ENGLISH AS A LANGUAGE OF LEARNING AND TEACHING SCIENCE IN RURAL SECONDARY SCHOOLS: A STUDY OF THE VLAKFONTEIN CIRCUIT IN LIMPOPO

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Declaration

I declare that English as the Language of Learning and Teaching Science in Rural Secondary Schools: A Study of the Vlakfontein Circuit in Limpopo is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Summary

The growing diversity of school populations around the world means that for many learners the language of learning in mainstream classrooms is not their first language. The researcher would submit that content-based second language learning in a context such as a Science classroom is considered advantageous as it enables the learner to manipulate a target language such as English in a way which is meaningful. However, Science learners who have yet to achieve communicative competence in English are disadvantaged when it comes to developing a deep understanding of scientific concepts. Many mainstream Science educators have concerns about this significant group of learners who can be left on the periphery of the class to cope as best as they can.

Very often educators aim to meet the needs of English Second Language (ESL) learners without any specific knowledge of the strategies which would enhance learning and ensure that learning environments encourage participation and interaction. The learners themselves have not only to deal with language and sociocultural issues but must face the cognitive demands of Science including negotiating its specialized language.

The aim of this study was to investigate how the use of English as a language of learning and teaching Science in rural secondary schools in the Vlakfontein Circuit of the Limpopo Capricorn District, influenced the ability of Grade 8 students to learn Science. The focus was on the Grade 8 classes since they are at the threshold of their educational pursuit. The study had two main purposes. The first goal was to describe the current situation with respect to rural secondary school learners and their educators in selected learning environments in Vlakfontein Circuit. The second goal was to bring about improvement in the learners' situations by employing specifically designed interventions. The study had three focal areas: the language; the teaching and learning environment; and the ESL learner.

The investigation was conducted in disadvantaged rural secondary schools in the Vlakfontein Circuit in the Limpopo province. Observations of the Science classes revealed that, even for

the learners with very limited English language proficiency there was little ESL specialist support available.

The data analyzed was collected using a variety of data collection tools. The main data generation tools were observation, semi-structured interviews and questionnaires. The analysis revealed that learners were lacking in Science register (terminology).

This study also found out that non-technical language used in Science lessons affected the learners' understanding much more than the educators were aware. Educators' attitudes and beliefs strongly influenced the interaction and participation of ESL learners in Science classrooms. The study also revealed that developing language skills prevented ESL learners from asking questions and answering questions in class and academic progress in Science was impeded by limited opportunities for ESL learners to clarify their understanding. Further, the investigation established that achievement in Science and in education overall was affected by assessment instruments which were infused with specific linguistic or cultural knowledge.

The study arrived at a conclusion that the needs of the research students could not be met by a programme based on the traditional format of ESP teaching. Hence, the researcher has recommended a Science Based English Programme (SBEP) which encapsulates several adjustments in orientation methods and materials to meet the ESL learners' needs. This kind of learning-centred arrangement will allow not only efficiency of SBEP instruction but also allow the kinds of activities that may not be possible in groups with a wide dispersion of interests.

However, the extent to which the research learners encountered difficulties with vocabulary suggests that there is a need to investigate more effective methods of dealing with this issue. Needed research could also be directed into the development of a Science glossary with appropriate language levels for ESL learners. This could include technical scientific terms with examples of how terms can be used.

From the outcome of the interviews with educators, it is evident that further research is needed concerning the educators' English proficiency and Science competence in ESL situations.

The following are key terms:
Senior Phase Learners; English Second Language (ESL); Learning Area; Learner Support Material; Learning Outcome; Science Education; Language of Learning and Teaching (LoLT).

Abbreviations and Acronyms

1. ANC : African National Congress
2. BICS : Basic Interpersonal Communication Skills
3. CA : Cognitive Acceleration
4. CALP : Cognitive Academic Language Proficiency
5. CASE : Cognitive Acceleration through Science Education
6. CCD : Centre for Community Development
7. CS : Code-Switching
8. DoE : Department of Education
9. EFL : English First Language
10. ESL : English Second Language
11. FET : Further Education and Training
12. GET : General Education and Training
13. HSRC : Human Sciences Research Council
14. LAC : Language Across the Curriculum
15. L2 : Second Language
16. LiEP : Language in Education Policy
17. LoLT : Language of Learning and Teaching
18. LTSM : Learning and Teaching Support Materials
19. OAU : Organisation of African Unity
20. OBE : Outcomes-Based Education

21. PANSALB : Pan South African Language Board
22. QDA : Qualitative Data Analysis
23. RNCS : Revised National Curriculum Statement
24. RSA : Republic of South Africa
25. SLT : Speech-Language Therapy
26. SPSS : Statistical Programme for the Social Sciences
27. TIMSS : Third International Mathematics and Science Study
28. UMTYMP : University of Minnesota Talented Youth Science Programme
29. UNESCO : United Nations Educational Scientific and Cultural Organization
30. WCED : Western Cape Department of Education
31. ZPD : Zone Proximal Development
32. ESP : English for Specific Purposes

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 Introduction

The role of language in Science is coming into focus for Science education researchers from a number of perspectives. With a constructivist paradigm dominating the field, language is being explored for its role in facilitating and assessing learning, and in understanding complex interactions related to Science teaching and learning (Lemke, 1990: 34).

The use of language is one of the situational factors that need careful consideration by the educators. In many South African schools and institutions of higher learning the problem of Language of Learning and Teaching (LoLT) is prevalent and much needs to be done. In South Africa, the language of learning and teaching (LoLT) is the concept used to explain medium of instruction. In instances where learners are from a disadvantaged background, this becomes a serious problem. Most of the educators attest to the fact that learners have a language deficit, which holds them back, not only in their learning, but also in simple social exchanges with one another (Cummins, 2000:35; La Plante, 2002:74; Reddy, 2000:65).

The role that language plays in the classroom is not simple, and there are numerous ways in which the interaction between language and learning is important to the classroom educator. In Science, where so much of the work is concerned with describing observations, this becomes a special handicap. The language barrier would seem to be a very obvious source of difficulty since Science is hostile with unfamiliar technical words. What has been shown to be the case is that the technical terms present few difficulties as compared to familiar non-technical terms which learners understand (Edwards and West, 2003:120).

Brock-Utne (2000: 120) argues that using a second language as a LoLT is a great constraint which hinders acquisition and expansion of Science education. It has to be stated that it is often erroneously believed that Science is relatively independent of language. However, assimilating and processing abstract concepts requires fluency in the language in which those concepts are taught. Lewin (2000:35) asserts that many problems of Science learning may be associated with lack of language proficiency because more often than not for the disadvantaged learner, “Science is taught through a medium of instruction which is not a mother tongue”.

In the same vein of argument, Mutasa (2002:7) asserts that “if pupils do not understand the language used in teaching Science, it means they do not and cannot receive education in the discipline. That means new ideas and knowledge cannot be transmitted to them”.

The tendency to define different versions of learner background as adequate or deficient compared to a linguistically rich learner background has proved particularly problematic for language minority learners. When these learners arrive in the classroom underprepared for learning secondary school Science, they are regarded as having two problems. They appear to have weak scientific knowledge, and more seriously, they are regarded as lacking the necessary linguistic tools to construct advanced Science concepts. The assumption is that low-level English language skills affect learning in a manner similar to low basic skills. Despite evidence to the contrary, it is implicitly assumed that knowledge and skills acquired in their native language are inaccessible (Diaz & Klinger, 2001:50).

In a view that contrasts with a basic skills approach to learning, social constructivists claim that meaning is constituted through a variety of social practices, especially language, which is a primary mediator (Reagan, 2003:124). The latter views learning as a type of enculturation in which learning occurs through adopting the cultural practices, particularly language, of a social group situated in its distinct culture.

Gunstone (1994:120) has described learning in secondary school Science as a process of understanding the linguistic organisation of content and acquiring the functional uses of Science language in the classroom. Although Gunstone detailed language use and its effects in Science, his research does not describe the situation of rural learners whose school experience may be different because their early years of schooling are focused on learning English. It is also uncertain how Gunstone’s recommendations for improving the quality of student learning would apply to learners who are still developing proficiency with the fundamentals of English grammar and forms of writing. For example, Gunstone suggests increasing student opportunities for talking and writing Science, but it is not clear how this is accomplished by learners whose discursive resources are limited. It is important to question how teaching should construct these opportunities.

It is in this context that Lemke (1990:81) states that educators not only have to be proficient in English per se but that they have to “realize that mastery of academic subjects is tantamount to the mastery of their specialized patterns of language use and that language is the dominant medium through which these subjects are taught and learners’ mastery of them is tested”. He further asserts that the Science educator should be proficient in the “subject register, syntax, semantics and pragmatics of the English required for understanding the content of his subject”.

It should also be borne in mind that language problems in Science are not confined to second language learners only. Aikenhead and Jegede (2002:38) point out that the difference between everyday language and Science or mathematics terminology also leads to first language speakers learning a new language when learning Science. This view is echoed by situated cognition theorists such as Lemke (1990:95), who maintains that learning Science is learning to participate in a new social practice. The learning of a new language is in itself part of another social practice, so a learner learning Science through a second language is trying to become initiated into two social practices at once. Worldview theorists too would argue for the use of home language to facilitate the ‘border crossing’ between the learners’ own culture and that of the culture of Science (Aikenhead and Jegede, 2002: 45).

Moreover, Aikenhead and Jegede (2002:11) argue strongly for home language instruction. They maintain that when Science is taught through the medium of English, learners are not able to apply what they have learnt in Science to everyday life. They further argue that important ideas are conveyed more easily when the educator does not adhere to the policy of English-only teaching.

Conceptual understanding is another challenge facing second language (L2) learners using English as a language of learning and teaching. Prophet and Dow (2003:134) maintain that variations in the language of learning and teaching affect concept attainment for learners emerging from primary school. According to Prophet and Dow (2003:134) "the quality of writing is closely related to the learners' conceptual understanding of the content of school tasks. Poorly written Science work is often attributed to poor language proficiency or poor conceptual understanding".

The above assertions are in tandem with Kolesnik's (2001:145) view on learning. He asserts that "thinking has been shown to depend upon an understanding, not only of the meaning of words but also on an understanding of the meaning and any deficiency of such an understanding caused by L2 could well lead to mechanical or rote learning". This is unfortunately what is happening in many English second language (ESL) classes, especially in rural areas. One does not have to have much first experience of schools in Limpopo to realise that such mechanical learning is a widespread phenomenon.

In terms of Kolesnik's (2001:132) reasoning, such rote learning is probably a response by the learners to their failure to grasp and understand what they have been taught through the medium of their second language (L2), English. This "manipulation of word tokens without meaning" (Gudschinsky, 2001:100) is the learners' attempt to solve the whole problem of a lack of understanding. It is the obvious futility of learning words without the meanings which is at the heart of the problem. Duminy (2002:18) refers to this type of learning as artificial knowledge. He also refers to it as superficial knowledge because it arises from mechanical learning.

The sources in the preceding paragraphs, sought to demonstrate that the close association between language proficiency, conceptualisation and learner achievement is now obvious. They have attempted to stress the very severe constraints often placed upon successful learning in schools by L2 (English) learning and teaching.

1.2 Awareness of the Problem

The researcher is a practising educator, teaching English and Natural Science in Grade 8. As an English and Science educator, the researcher had been for many years an observer of the influence of ESL as language of learning in the learning of Science. The researcher has observed firsthand that rural secondary school learners seem to lack the capacity to generate adequate scientific language to write up reports, transcode information in speech and writing into diagrammatic display, abstract and summarize written material for use ultimately in the examination and/or project they may be requested to submit to their educators at the end of their academic year.

The researcher has observed that most rural secondary school learners are faced with the challenge of mastering English at two levels, namely, the level of basic everyday discourse and the level of scientific discourse.

Although short-term remedial programmes (largely based on past and individual language teaching experience) are often undertaken to remedy such situations as described above, the researcher was aware that if appropriate and effective long term solutions are to be found, then a comprehensive study would be required. This study is the result of that realization.

Further, various indicators made the researcher aware of the problems regarding the use of English as a language of learning and teaching in Science education and the level of scientific literacy among the South African population in general and rural secondary school learners in particular.

The following findings from surveys conducted in and around the country serve to validate the above assertions:

In a world-wide study on Science achievement, the Third International Mathematics and Science Study (TIMSS) of 1995 and the Third International Mathematics and Science Study Repeat of 1998, South Africa performed worst among 38 participating countries. The Grade 7/8 and Grade 12 learners representing South Africa were considered scientifically illiterate;

especially female learners from all population groups performed particularly poorly (Howie, 2001:2).

Another important finding of the study was that the majority of South African learners could not communicate their scientific conclusions; had difficulty articulating their answers and even experienced trouble comprehending several of the questions. Howie (2001:2), reports that these problems can be attributed to the language of learning and teaching (English).

The performance on TIMSS of learners who do not learn in their home language and attend African schools has shown to be significantly lower than that of learners who are home-language speakers of the language of learning and teaching (LoLT) (Howie, 2001:75; Reddy, 2005:15). In 2003, 8952 learners participated in TIMSS, 11.6% of whom wrote the test in Afrikaans (a language derived from Dutch that is the home language of many White and Coloured South Africans) while the remainder wrote the test in English. Most learners who wrote in English were not home-language speakers of English, with 75% of them being African learners attending schools that served the African population group under the apartheid system of government.

The results of the 2003 Trends in Mathematics and Science Study were recently released by Human Sciences Research Council (HSRC). These show that South Africa still lags behind other countries in the study of Mathematics and Science (HSRC, 2002:2).

The Grade 6 National Systematic Evaluation, a survey commissioned by the National Department of Education and carried out by the HSRC in the late 2004, found that a vast majority of South Africa's Grade 6 learners are failing to achieve the expected outcomes in Natural Sciences, Language and Mathematics.

When English as a LoLT poses an obstacle to the acquisition of appropriate knowledge that impacts on the conceptualisation of Science, it becomes imperative to research on the magnitude of the problem and how it is manifested.

1.3 Conceptual Framework

1.3.1 Orientation

The impact of language competence on learning in Science has been investigated in a number of countries around the world, including African countries (Rollnick, 2000:123). Language proficiency is important for both social and academic interactions. Conditions of poverty are associated with lower levels of literacy in the population, affecting both first and second language acquisition. In South Africa, some of the learners who use English as a second or third language for learning, generally live in circumstances of poverty where there is already poor-quality teaching and learning in English. The learning of Science requires a learner to be proficient in the language of learning and teaching as well as in the language of Science, which is, acquiring the specialized vocabulary that characterizes the Sciences. Furthermore, poor performance in Science may be due to learners' misunderstandings of questions.

Understanding the specialized vocabulary of Science presents problems for English first-language (EFL) and second-language (ESL) learners, and, in some cases, learners' understanding is the opposite of the actual meaning of the word (Wellington & Osborne, 2001:35). Many words have specific meanings in Science that are different from the meaning of the word as used in everyday contexts. For example, words like *producer*, *consumer*, *energy*, *power*, *work*, *conduct*, and *field* have distinct and different meanings in Science and in everyday use. The word c*ell* may refer to a torch cell, or the smallest unit of life, or a cell phone, or a single unit of a table of data, or a prison cell. Moji and Grayson (2001:89) found that the four different scientific concepts, *power*, *force*, *work*, and *energy*, all translate to a single term in the Sepedi, yet each has a specific scientific meaning. Code-switching would lose the variations in meaning, unless conducted by a skilled educator. Words with multiple meanings seem to cause difficulties for EFL and L2, who confuse the meanings used in different contexts (Wellington & Osborne, 2001:103). African learners in South Africa have particular difficulties in Science when their home language is not compatible with the language of Science (McNaught, 2002:63).

