out whether teachers were aware of their own code-switching and code-mixing strategies. Table 4.2 lists the responses received to the question: Do you find that you use more than one language and switch back and forth from one to the other?

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	Yes
Teacher 2 (T2)	L1 isiXhosa	School A	Yes
Teacher 3 (T3)	L1 isiXhosa	School A	No, I'm completely against the use of isiXhosa or any other African language as medium of instruction.
Teacher 4 (T4)	L1 isiXhosa	School A	Yes
Teacher 5 (T5)	L1 isiXhosa	School A	Yes
Teacher 6 (T6)	L1 isiXhosa	School B	Yes, to make learners understand the content of the lesson.
Teacher 7 (T7)	L1 isiXhosa	School B	Yes, there is a great need for isiXhosa as a language, but the use of this language as a medium of teaching and learning is not going to make a change.
Teacher 8 (T8)	L1 isiXhosa	School B	Yes, to make learners understand.
Teacher 9 (T9)	L1 isiXhosa	School B	Yes
Teacher 10 (T10)	L1 isiXhosa	School B	Yes

Table 4.2: Responses received to the question: Do you find that you use more than one language and switch back and forth from one to the other?

The second question elicited a 'yes' response from most of the teachers participating in the study, although a few elaborated on their one-word answers explaining that they often used more than one language in their teaching, switching from one to the other in order to help the learners to understand the content of their lessons better (see the responses of T6 and T8 in Table 4.2). Nine of the teachers who responded to this question indicated that they switched back and forth between isiXhosa and English, but only two of them elaborated on why they did so.

Such a tendency to switch in unplanned, ad hoc way between the two languages concerned occurred continually during the observation that took place in the current study.

The teachers did not deny that isiXhosa was used to clarify certain points. So, code-switching and code-mixing appear to be the norm in both schools, where both teachers and learners speak the same language as their vernacular. The response of T3 in Table 4.2 that the teacher concerned found it useful to alternate between the two languages, as he was completely against the use of isiXhosa and other African languages as the medium of teaching, was noteworthy.

4.11.3 The usefulness of using isiXhosa together with English

Table 4.3 lists the responses received to the question: Do you think that it is useful to use isiXhosa together with English?

The third question was intended to find out from the teachers concerned in the study whether or not they found it useful to use isiXhosa along with English in their teaching and learning activities. While eight respondents agreed, only two indicated that they used only English in teaching and learning, while T2 mentioned that the use of isiXhosa was not helpful, because most words for the Natural Sciences in that language are difficult to understand, and tend to be misleading. T7 also mentioned that she taught only in English, though she did not elaborate on her response. Most of the respondents implied that they found it useful to use isiXhosa along with English to clarify content all the time, purposefully making use of that language. T3 agreed, saying that some learners explained things more easily when they used their home language. T5 agreed, in cases where it is necessary to explain difficult words or to translate something. T8 agreed, stating that it was extremely useful to use isiXhosa along with English. T1 agreed,

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	Yes, when explaining words or terminology which is difficult to learners.
Teacher 2 (T2)	L1 isiXhosa	School A	No, it is not much useful because most words for Natural Science in isiXhosa are difficult and confusing.
Teacher 3 (T3)	L1 isiXhosa	School A	Yes, some learners explain things easier when they use their home language.
Teacher 4 (T4)	L1 isiXhosa	School A	Yes
Teacher 5 (T5)	L1 isiXhosa	School A	Yes, when you try to explain difficult words or are translating.
Teacher 6 (T6)	L1 isiXhosa	School B	Yes
Teacher 7 (T7)	L1 isiXhosa	School B	No, it is better to stick in English.
Teacher 8 (T8)	L1 isiXhosa	School B	Yes, it is very much useful to use isiXhosa along with English.
Teacher 9 (T9)	L1 isiXhosa	School B	Yes, to make learners understand.
Teacher 10 (T10)	L1 isiXhosa	School B	Yes, to explain certain things so that learners understand.