These layers of difficulties that a learner from a poor household learning Science in an impoverished environment in a second or third language make the analysis of links between language and performance difficult to pinpoint. However, it is important to investigate this further, as the language of learning and teaching could be one of the leverage points used to improve performance (McNaught, 2002:65).

South Africa is a multilingual country with eleven national languages – nine indigenous languages and the two colonial languages of English and Afrikaans-recognized as official languages in the Constitution of 1996 (Constitution of the Republic of South Africa, 1996). Despite these provisions, since the democratic elections of 1994, English has expanded its position as the language of access and power with the relative influence of Afrikaans shrinking, and African languages effectively confined to functions of "home and hearth" (Mazrui, 2002:260).

Mazrui (2002:269) suggests that the constitutional recognition of eleven official languages in South Africa is largely "intended and perceived as a symbolic statement and that for instrumental purposes, English remains the dominant language in South Africa".

In the Vlakfontein Circuit, where this research was conducted, the main language, Sepedi, is the home language of the majority of learners but English is the LoLT for all learners from the beginning of Grade 4. This is despite the fact that the majority (if not all) of African learners in rural schools have little exposure to English outside the classroom apart from television and popular music. Thus for many rural learners, the oral language of the school and classroom beyond the first three grades, is frequently their home language, whereas the language of reading and writing and assessment at school is English. Bridging the gap and acquiring not only proficiency in English, but also the kind of cognitive academic language proficiency (Cummins, 2000:20) required for academic learning and meaningful engagement with the curriculum is the difficulty for many such learners.

Under apartheid, education was administered separately and unequally to the different racial groups. African schools were the most disadvantaged and White schools the most advantaged. The apartheid legacy means that even today, African schools are located in areas where most Africans live and these are characterized by high levels of poverty and unemployment.

Previously designated White schools are located in areas where, previously, White households were located and these areas are, generally, in better socioeconomic conditions. This racial categorisation of schools provides an indication of difference in infrastructure, qualifications of educators, management, governance of schools, educational culture and resource base of schools, and socioeconomic status of learners. All of these conditions impact on the quality of the educational experience of learners and the educational outcomes. In South Africa, in addition to the above factors affecting the quality and outcome of the educational experience, a further factor is the language of learning and teaching (Reddy, 2005:105).

The Constitution of South Africa states that schools can choose to educate learners in any one of the eleven official languages. Nevertheless, most schools have adopted English as the language of learning and teaching, despite the fact that the home language for most learners and educators is not English. However, it suffices to mention at this point that the official language policy in South Africa is that the home language should be the language of learning and teaching for the first 3 years of schooling. In many African schools, English is introduced as a subject in the third year of schooling, but takes over as the LoLT from the fourth year. Macdonald (1990:67) demonstrated that learners who make the change in the language of learning and teaching from an African language at grade 5 to English have about 700 words in English, yet they are expected to manage to learn with a curriculum of at least 7000 words in grade 5. Apart from only having about 10% of the vocabulary items they need, learners do not have sufficient grasp of the linguistic structure of the language. It is simply impossible for learners to learn effectively or even at all when they do not have the necessary language skills to do so.

This research is based on the fact that the majority of learners in rural secondary schools have poor English skills and must use English as the medium of learning content such as Science. Cummins (2000:23) suggests that second language learners will acquire language and content most successfully when they are challenged cognitively but provided with contextual and linguistic supports.

In schools where learners and educators share a common home language which is not English, especially in African schools, code-switching is widely practised. Code-switching refers to the practice of switching between English and the home language of learners in order to ensure that learners grasp the concepts (Rollnick, 2000:23; Setati, Adler, Reed, & Bapoo, 2002:25). The limited level of exposure of African educators and learners to English has led Setati et al. (2002) to classify English as a foreign language in rural schools, whereas it is a second or additional language in most urban African schools. Code-switching rarely occurs in non-African schools. In rural areas, African schools are largely monocultural and monolingual, while in urban areas, the school population in African schools may include children and educators with a diversity of home languages, rarely including English (Mda, 2004:76).

The above serves to explain why since the ‘90s there has been an alarming decline in the level of participation and performance in Science in secondary schools. “Where does the root cause lie?” This has been the big question. While the reasons given generally range from curriculum, resources, management, educators’ capability and learners’ background, the language barrier can certainly not be ruled out (Lubanza, 2002:33). Indeed even with the best of resources, curricula, management, etc., if learners and educators are unable to communicate effectively, then all the other improvements are in vain. It is now becoming evident that the official LoLT (English) is a barrier to effective learning and teaching and especially to the conceptualisation of the intricate Science concepts that calls for the mastery of the LoLT. The majority of the learner population in Capricorn District of the Limpopo Province is Black and speaks Sepedi as the language for daily communication. However, it has to be understood that almost all the secondary schools in rural Limpopo use English as the language of learning and teaching.

In many of the rural schools that enrol less able learners, the educators use Sepedi most of the time for teaching, classroom control, and interpersonal interaction. Interaction in English is mainly restricted to asking simple recall questions that require one-word or single-phrase answers from the learners, highlighting vocabulary in English textbooks with explanations in Sepedi, and going through worksheets or notes written in English (Evans, 1996:128).

The weakest learners cannot understand even very simple text written in English. Their learning style basically consists of translating content words in a text by looking in the dictionary (for those who are lucky enough to have any) and writing the Sepedi characters alongside the English vocabulary in their notes or textbooks. In order to prepare for tests and examinations, they have to commit to memory terms and isolated chunks of texts in English that they do not quite understand. Under these conditions, it is very unlikely that these learners can develop an intrinsic interest in and motivation for learning (Evans, 1996:128).

1.3.2 The School Science Curriculum Context of South Africa

The official description of the physical Science learning area is that "the subject Physical Science focuses on investigating physical and chemical phenomena through scientific inquiry. By applying scientific models, theories and laws it seeks to explain and predict events in our physical environment" (DoE, 1997:3). It is therefore, inevitable that to realise the ideal described above, the language of learning and teaching plays a crucial role. This is because the language which is used as a medium of learning and teaching in different educational settings has a major impact on the academic performance of learners, or on their interest to learn a specific subject or the way they communicate with the educator as well as fellow learners about different concepts of a subject.

The Natural Science National Curriculum Statement puts more emphasis on inquiry and the teaching of Science process skills (Department of Education, 2003:8), thus aligning itself with societal demands. Learning Outcome One of Natural Science states that "the learner must be able to explore confidently and investigate phenomena, thus being able to do scientific investigations (DoE, 2003:8).

The curriculum emphasises higher cognitive skills and the integration of process into the core of teaching i.e. inquiry learning. Learning Outcome one in the Revised National Curriculum Statement (RNCS) for Science requires learners to conduct investigations (DoE, 2003:8).

Further, the researcher is of the opinion that inquiry should by right encourage learners to be inquisitive, curious and ask questions in a given situation and try to search for solutions by themselves as explained in the taxonomy. A question that immediately begs for answers is whether the planning of lessons should focus on English language acquisition or should it go beyond teaching learners to be enquirers and problem solvers? The researcher poses the above question because according to Bybee (2004:9) inquiry instruction, which the Natural Science National Curriculum Statement propagates, is based on the following characteristics:

- Learners engage in scientifically oriented questions;
- Learners give priority to evidence in responding to questions;
- Learners use evidence to develop an explanation;
- Learners connect the explanation to scientific knowledge and
- Learners communicate and justify their explanations.

The researcher is fully aware of the fact that the inquiry-based approach is propagated because it is meant to develop learners to become problem solvers. However, to be successful in problem solving, learners must have background knowledge of content and context (Chang & Weng, 2002:441). To achieve the ideal cited above, the language of learning and teaching is very key and that is why this study wants to investigate how English as a LoLT can influence the successful learning of Science? It is very clear that for an *Inquiry-based* learning approach to succeed in the teaching of Science in rural secondary schools, the issue of the LoLT can no longer continue to be ignored.

It has to be noted, however, that the curriculum does not in any way oppose the acquisition of factual knowledge as can be seen from Learning Outcome two of Natural Science which requires the planning of lessons in such a way that learners are able to acquire scientific knowledge. The above statement is made because Science content comprises laws, concepts, principles and theories and these form the foundations upon which Science is built and progresses (Chiappette and Adams, 2004:48). Educators can use content process in class by organising learners in activities of linking content and investigation activities with the view of allowing learners to gain Science knowledge.

The Grade 8 Natural Science Programme follows a constructivist approach. It is organised around the premise that Natural Science should not be taught in isolation and that a significant percentage of content should be derived from local contexts. It falls within the integrated curriculum wherein the discreet disciplines of subject matter are related to one another (Victor and Kellough, 2000:147).

The Grade 8 Natural Science Learning Area envisages a teaching and learning milieu that recognises that the people of South Africa have a variety of learning styles as well as culturally influenced perspectives. It takes the premise that all learners should have access to a meaningful Science education. The programme is geared towards helping learners to understand not only scientific knowledge and how it is produced but also the environmental and global issues.

The Natural Science Programme has three outcomes that must be realised before learners can be regarded as competent with regard to the content of that Learning Area Programme. The outcomes centre around *scientific investigations; constructing Science; and Science, society and the environment.* Guidelines for the evaluation and assessment of learner performance are provided in the RNCS for each learning area (Department of Education, 2003:30).

However, the researcher is of the opinion that the RNCS does not recognise the role of language in the construction of reality; the RNCS for grades R – 9 (DoE, 2002:45) says the following for the grade 7 – 9 learner in the 'Senior Phase': *The learner can now use language to make finer distinctions, which demonstrates a better grasp of reality. For example, the learner can distinguish 'air' from 'steam', and 'steam' from 'smoke', and 'water vapour' from 'air' and the learner can also explain how the concepts 'air' and 'atmosphere' relate to each other.*

RNCS also does not emphasise the importance of language in the construction of reality as the scientist sees it, the RNCS (DoE, 2003:30) for grades R-9 states the following: *Acceptance of a less rigid style of reporting of scientific investigation. For example, 'I put a teaspoon of* sugar *in a glass of water and stirred it" should be equally acceptable to the more conventional "A spatula of sugar was placed in a beaker of water and stirred."*

Language is instead seen as something to be avoided; hence the RNCS for grades R-9 (DoE, 2003:30) propagate the "frequent use and acceptance of mind maps, flow charts, spider-grams, annotated drawings and the like instead of descriptions in words". Thus, according to McKoen (2000:45) the RNCS sees language (including the genres of Science) as something to be taught by the English educator.

Furthermore, the educator's role in the Science classroom, according to RNCS is to:

- Make resources available to learners and guide them as they learn to enquire (Zion, Shapira, Slezak, Link, Bashn, Brumer, Orian, Nussinovich, Agrest and Mendelovici, 2004:143);
- Plan how to handle inquiry activities in an overcrowded curriculum ((Johnson, 2004:48);
- Use effective questioning strategies and encourage inquiry activities in the classroom (Johnson, 2004:48);
- Adapt Science content to meet the interests, knowledge and abilities of learners;
- Encourage participants to be responsible for their own learning (Johnson, 2004:48);
- Recognise diversity among participants and help learners take responsibility for their own learning (Johnson, 2004:48), and
- Consider gender, culture, racial differences and knowledge background of learners when planning (Roth & Roychoundhurry, 1993:45).

The researcher is of the opinion that for the above cited roles to be played out successfully, the importance of the LoLT cannot be overlooked.

Thus, within the above-mentioned context of education, this study focuses on the use of English as the language of learning and teaching Science in rural secondary schools. The investigation is complex, because performance is affected by the level of knowledge and skills that the learners possess, as well as by language factors.

1.4 Statement of the Problem

There is sufficient evidence that the language of learning and teaching constitutes a major part in the learning of Science in secondary schools. The mastery of the concepts hinges largely on the knowledge of scientific terms articulated in the second language. Although English is the language of learning and teaching, it is not yet known whether its use as a vehicular language in Senior Phase Science learning facilitates the acquisition of the knowledge, skills and attitudes that the Senior Phase Science curriculum sets out for learners to acquire. Preliminary investigations seem to suggest that English as the language of learning and teaching may prove to be a barrier to more meaningful learning for the majority of secondary school learners in the rural areas (Evans, 1996:130).

To the researcher's knowledge, there is a gap in the literature concerning the use of English as a language of learning and teaching Science to underprepared learners from underpriviledged backgrounds. This area does not seem to have been investigated previously and certainly no major investigation of this nature has been conducted in Limpopo.

1.5 Research Question

This study was undertaken to investigate the use of English as a language of learning and teaching Science in Grade 8. The study sought to answer the question:

- *How can English as a language of learning and teaching (LoLT) influence the successful learning of Science?*

1.6 Hypothesis

The hypothesis was based on the opinion that the learners' difficulties were largely due to a lack of metacognitive strategies compounded by poor English language proficiency. The researcher was of the opinion that if language plays an important role in the development of scientific thinking then learners would have a problem in understanding Science in the language used in the learning and teaching of Science.

1.7 Aim of the Study

Given the limited relevance of the school English curriculum for the prospective Science learner and the fact that individual Science educators at the rural secondary schools cannot cater for the needs of the Grade 8 Science learners, this study aims to do the following:

- To investigate the problems emanating from the use of English by rural secondary Science learners to understand Science.
- To suggest a programme which will develop these learners' command of English within the context of scientific discourse.

1.8 Significance of the Study

The results of the research will be disseminated to the various stakeholders within the Department of Education. Firstly, the Provincial officials responsible for curriculum design will benefit in the sense that they would design Science programmes which accommodate linguistic challenges faced by second language learners. The recommended programme suggested in Chapter 6 would come in very handy to address the challenges faced by second language Science learners.

Secondary school Science educators would benefit because the study may shed valuable information on the nature of learners' learning strategies thus giving a direction for educators to device some form of academic intervention programme to improve underprepared learners' chances of successfully completing their studies (Reagan, 2003:120).

Furthermore, the study will contribute towards addressing problems such as concept formation in Science, responding appropriately to questions and explaining Science processes aptly. Subsequently, this study could constitute a basis upon which interventions, such as the one suggested in chapter 6, can be made in order to address the identified challenges. This study will also serve as a basis for other related research that may affect academic Science performance in schools.

This study may further benefit learners in the sense that if learners are given the necessary guidance, they can become more aware of their own thinking processes as and when they study. This will enable them to develop and acquire strategies with which to direct their own learning (Rollnick, 2000:38).

More importantly, this study will demonstrate that language and thinking strategies can be taught and should not be left to the incidental acquisition thereof as often happens (Edwards and West, 2003:15). This study acknowledges that much research has been conducted on the effect of second language as a language of learning and teaching in Science education in both primary and secondary schools (Khaphesi, 2003:15; Mwinsheikhe, 2002:67; Fredua-Kwarteng and Ahia, 200:4; Wilmot, 2003:94). However, little research has been undertaken in the field of Science education in rural areas of South Africa.

The researcher maintains that this study would make a contribution to the body of knowledge about rural secondary schools Science learners' learning experiences because studies done so far concentrated predominantly on urban environments.

Therefore, the significance of this study has implications for ESL Science education, not only in South Africa, but also in Africa as a whole where the ex-colonial languages are still being used as languages of learning and teaching.

1.9 Methodology

1.9.1 Research Approach

In order to address the research question(s) as deeply as possible a research methodology that uses both qualitative and quantitative approaches was adopted. The qualitative approach was suitable for studying the various verbal/linguistic interactions that take place in and out of the classroom while the quantitative approach was used because it is better suited for strengthening comparisons (Bogdan and Biklen, 1992:122).

1.9.2 Sampling

The sampling for the study comprised of purposive sampling for the seven educators and random sampling for the seventy learners.

1.9.3 Data Collection Techniques

The following techniques were used to gather information in order to realise the aims of this research.

1.9.3.1 Qualitative Data Collection Techniques

These included: (i) participant observation (in and out of classroom), (ii) personal in-depth interviews by using open ended interview guides, semi structured educator and learner interviews and (iii) documentation. Tools for collecting data (in addition to interview guides) included observation forms and recording devices such as laptop audio- recorder

1.9.3.2 Quantitative Data Collection Techniques

In this study quantitative data collection techniques included educator and learner questionnaires which were administered to seven educators who were teaching Natural Science and seventy learners who were registered in the Natural Science classes. The rationale for using the questionnaire technique was because “a questionnaire is relatively economical, has standardised questions, can assure anonymity, and questions can be written for specific purposes” (McMillan and Schumacher, 1993:238).

1.9.3.3 Document Analysis

This included the perusal of official documents such as the Language in Education policy and the learners’ mark schedules. This was in line with what Gilham (2000:58) advocates when he asserts that “written words, texts and objects constitute aspects of social organization, so they are meaningful constituents of the social world”.

1.10 Data Analysis

In this study, qualitative data was analysed using interpretational analysis, which is "a process of close examination of data in order to find constructs, themes and patterns" (Winegardener, 2001:5) that address the researcher's research goal.

Secondly, data analysis for the quantitative data sets was done by means of the Statistical Programme for the Social Sciences (SPSS) through the bar graphs, pie charts for the educators, and chi-square significance test, the test for the differences of proportions and percentages to display the frequency of occurrence for the learners. This was done because Gay (2003:275) asserts that "Collected data must be accurately and systematically organised in a manner that facilitates analysis".

Each analytical method used, was followed by an interpretation of the findings in relation to the purpose and hypothesis of the study.

1.11 Delimitation of the Study

This study was restricted to rural Black learners at secondary schools falling under the Vlakfontein Circuit. The study focused mainly on the use of English as a language of learning and teaching Science in the rural secondary schools of the Vlakfontein Circuit of the Limpopo Capricorn District. Other learning disciplines, although important, did not form part of this study.

The study was also restricted in terms of the homogeneity of the population in that:

(i) All learners were Black and from a rural background;

(ii) All learners shared a uniform first-language background, namely, they all spoke Sepedi as a first language.

(iii) All educators passed through the same system of education which had traditionally fallen under the control of the then Department of Education and Training (DET).

1.12 Trustworthiness of the Study

According to McMillan and Schumacher (1993:198) respondents should never be coerced into participating. Whenever possible, participation should be voluntary, and invasion of privacy should be minimised. Information obtained about the subject must be held confidential unless otherwise agreed on, in advance, through informed consent.

The researcher ensured that participants in a research study were protected from physical or psychological harm, discomfort, or danger that may have arisen due to research procedures. All subjects were assured that any data collected from or about them would be held in confidence.

1.13 Validity and Reliability

Newton (1998:147) defines validity as the accuracy of inferences that are made based on the outcome measure and reliability as the consistency of the outcome measure. An example of reliable (consistence) measure is one that yields the same (similar) score if a person is tested twice. An example of valid measure is one in which a prediction made from the score is true.

The researcher made an effort to control item reliability by asking the same question in different ways and compared the answers. The validity was achieved by compiling semi-structured questions that the researcher had asked and put them in such a way that the respondents would not realise what the purpose of this study was, so as to avoid prejudice.

1.1 Explanation of Key Terms

1.14.1 Science Language

According to Lemke (1990:34), Science is a language that needs to be taught so that learners can learn to talk in Science just like in any other foreign language. “Talking Science” means observing, describing, comparing, classifying, analysing, discussing, hypothesising, theorising, questioning, challenging, arguing, designing, experimenting, deciding, concluding, generalising, and reporting, in and through the language of Science.

1.14.2 Senior Phase Science Learners

This term refers to learners who are registered in the band between General Education and Training (GET) and the Further Education and Training band (FET) i.e. from Grade 7 to Grade 9 and are doing Natural Sciences learning area in rural secondary schools (Department of Education, 2002:7).

1.14.3 English Second Language (ESL) Learners

ESL learners are apprentice learners of English. One characteristic of these learners is that they are often unable to demonstrate their true competence in content subjects which are presented through the medium of English because they lack the necessary language and cognitive skills. In this study, this term refers to Grade 8 learners studying Natural Science through the medium of English (Ralenala, 2003:21).

1.14.4 Text

Halliday (1991:10) defines text as "a term used in linguistics to refer to any passage, spoken or written, of whatever length, that does form a whole". However, in this study the researcher uses the term "text" in the narrow sense in which it refers to the typical material which is prescribed or presented for learning or study in Senior Phase Natural Science learning area. This could be academic books, articles or teaching/learning notes.

1.14.5 Prior Knowledge

This refers to knowledge about a topic that an individual brings to a learning situation which may influence his/her ability to acquire or understand new knowledge about a given topic. Prior knowledge includes knowledge of content as well as knowledge of specific metacognitive strategies (Ralenala, 2003:21).

1.14.6 Underprepared Learners

This term refers to learners who have received their primary education at dysfunctional schools as a result of the past discriminatory laws, poor cultural and poor socio-economic factors. These learners are usually characterised by poor learning which is compounded by limited

English proficiency. Some educationists prefer the term “disadvantaged” or “at risk” learners. In this study all three terms will be used interchangeably (Ralenala, 2003:21).

1.14.7 Multilingualism

Multilingualism is the use of three or more languages by an individual or by a group of speakers such as the inhabitants of a particular region or nation. Multilingualism can have a positive learning and social benefits. This approach suggests that a second (or more) language is added to the first language throughout the process of education (CCD, 2001:130-131).

1.14.8 Bilingualism

Bilingualism means the ability to speak or write fluently in two languages (CCD, 2001:126).

1.15 Outlay of the Study

In the following paragraphs the researcher will present the structure of the thesis by describing main themes of the chapters.

Chapter One: Orientation to the Study

This chapter gives an introduction and general orientation to the study by highlighting and putting into perspective the precise nature of the problem as experienced by the research subjects, stating the conceptual framework underlying the study, describing the various research instruments that will be employed to illicit the necessary and relevant data from which the envisaged learning guidelines will be based, and explaining key terms to facilitate the reading of this research.

Chapter Two: Literature Review

This chapter will focus on a review of literature about the issue of language in education and the issue of the use of English as a language of learning and teaching Science in rural secondary schools.

Chapter Three: A Profile of the Environment of the Rural Senior Phase Science Learners

This chapter will deal with the educational setting as part of the learning environment. It will focus on the learners' general academic profile in relation to their secondary school learning experiences.

Chapter Four: Research Design and Methodology

This chapter will deal with the Research Design and Methodology. The design will be knitted together by the purpose of the study, conceptual context, research paradigm, research questions, and methods to be used in data collection as well as the qualitative approach to be used in the study.

Chapter Five: Data Analysis and Interpretation

Chapter five will cover Data Analysis and Interpretation. It will be the most comprehensive of the entire study and will also contain a built-in literature analysis to back the study's thesis. It will cover the analysis of the two interviews to be conducted in the gathering of data for the study, namely, the educator interview and learner interview. The chapter will also cover an analysis of the classroom observations that will be conducted in the sampled schools.

Chapter Six: Conclusions, Recommendations and Limitations of the Study

The main findings of this study which emanate from the literature study and empirical data will be summarized and recommendations of further research flowing from these findings will be made in this chapter. Finally, limitations of the study will be discussed.

1.16 Conclusion

This chapter has provided background and theoretical basis for this investigation. The problem was outlined, followed by the research questions and aims of the study. The limits of the study were also explained. This chapter also provided the layout of the entire study in terms of the chapters, including the meaning of concepts to be used.

Chapter two will provide a broad literature review on the use of a second language in the teaching of Science. It will provide the main pillar of the conceptual framework for this study, namely, the phenomenon of the language of learning and teaching in the studying or learning of Science. A literature study will be fused in this (second) chapter so as to put the research problem into perspective and the right context.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

In the previous chapter, the researcher outlined a general orientation to the study. The basis of the problem and the rationale for the research were discussed. The research question intended to guide this investigation together with the aim of study were stated to acquaint the reader with the whole study. The researcher also introduced the research approaches, data gathering techniques and means of analyses which would be employed in this study. The chronology of chapters to come was intended to give an overview of the research as a whole.

In this chapter the literature pertaining to the current study will be reviewed and discussed. The discussion of the literature has been divided into subsections which relate to the various aspects of the current study. Firstly, the role of language in learning Science will be discussed. Thereafter textual analysis in a Science academic situation will be discussed. Theories of second language learning and perspectives for teaching Science to disadvantaged learners will be scrutinized.

Further, studies relating to the impact of LoLT in Science learning (locally and internationally) will also be reviewed. Finally, policy matters relating to Science education and the language of learning and teaching in South Africa will be reviewed.

The researcher is of the opinion that this chapter is meant to set the stage for subsequent chapters which comprise a detailed and more contextualized review. This context based review approach avoids a loose reference of sources. Literature located in specific contexts and themes will be cited-thus playing a major role in framing the discourse of the study.

2.2 The Role of Language in Learning Science

The human mind is endowed with ability (not shared by any other species) for obstructing from natural experience an essence in an abstract form and articulating it in a manner that permits its transmission and manipulation (Bybee, 2002:234). It is this faculty to manipulate knowledge in a symbolic framework that enables humans to derive deeper meanings from their experiences and to generate new knowledge which natural experiences in their raw form could never reveal (Anstrom, 2001:132).

According to Simala (2001:311) "language makes it possible for us to understand and make sense of the world of Science by providing a cognitive framework of concepts. It is through the use of such a framework consisting of words and meanings that we interpret the concepts and exchange information about them with other people. Our entire knowledge and experience of the Science concepts is mediated by language".

Language is the most common medium through which learners and educators interact in the Science classroom. Given this, parents, educators and learners need to understand that whether learners are studying literature, history or Science; they need fundamental language skills to understand information and express their ideas on it. It is through language that learners are able to acquire skills that are essential in the workplace and for their livelihood (Setati, 2003:12; Yushau, 2004:183). Communication in Science relies heavily on context reduced, cognitively demanding language, which has been identified as being particularly difficult for second language learners to acquire (Cummins, 2000:200).

The importance of language in learning and teaching Science cannot be under-estimated. It is important for learners in developing their scientific knowledge, and for educators in understanding their learners' learning processes. But research has shown that the ways in which educators and learners use language in the classroom are complex and the effects, though considerable, are often highly subtle and not self-evident. Therefore it is important to develop what happens with language, why it happens and how it happens, since language is a tool that is used for expressing information and ideas. A variety of linguistic and non-linguistic modes are used for communication: listening and talking; reading and writing; discussing and arguing; narrating and describing; using actions, images and symbols–all of which are ways of signaling meaning and what linguistics term 'semiotics' (Lemke, 1998:88).

Bell (2001:140) asserts that “teaching and learning are vastly facilitated through the use of language. Not only is language used by educators to communicate information to learners, language is necessary for the complete formulation of most concepts and principles. In Science classrooms, one of the primary ways for learners to demonstrate knowledge and understanding of scientific ideas is through the use of language to express their conceptions of the ideas”.

McLean (2000:125) supports the above assertion by stating that “many of the learners’ learning problems in Science originate from an inadequate knowledge of the basic vocabulary of the language of learning and teaching (LoLT) since, as Bohlmann (2001:14) asserts, language is the medium by which educators introduce and convey concepts and procedures, through which texts are read and problems are solved.

In an analysis of recent studies on second language learning in Science, Rollnick (2000:100) states that “… it is acknowledged that expecting learners to learn a new and difficult subject through the medium of a second language is unreasonable, giving them a double task of mastering both Science content and language”. This double task entails the acquisition of two conceptually difficult and different skills at once – one being related to language, and the other to Science content. This confirms what Cummins (2000:23) asserts when he suggests that second language learners will acquire language and content most successfully when they are challenged cognitively but provided with contextual and linguistic supports.

The majority of learners (if not all) in the research area learn through a language other than their first language (primary language or mother tongue). In other words, they are experiencing schooling in a second interaction. This results in poor academic performance because research indicates that using the learners’ home language adds to the child’s ability to perform satisfactorily and to communicate in the second language (Brice, 2001:135).

Proficiency in conversational English is not the only prerequisite for English second language learners to master Science. They also need to be familiar with scientific English. According to Setati (2003:15), “learners engage in both conceptual and procedural discourses by using a language”. The difference between conversational language and scientific language is considerable, since according to Rollnick (2000:100), "… the difference between everyday language and Science or scientific terminology also leads to first language speakers learning a new language when learning Science".

Further, limited proficiency in the language of learning and teaching inhibits or restricts progress and overall achievement. Communication in the classroom is used to negotiate meaning, explain solutions, clarify misunderstanding as well as to verbalize (scientific) ideas and thoughts. All scientific ideas, interpretations reasoning and thoughts are filtered through language in the classroom (Mercer, 2001:40). Hence, Mercer (2001:42) suggests that "educators need to adjust their lessons according to the background knowledge and language skills because many of the textbooks presently in use take this variable for granted while demanding too much of the learners' reading skills". The implication here is that educators should look carefully at the text used in the textbook in order to identify vocabulary and concepts that might be difficult for learners.

Culture is also a critical determinant in shaping how learners speak and interpret words. Meanings of words are determined by the uses of words within a linguistic and cultural setting, and these settings are not the same in any two cultures. For instance, learners who are using English as their second language, like the subjects of the present study, need to learn words in English as well as the cultural background that gives words their English meaning (Meyer, 2002:120). To fully function in a particular language, one not only needs to understand the mechanics, such as grammar, but also to apply that language across various contexts, audiences, and purposes (Meyer, 2002:120).

The above serves to explain why it has always been advocated that meaningful learning takes place in an environment that accommodates learners' home language since that awakens a variety of internal development processes that a child has acquired in his socio-cultural environment (Meyer, 2002:122).

Zevernbergen (2001:145) echoes the same view when she contends that "when learners enter the school context, their "out of school" language practice becomes embodied in their habitus.

As a result, learners whose linguistic background is different from the one used in the classroom are likely to be marginalized by those who are proficient in the required language". In direct reference to the learning of Science, Zevernbergen (2001:204) asserts that "classroom interactions are imbued with cultural components that facilitate or inhibit access to the scientific content".

Torbe and Shuard (2002:121) contend that the forms of language, which learners experience in Science lessons, are often insufficiently varied to allow them to develop for themselves rich forms of language in which to express their scientific thinking. They further indicate that learners may consequently have considerable problems in communication and this may have considerable problems in developing thinking skills. In short, they imply that lack of suitable language is a grave handicap to the internal monologue, which forms the basis of thinking for both Science, and in other curriculum areas. The role which Science plays in communicating ideas and the role of the language (LoLT), which is used in communicating Science, are inextricably bound together.

From the arguments alluded to above, it is evident that learners must learn Science as a language as well as a discipline of knowledge (Zevernbergen, 2001:150). Both the language of learning and teaching (LoLT) and scientific proficiency is required for effective learning. Hence, commenting on the fact that second language learners achieve less in Science than their first language counterparts, Anstrom (2001:135) contends: "if second language (L2) learners do not have access to the linguistic skills required for scientific argumentation, they will not be able to engage in the level of discussion essential to scientific enquiry, and will have difficulty in scientific reasoning".