Table 4.3: Responses received to the question: Do you think that it is useful to use isiXhosa together with English?

in cases of having to explain words or terminology which was difficult for the learners to grasp. Judging from the responses of most of the teachers, they found it useful to use the learners' home language (isiXhosa) along with English, and that they had their own reasons for doing so.

4.11.4 The dominant teaching language(s)

Table 4.4 lists the responses received to the question: Which language/s do you use most during the teaching of Natural Science, and why?

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	English and some few isiXhosa words, because learners will be writing their exams in English only
Teacher 2 (T2)	L1 isiXhosa	School A	English, because there are less technical terms in isiXhosa
Teacher 3 (T3)	L1 isiXhosa	School A	I use both [no further elaboration]
Teacher 4 (T4)	L1 isiXhosa	School A	I use them equally
Teacher 5 (T5)	L1 isiXhosa	School A	I use both isiXhosa and English
Teacher 6 (T6)	L1 isiXhosa	School B	Both of them
Teacher 7 (T7)	L1 isiXhosa	School B	English, because most of the textbooks are in this language, and not a single university teaches in isiXhosa
Teacher 8 (T8)	L1 isiXhosa	School B	isiXhosa mostly, because most learners understand and grasp better in this language
Teacher 9 (T9)	L1 isiXhosa	School B	I use isiXhosa to explain certain terminology
Teacher 10 (T10)	L1 isiXhosa	School B	English and some isiXhosa, because English is a universal language

Table 4.4: Responses received to the question: Which language/s do you use most during the teaching of Natural Science, and why?

T1 response to the fourth question (see Table 4.4), though having some validity, is relatively short-sighted. At the end of the day, the learners write their exams in English only, though most teachers indicated that they used both languages in teaching and learning. T3 did not elaborate on his response. The general overview of this question was that the teachers concerned had their own reasons for using isiXhosa or English in teaching and learning. Most teachers indicated that they used both languages to clarify, elaborate, and bring about understanding and grasping of the content. So, there was a correlation between the observations made by the researcher concerned and what most teachers reported in their interviews.

Orally, the isiXhosa language was dominant, and English was mainly used for writing. More technical terms should be developed in isiXhosa, as the teachers involved in the study tended to resort to the borrowing of certain key scientific words directly from English.

4.11.5 The methods that teachers use to explain concepts

Table 4.5 lists the responses received to the question: Which methods do you use to explain a concept?

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	I use dictionaries to look for explanations of words/ terminology in the home language of learners
Teacher 2 (T2)	L1 isiXhosa	School A	Encourage learners to work in groups
Teacher 3 (T3)	L1 isiXhosa	School A	By making examples about their environment
Teacher 4 (T4)	L1 isiXhosa	School A	Explain things in learners' home language
Teacher 5 (T5)	L1 isiXhosa	School A	Encourage learners to use both isiXhosa and English
Teacher 6 (T6)	L1 isiXhosa	School B	Encourage learners to speak about their daily lives
Teacher 7 (T7)	L1 isiXhosa	School B	Explain terms in both languages
Teacher 8 (T8)	L1 isiXhosa	School B	Assimilate learners' experience
Teacher 9 (T9)	L1 isiXhosa	School B	Use learners' prior knowledge
Teacher 10 (T10)	L1 isiXhosa	School B	Use dictionaries

Table 4.5: Responses received to the question: Which methods do you use to explain a concept?

T1's response (see Table 4.5) does not indicate whether they use dictionaries to look up the explanations of words in English or isiXhosa. However, the researcher has seen teachers using English dictionaries and glossaries in textbooks to look for an explanation for certain words during their teach-

ing practice. Though isiXhosa was largely used along with English, certain terminology and concepts were not unpacked sufficiently to make meaningful teaching for the learners concerned.

Although most of the learners seemed to feel at ease when isiXhosa was used, most of them had little understanding of certain of the terms and concepts used. Some of the teaching strategies mentioned by the teachers involved in this study were not observed in the course of the study. However, the alternate use of isiXhosa and English in an unsystematic way was noted.

T2's encouragement of group work must be seen in the light that the learners concerned could only function effectively either in groups or individually once their teacher switched to isiXhosa and gave them permission to use their home language. Both T3 and T6 (see Table 4.5) talked about using the learners' immediate environment and experiences as their strategy or method for making the learners understand Natural Science concepts and terminology. None of the teachers observed referred to the prior experience of the learners concerned in this study.

Teacher concerned	Language used	School involved	Response made
Teacher 1 (T1)	L1 isiXhosa	School A	Yes, it is useful
Teacher 2 (T2)	L1 isiXhosa	School A	Yes
Teacher 3 (T3)	L1 isiXhosa	School A	No, it not useful
Teacher 4 (T4)	L1 isiXhosa	School A	Yes
Teacher 5 (T5)	L1 isiXhosa	School A	No
Teacher 6 (T6)	L1 isiXhosa	School B	Yes
Teacher 7 (T7)	L1 isiXhosa	School B	Yes
Teacher 8 (T8)	L1 isiXhosa	School B	No
Teacher 9 (T9)	L1 isiXhosa	School B	Yes
Teacher 10 (T10)	L1 isiXhosa	School B	Yes

Table 4.6: Responses received to the question: Is teaching Natural Science in isiXhosa useful or not?

4.11.6 The usefulness of isiXhosa for the teaching of Natural Science

Table 4.6 lists the responses received to the question: Is teaching Natural Science in isiXhosa useful or not? Mixed responses were received from the teachers concerned with the current study, some of whom felt that the use of isiXhosa was helpful in teaching Natural Science. T1's response showed that most teachers have a high regard for the use of isiXhosa for teaching and learning. Though question 6 was not open-ended, those teachers who wanted to elaborate on their answers were allowed to do so. T1 explained his answer by saying, 'Yes, we say science is everything that surrounds us, so to explain that in the home language of the learners, it gives better meaning or understanding to them.'

Some teachers mentioned that learners became more involved in the process of teaching and learning when isiXhosa was used to 'talk' about things. Given answers such as that of T8, who said, 'No, English is a universal language. Learners must be taught Natural Science in this language, because when they are at the university level English will be used to teach them.' It has become necessary to explain why teachers are sometimes so reluctant to use isiXhosa and other African languages as mediums of teaching and learning. Some teachers' reasons seem valid. Some teachers have fears or reservations, such as those expressed by T8 (see above). They fear that, when isiXhosa-speaking learners reach the tertiary education level, isiXhosa will no longer be used along with English. Despite this, most of the teachers interviewed felt that isiXhosa should be used to explain most of the concepts and terminology central to the teaching and learning of the Natural Sciences.

Most of the teachers involved in this study did not deny the fact that they used isiXhosa all the time when they taught, giving several reasons why they did so. A few teachers admitted their fears about using only isiXhosa for teaching and learning. The researcher suspected that those teachers were not sure about whether or not they were doing justice to the future of most learners in using isiXhosa for teaching, while they know for a fact that, at some stage in their future, the learners would be confronted with having to use English for their future studies.

4.12 Learning support material

At both School A and School B, there was no printed material (such as charts, posters and any drawings) in isiXhosa whatsoever, and very little in English, either. In the two classes that were observed, the few posters or charts on the walls were illustrated or labelled in English only. The textbooks were only available in English.

Considering the alternate use of isiXhosa and English in teaching and learning, some of the educational materials might have been expected to have been in isiXhosa. How the isiXhosa-speaking learners could have been expected to be developing cognitively and conceptually in the Natural Sciences when their language was only orally available is unknown. A need for African languages textbooks, therefore, was seen to exist that would engage children in abstract thought in their mother tongue (Mahlalela, 1999).

In informal discussions with some of the teachers at both schools, they mentioned that they had a few learning and support materials in isiXhosa, though most of the material was on general matters, which did not fall in the area of the Natural Sciences. Neither school had any textbooks in the learners' home language. One teacher mentioned that, as the teaching materials that they had were designed for OBE, they were in English only. Whenever the teachers had to use isiXhosa along with English, they were faced with the challenge of translating and adapting the text to suit the needs of their learners.