The implication here is that L2 learners will find it difficult to use certain linguistic structures such as logical connectors and specialised vocabulary because discourse patterns common to Science such as compare/contrast, and problem/solution require a high level of linguistic ability. Thus cognitive development in Science is heavily dependent upon linguistic development. Thus, in the context of the present study, the researcher is of the opinion that learning Science through English as a language of learning and teaching will inevitably lead to challenges of cognition.

The following section focuses on textual analysis in a Science academic situation.

2.3 Textual Analysis in a Science Academic Situation

In our literate society, it is difficult to think of any skilled work which does not require some form of and level of language proficiency and analytical know-how in independent learning and comprehension. For learners studying through a second language, this is critical because all learning that lies ahead of them is largely dependent on whether or not they possess sufficient metacognitive skills to be able to interpret texts with adequate understanding and appreciation (Clarkson, 2002:13; Cuevas, 2001:135; Lim, 2003:53). Improvement in analytical skills is necessary to achieve a number of goals including:

- to enhance understanding of the content information presented in a text
- to improve understanding of the organization of information in a text
- to increase personal involvement in the learning and reading material
- to promote critical thinking and evaluation of reading material
- to enhance registration and recall of text information in memory (Childs and O' Farrell, 2003:233; Gardner, 2001:10; Miller, 2002; Mortimer, 2003:55).

Although the researcher as a trained language educationist subscribes to the principle of an integrated approach involving the four language skills of listening, speaking, reading and writing in that order, on the grounds that focusing on one skill may sometimes be limiting and that utilizing other skills as back-up to the reading skill (to analyze written material) may enhance facility in the language skill targeted, he (the researcher) nevertheless takes the point made by Stahl and King (2000:15) that the single most important skill in most second-language situations is usually reading because "it is the platform from which critical thinking, problem solving, and effective expression are launched".

There are specific functions to be performed in academic learning and they must be performed involving higher–order thinking and problem–solving skills in particular. Any limitation or inability to access information from texts leads to over-reliance on the educator or notes. That is why the possession of strong analytical reading skills is of more importance in many English second language environments (McColvin, 2000:33; Ruddell, 2001:12; Stannovich, 2000:54).

Miller (2002:12) on the other hand points out that "while language may be the most important cognitive resource for a secondary school learner, reading with understanding is not just a language supportive tool for learning, but is the very process through which secondary school learning takes place". This is because the ability to interpret text is a prerequisite for setting up any programme to teach and improve Science learning. Hence, Christie (2001:293) contends that in the Science classroom, one needs to have both commonsense knowledge i.e. knowledge that is familiar and readily available; and uncommonsense knowledge i.e. knowledge that is unfamiliar and involves the use of specialist or technical language.

Further, Wilson (2004:1067) highlights the multi–dimensional nature of text analysis. He argues that reading a text should not be limited to exercises in comprehension, vocabulary development and word identification skills, but should also be seen in relation to the many cognitive aspects which are involved in comprehension over and above decoding linguistic items.

Secondary school learners in particular are expected to be competent learners who are able to infer an idea from a selection, identify a fact or opinion, infer a cause or effect, identify relevant information and follow logical connections in a text but more than anything else are able to internalize such information. To be able to do this, they must acquire particular learning strategies which they will use to suit their needs and goals and which they will be able to adapt according to the nature and complexity of the text they are reading and the tasks they are expected to perform (Vacca &Vacca, 1999:46).

For this reason it is important for particularly the educators to keep in mind all the time that the goal of learning in content area instruction must be to show learners how to analyze texts effectively to comprehend and learn from them.

2.4 The Science Classroom as a Site of Multiple Discourses

Learners bring into the Science classroom a great variety of common sense or views derived from individual experiences of the world. They also bring their own linguistic resources and communicate repertoires developed from early childhood in a variety of social settings. These contribute to the social context of the classroom (Lemke, 1990:15) where the learners' own discourse gradually becomes extended to incorporate scientific discourse. Scientific discourse comes about through a complex process of socialization that involves code-switching, using language for different purpose with different social determinants for what may, and may not, be said developing a sharing of experiences and thereby leading to the development of scientific knowledge and understanding. Most children quickly become adept at code-switching in situations they encounter, although it seems that middle class children are much better prepared to develop a formal use of language than are working class children (Barnes, 199:2; Lemke, 1997:66).

In addition, it is not easy to determine whether code-switching takes place within the classroom or not. Frequent shifts between talking about individual feelings or problems, describing and discussing scientific content, and the language of classroom management are just a few that occur. In a multi-lingual classroom language issues are complicated further. Using English as an additional language (EAL), learners may have developed sophisticated strategies for coping with the varieties of English they encounter. For them, scientific language may be yet another type of experience. Their code-switching is an additional layer to using different languages. Within the classroom, the Science educators' way of talking interacts with those of their learners to channel and develop the ability to engage in and share scientific discourse.

It is noteworthy to mention that Science lessons in ESL classes are based on inquiry and problem solving which is a challenge to learners for whom English is their second language. Different authors agree that scientific inquiries are suffused with talk, questioning, describing, explaining, hypothesising, debating, clarifying, elaborating, and verifying and sharing results (Carrel, 1988:17; Cousin, 1989:23; Jones, 1987:19). While language demands are significant, the potential is also strong that learners will learn important English language skills as well as Science content.

Learners in Grade 8 may need to begin with explicit instruction and progress to more exploratory learning, gradually developing independent learning skills. Some learners have difficulty using some language functions, such as reflecting, predicting, and hypothesising. Their prior experiences in primary school or home may not have prepared them to ask probing questions or to plan their own investigations. From a language perspective, an inquiry approach has many benefits. Aspect of inquiry such as discourse, questioning, investigating, observing, classifying and measuring objects and phenomena, collecting and analysing data can create an environment favourable to English second language development (Krippendorff, 2004:34; Marshall, 2002:331).

The learners can develop inquiry based and problem solving strategies before they are proficient in English. Marshall (2002:337) asserts that: "as learners move from concrete to more abstract content, their skills also progress on complexity, enhancing learning in both areas". In Science inquiry, activities should be relevant to learners' real life experiences and prior knowledge. Activities should include the use of graphics, manipulation and experiences to clarify and reinforce meaning. Learners should have many opportunities to write reports, explanations, descriptions, their own word problems and problem solving strategies, journal entries and so on. When the objective of the inquiry task is targeting content rather than vocabulary or some aspect of language, educators should give greater emphasis to what the learner is saying or writes and to grammatical or spelling errors secondarily (Marshall, 2002:337).

However, it has to be stated that, as a result of a foreign language medium, communication skills, which are totally dependent on what language is used as the language of learning and teaching have to be developed. This means that all presupposes a good mastery of the language of learning and teaching. Brock-Utne (2000:77) has observed, while conducting a study in some Tanzanian secondary schools, that “if learners are taught in a foreign language, they learn to obey, be quiet, to be indifferent and apathetic. On the other hand, if learners are taught in a familiar language, they develop critical thinking and they are able to challenge the authority”. Hence, the researcher would assert that a study on the influence of English as a language of learning of Science is imperative if learners at the disadvantaged communities are to be helped.

The researcher is of the opinion that Bloom’s (1956) taxonomy of learning domains is worth discussing as it has relevance to the section under discussion.

2.5 Bloom's Taxonomy of Learning Domains

Bloom's (1956:1) taxonomy was an attempt to classify student behaviours (outcomes) which are intended as the observable and assessable result of teaching and learning. The model was intended to be a hierarchy of intellectual abilities. It proceeds from the possession of knowledge, at the most basic level of memory or rote learning, toward an increasing ability to understand and manipulate the knowledge in an intellectual manner. Each step in the hierarchy subsumes the preceding stages. For example, application involves recalling fully comprehended information from one's knowledge bank and using it to solve a problem in a new or novel situation. Application is not possible without comprehension, which in turn is impossible without knowledge.

Bloom (1956:2) reports that in a survey of some 14,000 Science test items the taxonomy, showed that:

- 78% tested level 1 only (knowledge i.e. recall or rote learning)
- 14% tested level 2 (comprehension)
- 8% tested level 3 (application)
- 0.2% tested levels 4 - 6 (analysis, synthesis and evaluation).

The above observation confirms the tendency that is prevalent in many a Science classroom.

The taxonomy, (Bloom, 1956:1) comprises a hierarchical scheme of educational objectives in three broad domains: the cognitive domain (knowledge and understanding), the affective domain (values and attitudes) and the psychomotor domain (skills). These domains can be thought of as categories. They are often referred to as KSA (Knowledge, Skills, and Attitude). The taxonomy of learning behaviours can therefore be thought of as "the goals of the training process." That is, after the training session, the learner should have acquired new skills, knowledge, and/or attitudes. A discussion of the domains follows hereunder. However, in this study, attention will be given to only the cognitive and affective domains as they are more relevant to the issues under investigation.

Below is a discussion of the domains as identified by Bloom (1956:3-4).

2.5.1 Cognitive Domain

According to Bloom (1956) the cognitive domain involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. There are six major categories, which are listed in order below, starting from the simplest behaviour to the most complex. The categories can be thought of as degrees of difficulties. That is, the first one must be mastered before the next one can take place. The following table illustrates the above assertions adequately.

Table: 2.1 Categories of the Cognitive Domain

Category	**Example and Key Words**
Knowledge: Recall data or information.	**Examples**: Recite a Science formula. **Key Words**: defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	**Examples**: Rewrites the principles of test writing. Explain in one's own words the steps for performing a complex task. Translates an equation into a computer spreadsheet. **Key Words**: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives Examples, infers, interprets, paraphrases, predicts, rewrites, summarizes,

	translates.
Application: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the laboratory.	**Examples**: Use a manual to explain a scientific phenomenon. Apply laws of Science to evaluate the reliability of a written task. **Key Words**: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.
Analysis: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	**Examples**: Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a classroom and selects the required tasks for training. **Key Words**: analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
Synthesis: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	**Examples**: Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome. **Key Words**: categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
Evaluation: Make judgments about the value of ideas or materials.	**Examples**: Select the most effective solution. **Key Words**: appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.
(Adapted from Bloom, 1956)	

2.5.2 Affective Domain

The affective domain according to Bloom (1956:5) includes the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes. The five major categories are listed from the simplest behaviour to the most complex in the table hereunder.

Table: 2.2 Categories of the Affective Domain

Category	Example and Key Words
Receiving Phenomena: Awareness, willingness to hear, selected attention.	**Examples**: Listen to others with respect. Listen for and remember the name of newly introduced people. **Key Words**: asks, chooses, describes, follows, gives, holds, identifies, locates, names, points to, selects, sits, erects, replies, uses.
Responding to Phenomena: Active participation on the part of the learners. Attends and reacts to a particular phenomenon. Learning outcomes may emphasize compliance in responding, willingness to respond, or satisfaction in responding (motivation).	**Examples**: Participates in class discussions. Gives a presentation. Questions new ideals, concepts, models, etc. in order to fully understand them. **Key Words**: answers, assists, aids, complies, conforms, discusses, greets, helps, labels, performs, practices, presents, reads, recites, reports, selects, tells, writes.
Valuing: The worth or value a person attaches to a particular object, phenomenon, or behavior. This ranges from simple acceptance to the more complex state of commitment. Valuing is based on the internalization of a set of specified values, while clues to these values are expressed in the learner's overt behavior and are often identifiable.	**Examples**: Demonstrates belief in the democratic process. Is sensitive towards individual and cultural differences (value diversity). Shows the ability to solve problems. Proposes a plan to social improvement and follows through with commitment. **Key Words**: completes, demonstrates, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, selects, shares, studies, works.
Organization: Organizes values into priorities by contrasting different values, resolving conflicts between them, and creating an unique value system. The emphasis is on comparing, relating, and synthesizing values.	**Examples**: Explains the role of systematic planning in solving problems. . Creates a life plan in harmony with abilities, interests, and beliefs. Prioritizes time effectively to meet the needs of the organization, family, and self.
	Key Words: adheres, alters, arranges, combines, compares, completes, defends, explains, formulates, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes.
Internalizing values (characterization): Has a value system that controls their behavior. The behavior is pervasive, consistent, predictable, and most importantly, characteristic of the learner. Instructional objectives are concerned with the student's general patterns of adjustment (personal, social, emotional).	**Examples**: Shows self-reliance when working independently. Cooperates in group activities. Uses an objective approach in problem solving. **Key Words**: acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, verifies.
(Adapted from Bloom, 1956)	

Bloom's taxonomy becomes significant to this study when considered against the problems the researcher observed in his English and Science teaching career (see Chapter 1). The taxonomy provides possibility of analyzing learners' poor comprehension of Science content. For instance, their inability to comprehend Science concepts could be that they cannot *infer, interpret or paraphrase*.

The following section focuses on the second language as a language of learning and teaching. Firstly, a discussion of second language learning theories is provided below in order to give a broader context of issues related to learning via a second or foreign language.

2.6 Theories of Second Language Learning

Some theories on second language learning and acquisition will be presented in this section together with additional factors that affect second language learning. The theories are significant to understand the results of this research since the essence of it is an exploration of phenomena that come into play when Science is learnt through the medium of English as a language of learning and teaching.

2.6.1 The Input Hypothesis

According to Mitchell & Myles (1998: 126) "it has always been obvious that comprehensible and appropriately contextualised L2 data is necessary for learning to take place". The above language quotation is introducing the idea of Krashen's (1985:143) *Input Hypothesis* of second language learning. The *Input Hypothesis* states that in order for language acquisition to take place, the acquirer must receive comprehensible input through reading or hearing language structures that slightly exceed their current ability (Krashen, 1985:143; Brown, 2000:278). They assert that if the learner is exposed to enough input and the input is understood, then the necessary grammar is automatically provided. What is criticised in this theory is the claim that 'comprehensible input' is sufficient.

It is important to note that *The Input Hypothesis* often refers to a set of five hypotheses in Krashen's theory of second language learning, namely, the natural order hypothesis, the acquisition/learning hypothesis, the monitor hypothesis, the *input hypothesis* and the affective filter hypothesis. In this section, however, the researcher will only refer to the *Input Hypothesis*. This hypothesis postulates that learners acquire language in only one way i.e. by understanding messages or receiving comprehensive inputs. It answers the question of how learners acquire a second language or develop competency in second language over time. In other words, we acquire only when we understand language that contains structure that is a little beyond where we were before. The comprehensive input in this hypothesis simply refers to words, phrases and sentences, which a language learner may understand due to using the context of the language s/he is hearing from a speaker of the second language or reading a text and his/her knowledge of the world around him/her (Krashen, 1985:143).

This hypothesis contains three fundamental elements listed as follows:

- Language is acquired, not learned because a learner has received comprehensive input that contains structures beyond his/her current level of mastery**.**
- Communication should be allowed to emerge on its own as a result of the confidence that the learner has built through the comprehensive input.
- The input should not deliberately contain grammatically programmed structures (Krashen, 1985:143).

What can be deduced from this hypothesis is that a comprehensive input may be acquired in spite of whether it consists of mixing one or two codes together (code mixing). With respect to learners, they cannot acquire a comprehensive input without the assistance of others. Thus, some cases of code switching might be the result of the comprehensive input they received from the educators and peers. For instance, an educator may code switch in order for the learners to understand the language or if a learner exercises great effort to express him/herself, the other learner can assist by providing the comprehensive language in a meaningful context. Children have a rapid and natural way of communicating their meaning to their peers. The above discussion gives credence to the necessity to investigate how English is used in the teaching of Science for the majority of “at risk” learners found in the rural parts of the Limpopo Province.