All the books that the researcher saw in the field of the Natural Sciences were in English only. One of the teachers at School A told the researcher that most publishers are very reluctant to publish teaching and learning support material in isiXhosa and other African languages, because the market for material in such languages is so small, and therefore not profitable, resulting in investments in the field carrying much risk. Most South Africans who speak such languages feel that they are relatively insignificant.

The general feeling is that fluency in the African languages does not facilitate economic growth (Mahlalela, 1999), resulting in most teachers resorting to material that is only in English. At both schools, the learners were given their notes only in English, with isiXhosa only being used as supplementary oral text.

No material written in isiXhosa has yet been published in the learning area of the Natural Sciences. The teachers involved in the area have to use their own discretion to develop translated and adapted materials in isiXhosa to help those learners who are struggling with the English medium. They do so in an unplanned and unsystematic way, because no isiXhosa written text is used.

Vygotsky (1986:101) states that, in most instances, the learner uses a 'new word' for communication reasons, even before he or she has fully developed an understanding of the word. Vygotsky (1978) regards 'all higher human mental functions as product of mediated activity'. Most isiXhosa-speaking teachers mediate their teaching in isiXhosa in order to transfer conceptual understanding. Most learners in this study are more conversant in their vernacular, which is isiXhosa. The learners only struggle with the content of their lessons when they have to speak English.

4.13 Conclusion

Both teachers and learners were found to refer back continuously to isiXhosa (which was the learners' home language) whenever they had to deal with complicated scientific concepts and other general lexical terms. Such reference meant that (i) they are more at ease in their mother tongue or L1; (ii) their English was not developed enough to deal with scientific concepts that were explained in scientific jargon; (iii) the teachers concerned depended on English borrowings rather than on descriptive and prescriptive isiXhosa terminology. During the observation of lessons, the researcher managed to document teaching and learning practices, in which both teachers and learners relied on the phonetic transcription of the following words: 'mineral salts'; 'process'; 'photosynthesis'; 'matter'; and 'materials'.

Not only the language used can enhance the value of teaching and learning in any content subject, but such value can also be enhanced through the practicality, creativity and specialised knowledge of teachers, which is essential for the meaningful teaching of Natural Science. At the time of the current study, the chances for the learners who speak isiXhosa as their home language to develop scientific jargon and to improve their communication skills in the language of science were limited. Most learners struggle not only to communicate in the language of science, but also in everyday English communication and in isiXhosa proper, because neither English nor isiXhosa is used in a planned and systematic way when used alternately in an educational setting. The status of isiXhosa in schools does not enjoy a proper official standing, as everything is in the guise of English, as if isiXhosa were not capable of playing that role.

5. Conclusions and recommendations

5.1 Conclusions

This research project has shown that the teaching of Science in isiXhosa is a daily phenomenon. The teachers concerned think that the use of isiXhosa to teach content subjects in isiXhosa is ‘unofficial’, resulting in the covert use of isiXhosa. Switching between isiXhosa and English in the teaching of the Natural Sciences often happens in South African schools; for instance, if the Natural Science teaching period is of 40 minutes duration, a teacher might take 35 minutes (being the larger part of the lesson) speaking in isiXhosa, trying to disseminate knowledge and to mediate teaching and learning. In most cases, this happens in an unplanned and unsystematic way, resulting in a lack of consistency in the use of both languages.

A Western Cape study (Plüddemann et al, 2004) showed that the low proficiency skills of most learners with English as the medium of teaching resulted in poor performance in the high conceptual learning areas, such as the Natural Sciences. Such lack of skills led to decreasing numbers of learners doing Science in the more senior classes, as well as to an increasing number of drop-outs. The disjuncture between the language(s) of teaching and learning and the language of assessment leads to many unanswered questions by teachers, yet the agent of the parents, being the DoE, and the parents themselves continue to expect good results at the end of each year. Using isiXhosa alongside English in the teaching of Natural Science, with assessment being conducted in both languages, can only serve to improve the performance of the learners concerned.