2.6.2 The Interaction Hypothesis

Long's *Interaction Hypothesis* (Mitchell & Myles, 1998: 128-129) is an extension of Krashen's *Input Hypothesis* (Krashen, 1985:143) and explains a part of language acquisition as an interaction between the learner and someone with a higher proficiency in the second language. Research (Mitchell & Myles, 1998: 128-129) shows that in the conversational interaction between a native speaker and a non native speaker, there was a collaboration to make sure that they both understood each other and could proceed in the communication. In this way, output and input had to be dealt with to make it comprehensible for the learner and ensure that s/he was receiving input.

However, this hypothesis assumes that learning will take place *automatically* as long as there is interaction and negotiation towards comprehension between the learner and the other (Mitchell & Myles, 1998: 128-129). Thus an extension to the *Input* and *Interaction Hypotheses*, the *Output Hypothesis* was defined. The challenge that begs for attention is how interaction can easily flow if the educator and the learner use a language with which they are not familiar with, as it is the case with the situation under investigation in this study.

2.6.3 The Output Hypothesis

As stated previously, there are some gaps in the previous hypothesis because it states that interaction will inevitably lead to improved second language proficiency, whereas the *Output Hypothesis* has taken the theory a bit further. In this context, the term *output* refers not only to the product of the language of learning but also to the process through which the learner acquires knowledge (Hinkel, 2005: 475).

According to Hinkel (2005: 474-480), the *Output Hypothesis* has three functions that make learning take place:

(a) The noticing/triggering function: while the learner is producing speech (or writing) s/he will notice some of the linguistic problems or gaps in the target language. This awareness could trigger the learner to search to correct the errors or fill in the holes of lacking language skills.

(b) The hypothesis testing function: while the learner is testing the language – or how

s/he thinks the target language should be – s/he also engages to “modify [the] output in response to feedback” (Hinkel, 2005: 476). In short, when feedback is given to a learner who is expecting response, the learner reflects over her or his own hypothesis of how the target language is, and modifies the outcome. Recent studies have shown that learners who produce modified output were more likely to learn than learners who did not.

(c) The metalinguistic (reflective) function: it is based on Vygotsky’s theory (Vygotsky, 1986:2) that language is not only a tool for expressing ideas but also a tool for visualizing them. Hence making the person aware of them. It is also a tool for creating knowledge. The tool that language is in its form of speech or writing can “construct and deconstruct knowledge” (Hinkel, 2005:480).

The implications of the above key principles from the hypotheses for the Science classroom are that it becomes the educator’s job to provide comprehensible input in the form of authentic materials, exposure to different kinds of text, and as many opportunities for different kinds of interaction as possible. The classroom environment should be a supportive one which identifies with and accepts the learners’ cultures. There is a need for second language consciousness rising with incidental grammar teaching in mainstream classrooms.

2.6.4 Vygotsky on Language and Thinking

According to Vygotsky (1962:44) language has two main functions. Firstly, as a communicative and cultural tool it is used for acquiring, developing and sharing knowledge and culture, which enables human social life to continue. Secondly, quite early in childhood, language is used as a psychological tool for organizing people’s individual thoughts for reasoning, planning and reviewing their actions. Mercer (2001:100) asserts that “Vygotsky also believed that in early childhood, language fuses with thinking and shapes the rest of the individual’s mental development”.

Furthermore, Vygotsky (1962:44) viewed language and thinking as independent processes each with its own existence but “… at a certain point, these lines meet, whereupon thought becomes verbal and speech rational”. It is the capacity for verbal thought that distinguishes human intellect from that of other living creatures. Importantly, Vygotsky (1978:26) asserts that "children solve practical tasks with the help of their speech, as well as with their eyes and hands".

In the Vygotsky (1989) translation, he points out that language has three major functions in an individual, namely:

- Self-regulation : the ability of an individual to use language to think things out for himself, to control himself as well as control others.

- Other –regulation : the ability for an individual to use language to communicate effectively with other people. Paralinguistic features such as facial gestures also fall into this category.

- Object-regulation : the ability for an individual to use language to categorize and arrange objects in his environment in such a way that it will be easy to deal with them.

For the purpose of this study, these are very important aspects to take into consideration because when learners are given academic tasks to perform, their language and thought must have been developed to the extent that they can deal with such tasks effectively and with confidence. Without this development (of the shared language and thought), learners will have very little chance of carrying out complex academic tasks, especially in a content subject like Science.

2.7 Factors Affecting Second Language Learning

2.7.1 Orientation

Apart from the theories of acquisition and learning that have to be taken into consideration when talking about second language learning, there are several factors that influence the learning of and/or in a new language. Some of those factors will be presented below. They should be taken into consideration in the classroom, so that an optimal learning situation can be provided. Logically enough they are not only applicable on second language learning, but also the learning of any subject, including Science.

2.7.2 Styles and Strategies

All people have own personality traits that definitely affect their learning. Sometimes we are not even aware of them, but it is important for the learner to get to know different ways of learning so they can benefit as much as possible from the Science instruction.

The term *styles* refers to the fact that the characters of the learners are different in the sense that they might be, for example, more perceptive visually than aurally or more reflective in the process of the intake of information (Brown, 2000: 113). The styles affect the way we learn and it is very important for a teacher to be attentive to the diversity of the learners.

The term *strategies* refers to the fact that we have different methods to approach and solve a problem or a task (Brown, 2000: 113). In the second language classroom it is important to make space and time for the learners' varying strategies in order to optimize the learning process. In reference to this study, it can be considered as the educator's responsibility to introduce different methods in order to touch all strategies and styles.

2.7.3 Affect

Affect is a wide concept and can be interpreted in many ways. Krashen (1985:143) had some thoughts about this that he presented together with the *Input Hypothesis*. However, before him Bloom (1956:2) among others, made a taxonomy that was related to education and language learning, where three key concepts were defined: *receiving, responding* and *valuing.* In the process of learning in a second language, the learners have to be *receptive* to who they are communicating with and to the language itself. They need to be *responsive* to the persons they are interacting with and to the context, and finally they must *value* the "communicative act". This corroborates what Bloom's (1956) affective domain advocates (see paragraph 2.5.2). Hence, Brown (2000:144) asserts that "Understanding how human beings feel and respond and believe and value is an exceedingly important aspect of a theory of second language acquisition".

Within the affective domain there are some sub-factors that relate to second language acquisition. *Self esteem* is one factor that can be referred to in general, to the learner's personality or certain traits of personality and it can also be referred to a specific task in a specific situation. It is not yet known if high self-esteem improves a learner's language skills or the other way round (Brown, 2000: 147). According to Brown (2000: 147), an optimal and successful learning situation is due to the teacher's attention both to "linguistic performance" and "emotional well-being". It is also important to have a high self-esteem so that *inhibition* does not hinder the trying of new hypotheses and making mistakes for example in pronunciation or grammatical structure, because *risk-taking* is indeed another factor that a language learner cannot be without (Brown, 2000: 149).

Anxiety is another factor that, like *self-esteem,* can be defined on two levels; like a general tendency or trait in personality or as a "state [that] is experienced in relation to some particular event or act" (Brown, 2000: 151). Whereas the first level is difficult to detect in second language learning, the second one, that is bound to a certain situation and can be referred to as the "foreign language anxiety", has been investigated more. Most results have identified that there is a debilitative and a facilitative anxiety that either harms or helps the learning process (Brown, 2000: 152).

2.7.4 Motivation

The motivation factor is discussed not only in the second language learning context but in learning in general. It is something that can be "global, situational or task-oriented" and according to Brown (2000: 162) the three mentioned types are required in the language learning process. There are even more sides of motivation in the context of second language learning. One is the motivation related to *instrumental* goals, such as good grades or better jobs. The other one is the *integrative* motivation that comes from the learner's desire to be involved in the second language culture. Yet another side is the *intrinsic* motivation that is related to the "reward [of] the activity itself" as opposed to the *extrinsic* motivation that is related to success in a task and a reward beyond oneself. Grades, prizes and "behaviours […] to avoid punishment" are examples of *extrinsic* motivations (Brown, 2000: 162-165).

However, while many instances of intrinsic motivation may indeed turn out to be integrative, some may not. For example, one could, for highly developed intrinsic purposes, wish to learn in a second language in order to advance in a career or to succeed in an academic program. Likewise, one could develop a positive affect toward the speakers of a second language for extrinsic reasons, such as parental reinforcement or a teacher's encouragement (Brown, 2000: 165).

2.7.5 Meaningful Learning

In mental terms, the more a fact is associated with in the mind, the better possession of it our memory retains (Brown, 2000: 85).

Brown (2000: 83-86) asserts that learning acquired in a meaningful context is remembered for a longer time. Rote-learning may not have a meaningful situation to be related to, neither for association with the learners cognitive structures, nor with anything else than performance results in the classroom. There has to be a more integrative meaning to learning so that real knowledge can be constructed.

The following section focuses on theories of learning Science by disadvantaged learners.

2.8 Theories and Perspectives for Teaching Science to Disadvantaged Learners

2.8.1 Introduction

As far as the learning of Science is concerned, the past two decades have been dominated by two strong theories of learning: the first, the behaviourist learning theory, emphasizing the factual recall of Science content to the near exclusion of the knowledge-generation process; and the second, the constructivist learning theory which emphasizes the learners' personal construction of knowledge (Ralenala, 2003:65). These theories are explained in detail below:

2.8.2 The Behaviourist Theory

The first coherent conception of learning was the behaviourist conception based on the work of Pavlov in the Soviet Union and Skinner in the United States. This conception says that there is an objective world from which people form associations in their minds and these people seek the truth by matching these associations (in their minds) with what is presented by the world around them. If these associations match each other, then that person is described as having gained knowledge, which according to them is equivalent to learning. And if these items do not match, then learning is perceived as having not taken place (Monk & Dillon, 2000:15).

This thinking originates from the popular but faulty belief that academic texts particularly in the hard Sciences are a series of impersonal statements of facts which add up to the truth. This theory regards learning as a mechanical process of habit-response sequence. Teaching based on the behaviourist view of Science attempts to transmit to learners, concepts that are precise and unambiguous, using language capable of transferring ideas from experts to novice (educator to learner) with precision.

The researcher is of the opinion that educators are likely to support the behaviourist way of presenting knowledge which discourages learners from asking questions since they (learners) will not know what to ask. All they can do is to commit this information to rote learning. This is an unhelpful way of learning and teaching Science. If learners come to classes with ideas about their world which already make sense to them, then teaching needs to interact with those ideas, first by encouraging their declaration and then by promoting consideration of whether other ideas make sense.

The practice of encouraging learners to make use of their prior knowledge when they read is very uncommon among many traditionally African schools where the textbook and the educator's notes are the "be-all" of knowledge. Learners are not only encouraged but urged to memorize and reproduce information verbatim (Ralenala, 2003:67).

This approach takes away construction of knowledge on the part of the learner and should be discouraged at all times. It reinforces the assumption that the educator's job is to fill a learner's mind with bits and pieces of knowledge the way a shop assistant fills the supermarket's shelves with stock. Further, it encourages passive learning which is not engaging. For learners to sense that their work is important, they need to tinker with real-world problems, and they need opportunities to construct knowledge (Ralenala, 2003:67).

2.8.3 The Constructivist Theory

This theory of learning is based on the premise that people are naturally curious. The implication is that education can either develop or stifle their inclination to ask or to learn. If the learner's task is to memorize rules and existing knowledge without questioning the subject matter or the learning process, their potential for critical thought will be restricted. Whereas the behaviourist theory of learning portrays the learner as a passive receiver of information, the constructivist view takes the learner to be an active processor of information. This perspective is currently enjoying popularity as a framework for both the analysis and practice of Science and mathematics education even though there is no consensus of what is actually meant by this term (Ralenala, 2003:68). It emphasizes Bloom's taxonomy as explained in paragraph 2.5.1. above.

The core of constructivism is the belief that learning is an active process in which learners construct new ideas and knowledge based upon their current and past experiences. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so (Brunner, 1986:45). This view replaces the more traditional view that claimed that knowing the subject is a pure entity unaffected by biological, psychological and sociological contingencies (Roth, 1995:15).

According to this theory, which is based heavily on the work of psychologists Vygotsky (1978) and Piaget (1972:10), genuine learning is deeply subjective and intensively active. Beginning in infancy, each of us constructs a personal understanding of the world, weaving every new experience or fact into our widening fabric of integrated concepts. Learning, then, occurs when learners actively assimilate new information and experiences and constructs their own meaning. Accordingly, a fundamental principle for how learners should learn Science is that they should be actively involved in the learning process. Hence, Osborne and Wittrock (2003:103) describe a constructivist theory adapted for Science learning as the ability to comprehend what learners are taught verbally, or what they read, or what they find out by watching a demonstration or doing an experiment. These learners must invent a model or explanation that organises the information selected from the experience in a way that makes sense to them, that fits their logic or real world experiences, or both.

Osborne and Wittrock (2003:16) hinted that "the process of building such a theory requires metacognitive strategies of evaluating the plausibility of the theory and revising hypothesis if necessary". The implication for this is that educators should abandon the notion that subject matter is something fixed and ready made in itself, outside the learner's experience; they should stop thinking of the learner's experience as something hard and fast, and they should realise that the learner and the curriculum are simply two limits which define a single process.

In as far as the teaching of Science is concerned; the constructivist theory accepts that, because scientific knowledge is constantly being discovered, questioned, re-evaluated, and tested, changes in what is taught will inevitably occur (Osborne and Wittrock, 2003:16). This conditional nature of scientific knowledge is sometimes distressing to some educators because they regard knowledge as stable. These educators believe that one may sometimes add to the knowledge at hand but unless it was wrong from the beginning, it should not change.

In the constructivist approach, therefore, teaching Science is more like engaging Science the way scientists do. It is an active, social process of making sense of experiences. By using constructivist epistemology as a referent, the role of the educator becomes one of listening to what learners say and trying to understand what they do and how they are doing it (Thier, 2001:25). Thus, learners learn by thinking about and trying to make sense of what they see, feel and hear all around them. Further, in trying to make sense, the learner utilizes all his existing knowledge, namely, current experience, past experience, textbook knowledge, learning from society (elders, the media, cultural legends, etc). The learner therefore, tries to predict lines of thought, interrogate the author on his position, and evaluate work for its usefulness and importance to his own life.

The researcher is of the opinion that the two theories are of importance to the study of Science and therefore very key to the present study. Science learners do work with existing empirical data, and therefore they need to be able to collect reliable empirical data (behaviourism). At times, the same learners have to spend time explaining, discussing and offering personal opinions to a particular phenomenon (constructivism).

At the other times still, the same learners may have to codify, simplify and publicize findings among their peers (behaviourism and constructivism). Whatever the case, it is important to note that Natural Science is made up of different learning activities and therefore if its learning is going to focus on one aspect and neglect the other, it may create in the minds of the learners a one-sided and distorted image of Science.

The behaviourists' view on language learning (paragraph 2.8.2) and the constructivists' viewpoint (see paragraph 2.8.3) all confirm that the way a learner views learning has a bearing on how he goes about his learning and in selecting a language through which learning has to be facilitated, a knowledge of the above cited theories of learning is a sine-qua-non.

2.9 Gender Differences on Learners' Science Performance

Since the 1970s research in Science education has established some basic facts about gender differences in the performance of girls and boys.

A report looking at gender differences in mathematics achievement in the United States of America entitled, *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (National Research Council, 1989), maintained that as girls and boys progress through the mathematics curriculum, they show little difference in ability, effort or interest until the adolescent years. Then, as social pressures increase, girls tend to exert less effort in studying Science, which progressively limits their future education and, eventually, their career choices. The report also noted that gender differences in Science performance result from the accumulated effects of sex-role stereotyping perpetrated by families, schools and society. Although American society pays lip service to being committed to equal opportunity, public attitudes perpetuate stereotypes that "girls really can't do Science" and that "Science is unfeminine". As long as such stereotypes exist, females will continue to drop out prematurely from mathematics education (National Research Council, 1989:23).

Looking specifically at Science achievement, Terwilliger and Titus (1995:34) studied participants in the University of Minnesota Talented Youth Science Programme (UMTYMP) to determine gender differences of scientifically talented youth on attitudinal measures related to academic success. The researchers examined specific measures related to interest, motivation, confidence, readiness, support, priorities and stereotypes.

Males showed significantly higher levels of motivation, confidence and interest in Science than females. Despite the efforts of the UMTYMP programme staff to provide a supportive, encouraging atmosphere for females, gender differences increased over the two-year period. Specifically, Terwilliger and Titus (1995) found that females' enthusiasm decreased over that time, possibly as a result of peer pressure and competition from emerging extra curricular and social interests.

Focusing on risk-taking and Science achievement, Ramos and Lambating (1996:94) examined females' reluctance, and males' tendency, to be risk-takers. They proposed that students more prone to taking risks perform better on Science tests. Therefore, males' tendencies to take more risks might explain their higher Science achievement. The researchers documented females' reluctance to guess on multiple choice tests, as well as their tendency to skip more difficult questions, regardless of whether the format is true-false, multiple choice or relationship analysis.

Ramos and Lambating (1996:97) offered two recommendations. First, educators should emphasize females' ability and competence, and encourage them to take risks when solving mathematics problems. Second, they urged test constructors to consider how directions on guessing might influence female test takers. Berkovitz (1979:43) and Butler and Sperry (1991:18) considered the effects of mathematics testing and concluded that when instruction and assessment reflect female perspectives, females are just as capable at mathematical analysis as males are .

One study examined the relationship of selected cognitive and affective variables to mathematics achievement among students in the 6th, 8th, 10th and 12th grades (Tartre & Fennema, 1995). It concluded that males consistently gender-stereotyped the study of mathematics more than females do (i.e. males tend to view mathematics as a male domain); however, both males and females appeared to stereotype less in 10th grade than in the 8th grade.

Williams (1994:232) studied gender differences in 5th-, 8th- and 11th-grade students' perceived abilities to meet successful performance levels, compared with their actual performance levels in mathematics, reading, English and Science. Approximately equal numbers of male and female students overestimated their performance capabilities. Williams found that: (1) students with higher expectations for success generally had higher performance outcome scores and (2) the relationship between judgments for performance and actual performance proved stronger in mathematics than in other subject areas.

The under-representation of girls and women in Science fields has been considered primarily a "girl problem" (Campbell, 1995:225). To avoid blaming girls, educators need to begin changing how they teach Science, and reconsider how they, and boys, treat girls in Science classes. Changing institutional perspectives toward females and changing boys' perceptions of who can excel in Science can have a powerful effect on girls' Science success (Campbell, 1995:225).

Meech and Jones (1996:393) looked at motivation and strategy use and questioned whether females were rote learners. After studying 213 5th- and 6th-grade students' self-reports of confidence, motivational goals and learning strategies, Meech and Jones (1996:405) found few gender differences. Compared with females, however, males showed greater confidence in their Science abilities. Average-achieving females reported greater use of meaningful learning strategies, whereas low-ability males reported a stronger mastery orientation than low-ability females. Both genders showed greater confidence and mastery motivation in small-group instruction than in whole-class instruction. Thus, Meech and Jones (1996) concluded that the evidence did not support females being more likely than males to learn Science in a rote or verbatim.

Examining participation in Science fairs, Greenfield (1996:901) sought to determine whether the genders differed with respect to: decisions to enter Science fairs, project topics (life Science, physical Science, earth Science and mathematics) and project types (research or display). She examined 20 years of participation in the Hawaii State Science and Engineering Fair and concluded that: 1) females are more likely now than 20 years ago to participate; 2) female representation in the physical Sciences has increased over the years; 3) females continue to be less likely than males to engage in physical Science projects, earth Science and mathematics; and 4) females tend to avoid projects based on scientific inquiry and experimental research in favour of those based on library research. In her study of Science achievement, Greenfield (1996:933) concluded that males reported more stereotyped views of Science than females.

Jeffe (1995:206) questioned the historical nature of females' difficulties in Science, stating that the historical, social and political context of women's experiences in Science challenges the belief that females "historically" have had a difficult time in Science. Jeffe (1995:210) explained that women are not historically uninterested in Science; rather, many biographies of women from all eras reveal their interest in the field also explored the "weaker sex". Jeffe (1995: 210) argued against the idea that women are more suited for domesticity and for certain occupational opportunities. She examined gender and achievement, especially Science, in a new light and debunked many historical stereotypes.

The report *Project 2061: Science for All Americans* (American Association for the Advancement of Science 1989::1) presented recommendations on the scientific knowledge, skills and attitudes that all students should acquire. Its recommendations cover the nature of Science, mathematics and technology; the physical setting; the living environment; the human organism, human society; the designed world; the mathematical world; historical perspectives; common themes; and habits of the mind. The report urged educators to use interdisciplinary approaches, to base learning on systematic research and well-tested practice, and to emphasize thinking skills over specialized vocabulary and memorized procedures. Specifically, the report also suggested that teachers should begin lessons with questions about nature, engage students actively, concentrate on the collection and use of evidence, provide historical perspectives, insist on clear expression, use a team approach and de-emphasize memorization.

Raizen (1991:25) also reported a dismal picture of Science instruction and achievement at the middle school level. Although education reform proponents have called for curricular exploration, interdisciplinary curricula and student self-evaluation in Science classes, many middle school students experience Science only as a static body of facts, principles and procedures to be mastered and recalled on demand. The way that Science is currently taught in middle school could be a major reason for the gender gap in achievement in the physical Sciences, which increases as students move through school. The achievement gap looms large by the 11th grade, with girls lagging considerably behind boys (Raizen, 1991:43).

The researcher is of the opinion that by understanding the research on gender differences in Science achievement, secondary school educators can begin to offer more equitable responses to females' participation and achievement in those fields. Learners at Senior Phase level are forming gender identities and self-esteem during these years (another reason why middle schools need to provide gender-responsive learning environments and experiences). For many decades, educators, perhaps unknowingly, considered reading and literature as female domains and Science as male domains. While understanding the need to address gender differences represents a vital first step, making education gender-responsive will require a genuine commitment to provide teaching-learning experiences that reflect females' and males' gender differences.

The following section examines some of the dilemmas confronting policy-makers and reviews the literature that discusses the effect of using a second language as the language of learning.

2.10 Issues around the Second Language as a Language of Learning and Teaching

2.10.1 Orientation

The question of what language should be used in school as the language of learning and teaching has created a renewed awareness of the dilemmas policy-makers face when it comes to decision-making, particularly in multilingual societies. It has also created some interest among scholars concerning the effect on the academic performance of learners who use a second language as the language of learning.

2.10.2 Choice of the Language of Learning

The process of becoming educated involves the use of a particular language as the language of learning. The choice of the language itself is crucial to the fulfillment of the society's desired goal in education. Prah (2005:21) defines the language of learning and teaching as "the language in which basic skills and knowledge are imparted to the population and the medium in which the production and reproduction of knowledge take place".

This means that the language of learning and teaching should be an enabling tool in the teaching and learning process. It should facilitate the learning of subject content as suggested by Lemke (1990:34) in paragraph 1.1. It ought to help learners react to different facts and viewpoints in order to construct a new view of the world, including the meanings they attribute to the new concepts they are introduced to, and the values they attach to them (Namuchwa, 2007:13).

The implication of the above statement is that the language of learning and teaching should of necessity be the one which is familiar to the educator and the learner if communication has to be effective. However, it seems the policy makers in South Africa take the learners' language ability for granted and perceive any gaps in learning to be merely a result of educators' and learners' lack of commitment by promoting English, a former colonial language as a language of learning and teaching in secondary schools, especially in rural Limpopo.

Furthermore, the language of learning should be able to fulfill the functions that researchers (Heugh, 2002:54; Pluddemann, 2002:45; Rodseth, 1987:110) propose: communion, expression, conceptualization and communication. What the above mentioned researchers refer to as communion is the social function of language. The language must allow learners to relate effectively to their educators as well as to their peers and avert what was noted in the TIMSS study (see Chapter 1). It is through this kind of interaction that mutual trust and confidence among learners are built. Trust and confidence might create security in the learning environment.

Mchazime (2001:90) asserts that "the language of learning should also enable learners to react to learning experiences both covertly and overtly. Since learning involves thinking and learning to think logically, the language of learning should enable learners to conceptualize in that language and should afford them the opportunity to receive and transmit information clearly". In other words the language medium should give learners an opportunity to examine critically what others say and enable them to express and elaborate their point of view.

Rodseth (1987:163) argues that such a language "should be accepted by all concerned (parents, educators, learners and the society) as suitable for its assigned role and of such functional importance as worth the effort of acquiring". He further argues that the learners should experience the language itself. In other words learners should hear the language or observe it being used in their everyday life or they themselves should use it. Lastly, Rodseth advises that the language so chosen should be teachable.

However, Rodseth (1987:163) does not seem to perceive the fact that in matters of language choice there are also political, cultural and economic considerations. Politicians sometimes have their reasons for wishing a particular language to be used and as Olshtain (2001:54) points out that "political considerations have to do with particular regime in power, and how it views the question of language in general". Then there are cultural groups which may also put pressure on policy-makers. Economic considerations may be viewed from two different points, namely, the nation's wish to be modernized through a language of wider communication such as English and the shortage of money to invest in the adoption and implementation of the chosen language. Thus Rodseth's (1987) criteria may not be sufficient without these other factors.

The researcher is of the opinion that the question of acceptability is an attitudinal one. It is, therefore, difficult to gain acceptance of the chosen language of learning by all stakeholders. This difficulty is particularly prevalent in African countries where there are many multi-ethnic and multi-lingual societies. Policy-makers in these countries are always in a dilemma. They have to weigh the implications of choosing one language among a host of other languages.

Hence, Kelman (2001:48) advises that "in determining whether a common language would be helpful and if so, what form it ought to take, policy-makers and language planners must consider not only the potential of such a language in binding the population to the nation state, sentimentally and instrumentally, but also the sentimentally and instrumentally based resistance that the proposed policy would call forth in different subgroups within the population". It is not surprising that Prah (2005:2) asserts: "where the language of instruction is different from the languages of mass society, those who work in the language of instruction, foreign from the languages of the masses, become culturally removed and alienated from the masses. Indeed, where the language of instruction is different from the mother tongue of the people there is almost always a history and persistence of patterns of dominance, over-lordship or colonialism".

The above mentioned dilemma is not recognised by policy-makers only. Even the international community acknowledges the problem. Brown (2000:211) for example, observes that "the choice of the language of learning is one of the least appreciated of all the main educational problems that come before international forums". The UNESCO (2000:25) report on education in Zambia contains an example of the way the problem has been viewed. In 1963, a UNESCO mission was sent to Zambia to advise the Zambian government on the education system to be adopted and what language policy it should follow. At that time, Zambia was preparing for its independence from Britain in 1964. The UNESCO report (2000:25) reiterated its long-held stance regarding mother tongue education by recommending that “A child, therefore, may have begun in his mother tongue, changed to a main official vernacular, if that is not his mother tongue, changed to English as the language of learning two years later. We [therefore] recommend that a policy decision be made to introduce English as the universal medium of instruction from the beginning of schooling”.

Since its publication of a document on mother tongue education in 1953, UNESCO’s main thrust had been to encourage mother tongue as the language of teaching and learning. For many people therefore, this recommendation came as a surprise. However surprising it may be, the recommendation does reflect some of the dilemmas and problems that confront multilingual and multi-ethnic societies in Africa. De Klerk (2002:13) rightly points that the acceptability of the language of learning has a bearing on motivation. Unfortunately, the acceptance by all concerned that he proposes is difficult to find in Africa. African governments have sometimes imposed the language of learning on the masses. One does not need to look far to find an example of the above-mentioned scenario. The attempt by the South African Government to impose Afrikaans on the Black learners is well known (Brocke-Utne, 2005:238).

However, there has always been an unfavourable perception of Africans about the mother tongue language policy put forward by Western educationists during the time of colonialism. Brocke-Utne (2005:238) observes that “the Africans suspected that the language policies were designed to keep them in their ghettos. They therefore rejected the systems supposedly tailored to their needs and demanded to be educated to exactly the same standards as the Whites were”.

The examples and arguments cited above illustrate the observation that language choice in education is a complex issue. It is therefore, not surprising that the ideal education that researchers allude to, is not attainable in many African countries.

It is within this context that Bamgbose (2005:126) argues that “whenever everything possible has been done, there will be small languages which cannot feature in formal education. There

will also be others which can support use of initial literacy only in transition to the use of another language as medium. This is the reality in many African countries and no appeal to language rights or rhetoric can change the situation”.
Hereunder follows a review of literature relating to the language of learning and teaching Science as an international problem.

2.11 Research on Language of Learning and Teaching Science: An International Problem

Research on the effect of the second language (English included) as a language of learning and teaching is not new (see paragraph 2.5.). Numerous studies have been conducted and without exception, many of them indicate that a number of words commonly used in Science texts are poorly understood.

In a study involving more than 12,000 secondary learners in Hong Kong schools, Marsh, Hau, and Kong (2000:302) traced the achievement of native Chinese-speaking learners in ESL and mother tongue schools in language subjects and content subjects for 3 years starting from Grade 1. While the mother tongue schools basically used Cantonese for teaching, the language of learning and teaching in the ESL schools varied greatly according to the abilities of learners. For many ESL schools with less able learners, the educators might use mainly Cantonese or a mixed code of Cantonese and English for teaching content subjects, though the textbooks and the examinations were in English.

Prior learner achievement was based on a placement score that represents an aggregate of achievement of a learner in all academic subjects at the end of primary schooling, moderated by external examinations. In each of the 3 years following entry into secondary school, the Education Department administered standardized achievement tests in English, Chinese, Mathematics, Science, Geography, and History. The achievement tests were administered to all learners near the end of the school year (May to June) in the language of learning and teaching in which the learner studied the particular subject.

Marsh et al. (2000:346) report the findings as follows: After controlling for learners’ prior ability and other factors, comparison of learners’ achievement indicated that ESL (LoLT) had positive effects on English proficiency and, to a lesser extent, Chinese proficiency. However, the effects of ESL (LoLT) were negative on all other subjects, being relatively slight for Mathematics and greater for History, Geography, and Science. The positive effects of ESL as a language of learning on English and Chinese achievement were expected.

These results support the parental belief that immersion in English promotes the development of both English and Chinese. However, a possible reason for the strong negative effects of ESL on History, Geography, and Science is that these three subjects were new content areas for secondary school learners. Learning these subjects in a second language was always going to be particularly demanding for learners because they would have to master the basic terminology as well as develop conceptual understanding of the subject matter and comprehend the textbooks in English. The results also suggest that the English-language skills of the English language medium learners might be insufficiently developed to cope with the complex curriculum materials in these content subjects.

These problems were less serious with Maths, as mathematics learning involves the use of symbolic terminology that may not be so dependent on the language of learning and teaching. For History, Geography, and Science, the negative effects associated with teaching in English were the same, irrespective of learners' initial academic ability. However, learners who were initially more proficient in English were less disadvantaged by learning in English (Marsh et al., 2000:346).

Nevertheless, the findings of the study suggest useful criteria for identifying learners who would benefit from English immersion, for example, postulating that the negative effects of teaching in English would be minimized if the selection of learners into ESL schools is based on prior English ability.