If isiXhosa, the learners’ home language, can be used alongside English in the teaching, learning and assessment of most learners who speak the language, such use would benefit them in the conceptual and cognitive challenges that they have to face in their everyday educational experience.

5.2 Limitations of this study and future research possibilities

There is no doubt that learners’ home language or L1 is crucial for the promotion of cognitive development and conceptual understanding in teaching and learning. My study was not at all intended to prove that the home language can promote cognitive and conceptual understanding, since that has been demonstrated by a number of studies, such as the Nigerian six-year project (1970), the South African Threshold project by Macdonald (1990), recently by Brock-Utne (2004) as part a South African – Tanzanian study on language of instruction, as well as by a number of international studies such as Ramirez et al (1991), amongst others. What my study was seeking to do was to show how teachers’ teaching and learning practices in teaching Natural Science concepts and terminology can either promote or block cognitive development and conceptual understanding in isiXhosa-speaking learners.

Future research needs to explore the mechanisms, strategies and methods that can better transfer concepts and scientific vocabulary in African-language-speaking learners. This will help to dispel the myth that it is not possible to teach high conceptual learning areas in African languages such as isiXhosa. There is a great need also to focus on the engineering of a technical corpus and production of teaching materials in African languages in science, mathematics and other highly specialised learning areas.

There is also a need for translation, creation, adapting and adopting scientific words in African languages; this could be done from English mainly, but also from other African languages in order to enhance the status of our languages to operate in high-status domains.

5.3 Recommendations

The following recommendations are made:

- The teachers concerned need to be equipped with innovative ideas regarding the use of language(s) across the curriculum, so that they can be helped to improve their teaching and learning of the content subjects, such as the Natural Sciences.
- The development of the isiXhosa corpus, as well as the development of other teaching and learning resources in the Natural Sciences and other conceptual learning areas, would allow for the addressing of the learners’ current conceptual and cognitive deficiencies in such areas of learning.

- The challenges involved in the teaching of the highly technical learning areas in any of the African languages should not be used to justify the belief that such languages are not capable of teaching in the areas concerned. The holding of such attitudes and myths needs to be counteracted by the use of the African languages in teaching and learning.
- The collaboration and co-operation of subject specialists, linguists, and of speech communities including teachers and learners is needed to help develop their languages, so that they can be used beyond the domain of arts and culture. The languages should be so enhanced that they become capable of transferring the concepts of science and technology within the teaching environment.

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Appendix 1

Teachers' observation schedules for Intermediate Phase Natural Science teaching

Name & surname	School	EMDC	Grade	Duration

Language distribution during teaching and learning – oral and written language

1. Introducing a new concept/term: use of code-switching; illustrations; references to the textbook
2. Explaining the term: Contextualisation; the use of English or isiXhosa terms; descriptions; definitions. (How do the learners respond?)
3. Asking questions about the term. (What term do the learners use?)
4. Providing exercises (oral or written) that elicit the use of the term(s).
5. Providing feedback.
6. Recapping and concluding, by briefly re-explaining the term.

Teacher talk	Specific terms	Learner talk	Specific terms
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Appendix 2

Teachers' perspectives on science terms in isiXhosa used in the teaching of Natural Science

Surname	School	EMDC	Grade

1. Which language/s do you use when you teach Natural Science?
.....
.....
2. Do you find that you use more than one language and switch back and forth from one to the other?
.....
.....
3. Do you think that it is useful to use isiXhosa together with English?
.....
.....
4. Which language/s do you use most during the teaching of Natural Science, and why?
.....
.....
.....
5. Explain what methods you use to ensure that the learners understand concepts and terms when teaching Natural Science.
.....
.....
.....
6. Do you think that teaching Science in isiXhosa would be helpful for your learners?
.....
.....
.....
.....

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