While the findings of the above studies regarding the effects of LoLT on learner achievement are inconclusive and sometimes conflicting, some generalizations can be drawn to guide policy making on the language of learning and teaching for schools in South Africa. There is evidence that teaching in English or in mixed code has negative effects on learning for low-ability learners. However, the negative effects may decrease as learners' English proficiency improves. For high-ability learners who have reached a threshold proficiency in both languages, using English as the LoLT may enhance language acquisition, particularly in English. For these learners, achievement in different content subjects may be affected to a lesser degree.

In the USA, Warren, Ballenger, Ogonowsi, Rosebury and Hudiscourt-Barnes (2000: 529), conducted a study which sought to understand the gap in Science learning and achievement separating low-income, ethnic minority and linguistic minority (L2 speakers) children from more economically priviledged learners. In their study, the relationship between everyday and scientific knowledge was approached from two perspectives. One of the perspectives viewed the relationship as fundamentally discontinuous whereas the other viewed it as fundamentally continuous. Basing their research on the latter tradition, they proposed a framework for understanding the every day sense-making practices of learners from diverse communities as an intellectual resource in Science learning and teaching.

Further, Warren, et al (2000:529) argue that too little attention is paid by researchers and educators alike to the potentially profound continuities between everyday and scientific ways of knowing and talking. They state that the pedagogical possibilities that may be derived from such an analysis, especially for "at risk" learners, are seldom realized. They then concluded that what learners from low-income, linguistic, racial and ethnic minority communities do as they make sense of the world, is different from what Europeans are socialised to do, even though what is done is intellectually rigorous and generatively connected with academic disciplinary knowledge.

In a related study, Lee and Luykx (2003:12) conducted their study in two elementary schools in the Southeast of USA. The schools were chosen on the basis of availability of culturally and linguistically diverse learners in them. The groups of learners who participated in the study comprised of: (a) monolingual English speaking learners; (b) African American learners who spoke Standard English and Black vernacular English; (c) bilingual Hispanic learners and, (d) bilingual Haitian learners. Selected learners had to belong to one of the groups and were required to obtain a written permission from their parents to participate in the study.

The study was done in controlled environments outside classroom contexts. The Hispanic and Haitian learners were further divided into two categories: learners who were proficient in English and learners who were still in the process of learning English as a second language. Language proficiency was determined by the authors through a story telling exercise using pictures from a wordless book. Only those learners whose age was considered to be appropriate to their reading level participated in the study. A total of thirty two learners participated in the study. The learners were organised into 16 groups of two learners each. The authors refer to these groups of two learners as dyads. The dyads were encouraged to work cooperatively rather than competitively.

Learners were asked to work on three tasks that involved finding out, manipulating, generalizing and summarizing ideas concerning the topics. The learners worked in dyads of learners with the same language and culture with educators from the same cultural background and gender. Each Science task was accompanied with an elicitation protocol to ensure consistency among educators. Educators were encouraged to change to the learners' alternative languages whenever necessary. All sessions were audio and videotaped and audio recordings were transcribed and analyzed. The video recordings were used to observe and analyze non verbal behaviour.

The results about Science knowledge and vocabulary indicate wide variations among the dyads of learners. With a possible maximum score of 42 for the three tasks, the scores for the dyads ranged from 32 to 3. The mean score for the 16 dyads was 15.6 and the standard deviation was 7.5. The study showed that learners who had thorough grasp of Science knowledge and vocabulary outperformed those who had problems in either Science knowledge or vocabulary or both. The authors found learners who appeared to understand the vocabulary but did not actually understand what the terms meant.

In the context of the present study, the above statements about vocabulary corroborate what Dlamini (2003:57) described when commenting on the Matric results for the province of Kwazulu-Natal. He (Dlamini) attributed the high failure rate of the matriculants in that province to the issue of learners' lack of English functional vocabulary. He contended that "English is a complex language, and learning through it requires a great deal of effort and practice to master its vocabulary".

The discussion (on the language of learning and teaching) presented above has tried to present a compelling view of the nature of the problem. Research findings from various parts of the world, particularly the United States and Europe have been presented and examined. The main concern of most studies has been to find causes of learner failure, especially reasons why foreign learners do not perform as well as native learners in countries of migration. In the literature, the major apparent cause seems to be the language of learning and teaching.

While it is generally accepted that there have been many studies that seem to indicate that teaching through an L1 results in high academic performance, the studies that show the opposite cannot be ignored. They too have something to contribute to the on-going search for conclusive evidence.

What one concludes from the literature review is that the search should therefore continue. It was in the light of this understanding that the researcher decided to investigate the use of English as a language of learning and teaching in the learning of Science in the Vlakfontein Circuit within a specific context and learning environment.

2.12 Research on Language of Learning and Teaching Science: A Continental (African) Problem

An abundant and diversified research attests to the existence of disadvantaged groups in Science education (Adigwe, 2000:773; Baker and Taylor, 2005:695; Ezeife, 2003:319; Grayson, 2001:107; Mordi, 2000:588). Compared to their counterparts in Europe or America, learners in African countries constitute disadvantaged or underachieving groups in as far as Science education is concerned. Research confirms that African countries perform poorly in

Science education. Lewin (2001: 203) reports that "the proportion of schools scoring below the lowest school in the highest scoring country (Hungary) is high in the lows-scoring developing countries in the population 2 sample (Ghana 64%, Nigeria 88%, Zimbabwe 80%). In these countries the performance of the lowest 20% of the learners tested indicates that they have learned very little Science as a result of using a second language as a medium of instruction. This is particularly worrying when it is realized that the Nigerian learners were from a higher grade than in other countries, and the Ghanaian learners were from selective elite schools. The IEA data suggests that the bottom 20% of the learners in Ghana, Italy, Nigeria, and the Philippines are scientifically illiterate".

In the excerpt above Lewin (2001: 206) explains the performance of African countries in the second IEA study. Population 2 sample were 14 years old learners in middle secondary school. As indicated in the excerpt, the performance of African learners was very poor. It should be borne in mind that what were compared in the IEA studies are average scores. As indicated in the following paragraphs African scholars have taken on the task of explaining these low average scores.

Peacock (2001:149) sees the problem of learning Science in Africa as one of dissonance between concepts of learning embedded in current Science curricula and the concept of learning traditionally held by learners and their parents. The factors that contribute to failure in learners' learning in African countries have further been summarized by Grayson (2001) as:

- Inadequate background in the language of instruction and in Science.
- Use of inappropriate learning styles.
- Behaviours that may have a detrimental effect on their learning.
- Absence of prerequisite cognitive skills in the learner.
- Lack of practical skills.
- Absence of metacognitive awareness.

In support for the factors listed above, studies have shown that learners' fluency in the language of learning and teaching is an important factor in determining achievement (Human

Vogel and Bouwer, 2005:229; Kozulin, 2000:23; Kulkarni, 2001:150; Ross and Sutton, 2003:311; Prophet, 2001:13).

Similarly the importance of language ability in learning Science has been widely acknowledged (Claxton, 1991:75; Hudson and Liberman, 2002:117; Okpala and Onocha, 2000:361; Starvy and Tiroshi, 2000:13). What appears to be missing from Grayson's list is epistemology of Science. A spate of studies has in recent years suggested that learners' epistemological beliefs about Science and Science learning are significantly related to their orientations to Science learning and integration of scientific knowledge (Songer and Linn, 2001:761).

Ross and Sutton (2003:323) arrived at a similar conclusion in their study of concept profiles and cultural contexts. These authors set out to identify language barriers that secondary school learners in Nigeria experience when learning Science. Although their study showed that it was cultural differences rather than language differences that contribute significantly to variation in performance between their samples, they acknowledged the inconveniences of learning Science in a second language.

Furthermore, in a study by Prophet and Dow (2003:205) from Botswana, a set of Science concepts was taught to an experimental group in Setswana and to a control group in English. The researchers tested understanding of these concepts and found that Grade 8 learners taught in Setswana had developed a significantly better understanding of the concepts than those Grade 8 learners taught in English.

A similar study with the same results has been carried out in Tanzania. Secondary school learners taught Science concepts in Kiswahili did far better than those who had been taught in English (Mwinsheikhe, 2002:303).

In Ghana, Wilmot (2003:12) conducted a case study among second graders which shows some effects of the English language policy of Ghana. He made clinical interviews with 30 selected learners by probing each child's problem solving behaviour in Science, by using various tasks.

By changing the language of learning from English to a home language, this study revealed how much more learners know and how much better they learn when taught in a language familiar to them. Wilmot (2003:135) shows that "children who were classified as low achieving children actually had a lot of knowledge which by the school was incorrectly assessed because the children did not master the foreign language which was the language of instruction".

The foregoing review has suggested that the problem of poor performance in Science is a problem of disadvantaged or underprepared learners. Characteristics of disadvantaged learners have been delineated. However, these characteristics may be more of the symptoms of the disease, as it were, rather than its causes. Attempts have been made to improve the performance of disadvantaged group.

This study sought to determine whether the use of English second language has an effect in the learning of Science among Grade 8 learners in rural Limpopo. The aim was to investigate how the use of English as a language of learning and teaching can influence the learning of Science at the secondary schools in the research area.

Below is a discussion of the situation of the language of learning and teaching Science as a national problem.

2.13 Research on Language of Learning and Teaching Science: A National (South African) Problem

2.13.1 Orientation

In South Africa, for many years, the language of learning and teaching at secondary school level, especially among learners for whom English is a second language, had been a subject of scrutiny and as well as a source of disappointment among many educators and learners alike. South African education currently faces the daunting challenge of attempting to arrest and turn around the downward spiral in the teaching and learning of Science, with its corresponding requirement that learners attain a certain level of language competence. These deficits are all too evident in the poor performance of school-leavers over the last few years:

- Of 508 363 learners who wrote the Senior Certificate in 2005, only 26 383 (5.2%) achieved higher- grade passes in Science.
- Most disturbing is the small number of African school-leavers with higher-grade Science passes. In 2004, there were only 7 236, of which only 2 406 achieved the minimum C symbol necessary for university entrance (ZENEX Foundation, 2006:33).

Research (Diedericks & Winnaar, 2006:54; Heugh, 2002:171; Howie, 2001:37) has shown that these results stem from a range of factors, including the issue of non-proficiency in the language of learning and teaching. Taylor (2007:7) concedes that "while home-language instruction is preferable, the rudimentary nature of the academic register in most South African languages for Physics, and Chemistry still requires the development and agreement on a multitude of technical terms". The above statement sounds a death knell to the aspirations to have an indigenous language as a language of Science and technology.

Schollar (2006:7) further reinforces the inevitable use of English LoLT in Science education by stating thus: "One way or the other, it appears inevitable that English will remain the language of learning and teaching. …Consequently it is of the utmost importance that serious and sustained attention is paid to improving the level of competence in this language if we are to have any hope of improving the quality of the outcomes of the education system. And we must also pay attention to a host of other factors that affect learner performance if gains in language competence are to translate into gains in content subjects".

Taylor (2007:8) asserts that "the lack of proficiency in the language of learning and teaching is a major obstacle to efforts to access the curriculum and to reduce educational inequality. Quality improvement initiatives that do not recognize this obstacle are unlikely to have significant impact".

Lynch (2001) points out that learners for whom English is not a first language often feel overwhelmed by the complexity of the texts which they have to deal with in Science subjects. According to Lynch (2001) the root of the problem was that English classes at schools seldom equipped learners with the unique learning strategies that the Sciences demand. The study's main thrust was to look at contextual factors, including English second language in the learning of Science among first year university learners. Lynch (2001:18) observed that disadvantaged learners displayed adverse characteristics such as *lack of work ethic, inability to manage time, failure in taking responsibility for own action, inability to work persistently on a problem, underdeveloped critical thinking skills, lack of reading culture and a generally low of literacy*.

To Grayson (2001:20), the solution to the problem of learner underdevelopment is to present both Science content and learning skills to the underdeveloped learners. It can therefore, be concluded that both psychological and learning theory related factors are important in raising the quality of underdeveloped learners. Approaches to the problem that take into account many sets of factors are likely to be more successful than those that are centred on one set of factors to the exclusion of other factors.

In a related study conducted by Probyn (1998), reflections of educators on teaching in a second language were recorded. Educators' reflections were mainly based on the impact that teaching in a second language has on learning and teaching and the coping strategies that educators and learners employ in order to navigate the curricula. The study noted that in order to cope in the ESL environment educators had to increase more time in teaching new concepts and that they (educators) always found themselves caught between teaching Science content and language: if they focus on the content and use the learners' home language to get concepts understood, they find themselves compromising their role in teaching English; if they focus on the English, they find themselves compromising the extent to which content is understood.

On issues related to classroom pedagogy, the study (Probyn, 1998) noted that learners had problems communicating what they knew and that as a consequence they had a feeling of helplessness resulting from the inability to comprehend the language of learning.

Setati, Adler, and Bapoo's (2002) study notes the importance of talk as a tool for thinking as well as learning Mathematics and Science. They contend "although it is appropriate for much of the learning to be in the learners' main language(s), they also need opportunities to speak, read and write in English because it is the LoLT". The implication of the latter statement is that in the Science class, for instance, learners have to understand and use formal mathematical and scientific discourse through the medium of English. Educators therefore, need to consider two different kinds of 'learning talk': "exploratory talk, which is a necessary part of talking to learn and which is likely to be the most effective in the learner's main language… and "the discourse-specific talk", which is part of learners' apprenticeship into the discourse genres of subjects in the school curriculum" (Setati et al, 2002:11).

It is the second type of talk that always proves most problematic for the majority of learners who are not proficient in English. However, Setati et al (2002) argue that proficiency in English must be acquired not only through the formal English class, but in the course of learning Science as well. A key finding of the study was that learners and educators never managed to move from the point of informal exploratory talk to discourse specific talk. In this way, educational inequalities are exacerbated as educators and learners are left stranded at some point in their educational journey.

The above cited studies aptly corroborate what the Threshold Project of 1999 found out. The project had its genesis in an earlier pilot study among Sepedi-speaking children in 1985. In the pilot project, it was reported that the quality of English of Standard 3 (now Grade 5) children was poor and that the learners themselves could not adequately handle content subjects through the medium of English. The Threshold Project ran from 1986 to 1989. Five different reports, based on five different areas of the project team's concerns, were produced. Of relevance to this study are the two reports on English language skills and on the disparity between the English taught as a subject and the English in the content books such as Science, Geography and History (Heugh, 2005).

In the English language skills evaluation, the study focused on the conventional language skills of oral and listening comprehension, reading and writing. The study used a variety of tests, including composition and cloze tests. The subjects were drawn from black children in state schools. Results of the tests were compared with those obtained from non-racial schools.

Heugh (2005:120) reports that the situation was so distressing because “children from state schools consistently scored 30% and 40% while their counterparts displayed a mastery level of 80-90%”. It was observed “a high level of grammatical error and the absence of cohesive ties and any notion of coherence marked the children’s writing skills”.

The results also showed that the learners’ oral and listening skills appeared to have been inadequately developed. In reading comprehension, the subjects appeared to have difficulties with the “why” questions. Their comprehension was so weak that they were not even able to answer low level inference questions, including those pertaining to agency, reason and cause and effect. Makua (2004:120) referring to the results of the Project contends: “The pronounced weakness discovered with the children’s English skills leads us to believe that the current generation of junior primary school children are not competent in terms of the demands of the medium transfer in Standard 3, at least in its present form”.

Again, as in other studies related to learner achievement, other factors should not be ignored. The research has to be put into the context of the educational environment of the schools the black learners attend. In the recent past, Ralenala (2003) conducted a study at the University of the North (now University of Limpopo) in which he investigated the reading behaviour of first-year Science students.

Ralenala (2003:12) sought to:

- Identify and explore the study reading behaviour of first-year university Physics learners, that is, establish the extent to which metacognitive strategies are used in the Physics reading process and the idiosyncratic use of these strategies.
- Gauge the severity of first-year university Physics learners’ reading and learning problems.
- Assess learners’ English language proficiency in relation to their reading comprehension.

The findings of the above cited study revealed that:

- Reading was a problem for the majority of fist-year university learners; but alongside it was also that the English language proficiency level for these learners was below the expected level.
- There was a significant relationship between the learners' level of English language proficiency and the capacity to do well in content subjects.
- The majority of the learners lacked metacognitive strategies needed to read effectively and efficiently in Science studies.

It is worth mentioning that the research subjects in this research feed this institution and thus the persistence of the problem affects the performance of the institution in Science courses. There is therefore, a need to understand what happens in the secondary school-hence this study.

The studies cited above, reaffirm that learners in black schools had not sufficiently developed competence in English to allow them to read content subject textbooks with full comprehension. In other words the English scheme may only have developed the learners' Basic Interpersonal Communication Skills (BICS) at the expense of their Cognitive Academic Language Proficiency (CALP).

Other studies showing the negative effects of English as the language of learning and teaching have also been reported within the Republic of South Africa (RSA). In the Western Cape, Ogunniyi (1983:342) conducted a study among Grade 7-9 learners and observed that there was often a mismatch between the cognitive demands of a Science curriculum and the cognitive readiness of those studying Science. He found that learners experienced difficulties in understanding Science texts in both linguistic and conceptual modes and therefore advocates that an effort has to be made to simplify the material, especially since the "language of the texts and instruction very often is well above that of learners". He also found that children could not understand without the explanation in the mother tongue. Even in English lessons, reading to learners was interspersed with brief explanation in the mother tongue. This study will however, be conducted in rural areas and not in urban areas like the one conducted in the Western Cape cited above.

However, this study will further probe for answers to the widely held notion that unless the level of English proficiency is raised to acceptable levels, the majority of black learners will remain disadvantaged in their pursuit of educational endeavours.

The above cited research studies underline the difficulties which most Black learners have been going through for many years. When seen against the Chinese and Australian studies discussed in paragraph 2.8 above, there is a relationship in that the strong negative effects of ESL in Science seems to emanate from the fact that this subject (Science) has new content for the secondary school learners. Learning this subject in a second language was always going to be particularly demanding for learners because they would have to master the basic terminology as well as develop conceptual understanding of the subject matter and comprehend the textbooks in English. Further, studies done in Africa have helped to widen the researcher's understanding of the problem of English as a language of learning Science. The studies discussed above (in paragraph 2.9.) have also highlighted the dissonance between children's conception of learning as derived from their societies and the concepts of learning that are embedded in Science learning (Peacock, 2001:156). The following section deals with the issue of Language in Education Policy of South Africa and how it impacted on the LoLT issue over the years.

2.14 Language in Education Policy of South Africa

2.14.1 Orientation

The issue of language in education policy is not unique to South Africa. As discussed in 2.7.2.above, a number of factors come into play. "Political considerations which have to do with a particular regime in power, and how it views the question of language in general" become very much pronounced before a language in Education policy is officially adopted (Olshtain, 2001:54). In Zambia, for example, the situation was so tough that it was even deemed necessary to ask help from UNESCO (see paragraph, 2.7.2.).

In South Africa, official language policy has always been caught in the political web of domination, exploitation and discrimination. Heugh (2002:120) indicates that decisions on language in education had often been taken on "pragmatic, political and economic grounds rather than on the basis of what is educationally and linguistically sound and best for all learners". According to the *ANC Policy Framework for Education and Training (1994, Part 5, Section 12)* "over the past two centuries, South Africa's colonial and white minority governments have used language policy in education as an instrument of cultural and political control. First, in the battle for supremacy between the English and the Boers, and subsequently, in maintaining white political and cultural supremacy over the black majority".

Over the years, attitudes have formed either in favour of or against a particular language(s). Such attitudes were influenced by the State's political agenda of domination. History has, however, clearly illustrated that when a language is imposed it meets with resistance. It is within this context that we need to view the role of Lord Alfred Milner who, after the *Vereeniging Treaty*, wanted to control language usage in schools. Milner declared, in the *Milner Papers*, that they had to "make English the language of… education. Dutch should be used to teach English, and English to teach everything else". Afrikaner opposition to Milner's policies or Milnerism, as it was called, (Alexander, 2003:26) was predictable, immediate and vehement.

It is worth mentioning at this point that with the changing political landscape of South Africa, a multilingual model has been enshrined in the country with eleven national languages-nine indigenous languages and two former colonial languages of English and Afrikaans-recognised as official languages in the Constitution of 1996 (Constitution of the Republic of South Africa, 1996).

Despite these provisions, since the democratic elections of 1994, English has expanded its position as the language of access and power with the relative influence of Afrikaans shrinking, and African languages effectively confined to functions of 'home and hearth'. English is still the language of power and status, the home language of only 8% of the population with the rest striving to achieve English skills (Statistics South Africa, 2003).

In fact many Blacks, who still feel disempowered, view English as a ticket to upward mobility. Instead of challenging its hegemony, they assess it as an important and a necessary commodity

(Sonntag, 2003:18). Hence, Mazrui, (2002:269) suggests that the constitutional recognition of 11 languages in South Africa is largely ‘‘intended and perceived as a symbolic statement and that for instrumental purposes, English remains the dominant language in South Africa’’.

The Language-in-Education Policy (LiEP) of 1997 (Department of Education, 1997) obliges each school to decide on their own language policy, in terms of the language of learning and teaching (LoLT) and languages to be taught as subjects: learners have to learn at least two official languages as subjects and one of these should be the LoLT; school language policies should promote ‘additive bilingualism’, defined as maintaining home languages while providing access to and the effective acquisition of additional languages.

Although the LiEP encourages the use of learners’ home languages as LoLT, it appears from several small scale research projects (Probyn, 1998:266) that the trend in township and rural schools has been towards not only retaining English as LoLT in the Junior Phase, but introducing it even earlier than before, either to bring the switch to English in line with the beginning of the Intermediate Phase in the new curriculum or to start with English as LoLT from Grade 1.

However, according to Heugh (2000:19) it is “a serious mistake to believe that teaching and learning is taking place through English in township or rural schools where the majority of pupils are from African language communities”. The implication here is that although the policy stipulates that the language of learning should be English, in practice educators and learners find it difficult to actualize and implement it (Brock-Utne, 2000:16).

Thus, education being the imparting of knowledge, skills and values, the role of English as a language of learning and teaching in secondary schools of rural Limpopo has not been translated into practical, conscious and careful manipulation of learning activities. This is because learners only experience it in the formal academic and structured arrangement of the classroom. Educator and learner interaction has only been with their non-native speaking educators and a few English textbooks, and this is commonly done for the purpose of passing examinations (Howie, 2001:7).

2.15 English Second Language Intervention Programmes

2.15.1 Orientation

The relationship between English proficiency and success in Science seems to be an important one, yet few of the research articles consulted specifically addressed this problem with a focus on rural school. However, many studies involving ESL intervention programmes have been undertaken and they are referred to here for purposes of supporting or providing a framework for the programme that will be proposed in this study.

2.15.2 Cognitive Acceleration Intervention Programme

Cognitive Acceleration (CA) is an intervention programme which describes a lesson style originally developed by Adey, Shayer, and Yates (1989:43) in London, which was designed to promote students' thinking from "concrete" to "formal", abstract thinking.

The first series used a secondary Science context: CASE (Cognitive Acceleration through Science Education). Students experienced 16 Cognitive Acceleration lessons per year for two years. These replaced some of their normal Sciences lessons, they were not extra lessons. As a comparison, a similar "control" group did not experience the CASE lessons, but had their usual conventional Science lessons instead (Adey, et al., 1989:43).

Compared to the control group, the CASE students not only scored about one grade better in their Science grades but their English grades were also improved by about the same amount. It is very rare to see such 'transfer' of learning to other subjects in educational research which suggests that something very deep was happening. Cognitive Acceleration appeared to be 'teaching intelligence'.

While facts and descriptions can be learned, CA shares with constructivism the view that concepts cannot be learned in the same way. The learner needs to "construct" the meaning for themselves. CA lessons centre on a challenge which can only be explained through an abstract idea.

2.15.2.1 Theoretical Background

The CA approach builds on work by Piaget (1972) and Vygotsky (1962) and takes a constructivist approach.

From Piaget (1972), CA recognised that there are stages in intellectual development. At school the most important transition is from concrete thinking - which deals with facts and descriptions, to abstract thinking - any thinking which involves a mental process.

From Vygotsky (1962), CA takes the concept o*f Zone Proximal Development* (ZPD): the difference between what a learner can do without help and what he or she can do with help. It also takes the concept that intelligence is not fixed, but is plastic and can be developed. This requires the help of a Mediator: someone who asks questions and allows “guided self-discovery". This mediation can often be done better by peers than by a teacher and so promotes the idea of learners working in groups to solve a problem.

2.15.2.2 The Role of the Mediator

According to CA if the learner is simply given the challenge they will probably fail. If the educator simply gives the answer, the learner can only take it in as a fact to be learned. Understanding does not automatically occur. An educator tells the learners what he thinks they ought to know. A Mediator sets up a good learning-context and intervenes only to guide the learners towards the learning goal (a touch on the tiller). The mediator asks probing questions: "What do you think?", "Which one is a more likely solution?" "What do you think about Fred's idea?" gradually leading the learner to discover the answer themselves. They can also offer clues which send the learner off in the right direction, improving the chance of successful thinking.

Lessons which develop abstract thinking directly had the following structure:

- An introduction which sets the scene (concrete preparation)
- A puzzle or challenge which needs to be solved (cognitive conflict)
- Group-work and discussion where pupils share ideas for solutions (social construction)
- Explaining the thinking which gave the answer (metacognition)

- Making links to everyday applications of the ideas discussed (bridging) (Adey & Shayer, 1994:43).

2.15.2.3 Concrete Preparation

Cognitive Acceleration also advocated a concept called "Concrete preparation". This serves a similar purpose to the final "bridging" section: it links the activity to current knowledge, explains the task and checks vocabulary (Adey, 1993:351).

2.15.2.4 The Challenge

This must be set just above the current level of secure knowledge - hard enough to be a challenge, but not so hard as would make the learners "switch off". In a Science lesson this can take the form of a demonstration with an unexpected effect. In English it could be reading a text which has an implied meaning (Adey, 1993:366).

2.15.2.5 Group Work

Clearly the classroom teacher cannot be the Mediator for every child in the class. If pupils work in groups and discuss their ideas (social construction) there are several benefits:

- group members act as mediators for each other, suggesting solutions, trying out ideas.
- individuals feel less vulnerable and more able to participate.
- random ideas from group-members act as the clues offered by the mediator.

Once the groups have discussed their answers, the class is brought together to share their ideas. Again the teacher does not give the answer. They ask one group for their solution, then ask another if they agree or disagree and why. The discussion continues until there is wide agreement in the group. The teacher leads the group towards the answer through questioning (Adey & Shayer, 1994:50).

2.15.2.6 Metacogntion

During group-work and discussions, the teacher (mediator) asks questions designed to reveal the thinking process. This process - metacognition - has been shown to be highly effective in securing the knowledge. The learner has to put into words the line of thinking - which makes the process more available both to others listening and the learner (Shayer, 1999:883).

2.15.2.7 Bridging

Knowledge learned in isolation from the learner's secure knowledge is usually lost. The learner needs to link (bridge) the new learning to existing experiences. CA lessons conclude with a discussion about where these ideas could be used in everyday life. This is the same as the concept of "scaffolding" in constructivism (Shayer, 1999:887).

2.15.3 The Australian English Second Language Intervention Programme

Morris (2006:203) conducted a research on Science education and the English second language learner in Australia. The research was conducted using secondary students whose English is not their mother tongue. The study was carried out in three phases using the interpretive methodology based on a modified action research approach in naturalistic settings.

The following were the major findings of the study:

- There was no planned or coordinated approach to developing the communicative competence of the ESL learners.
- It also emerged that it did not occur to the educators to promote English language and literacy development as part of their subject area instruction.
- The individual classroom teacher exerted the main influence on interaction and participation.
- Science subjects were too difficult for learners with language difficulties and that consequently failure was inevitable.
- Educators unconsciously use non-technical language.

2.15.3.1 Intervention Strategies

After careful analysis of the situation, it was decided that the following broad interventions would best meet the needs of the ESL students and their educators. To achieve integration of language and Science education, the development of learning resources with the ESL learners in mind was mooted.

Worksheets: The researcher, (Morris, 2006:166) asserts that it was decided that in order to address the specific language needs of each student as determined by their needs analysis, customised materials or value added resources be developed. Consequently, language activities in the form of worksheets and exercises were developed and integrated into the Science units.

The researcher is of the opinion that the above cited strategy or programme was motivated by the views of Carrasquillo and Rodriquez (2002:56) who recommend "decoding essential vocabulary and paying attention to non-technical terms" if one has to succeed in scaffolding the learning materials for ESL Science learners. The researcher is also of the opinion that integration of language and literacy with Science education was attempted by both the specific literacy needs of the learners and the language skills involved in their individual units of study. Language objectives were developed alongside Science objectives. Worksheets were developed which addressed difficulties at the word, sentence, paragraph and passage levels.

Glossaries: Morris (2006:175) asserts that general and personalized glossaries were constructed. This was done bearing in mind the emphasis which Wellington and Osborne (2001:75) put on glossaries when he stated: "as well as making meanings clear, glossaries can be used to highlight the new words that will occur in teaching a topic".

Individual assistance in the learning environment: Morris (2006:176) states that as a way of making the learning environment more hospitable, the provision of individual assistance became a necessity. Morris (2006:176) asserts that the said provision came from a realization that "ESL students learn best when they are treated as individuals with their own needs and interests". Henney (2006:123) posits that when teachers have solid knowledge of their ESL students and respect individual needs, they are more likely to develop strategies that will support such students and that the best way of determining individual needs is by interacting with students.

The intervention programmes discussed above lends credence to the challenges that ESL Science learners go through and have shown that learners' lack of mediated learning experiences can be offset through the use of intervention programmes such as the ones described above. The researcher is of the opinion that an intervention programme to help the subjects of the study is a necessity and will use this insight to propose one for the research area in Chapter 6**.**

2.16 Conclusion

This chapter was dedicated to show the relation between the previous researches and opinion on the topic and understanding of the relevance of the previous research to the study being conducted. This chapter has given the reader a clear view about the role of language in Science education. Different authors (Brice, 2001; Brock-Utne, 2000; Cuevas, 2001; Mortimer, 2003; etc.) agree that language plays a critical role in the learning and teaching of Science.

The language policy indicated an important fact that everyone in South Africa has the right to study in their language of choice in any public educational institution where that education is reasonably applicable, so it is important for secondary schools to facilitate this matter urgently.

The ultimate intended outcome of the Language in Education Policy is that two or more languages will be perceived and used as languages of learning and teaching for all learners in the country (DoE, 1997:13). First of all in point (3) it is stated that the LiEP is meant to facilitate communication between groups.

However, this could suggest that this is something that is wished for but not certain. Additionally, it is not specified how this will be achieved, which could be interpreted to mean that speakers of African languages are required to learn English or Afrikaans, but the speakers of English or Afrikaans are not required to learn African languages. This, to the researcher, suggests a diglossic situation which serves to maintain English (and to some degree Afrikaans) as high variety language(s), to be used more in public domains with the African languages remaining low variety languages, to be used in informal settings and for initial literacy only.

Furthermore, this brings to mind the issue of equity as suggested by Kress (2001:31) where equity should be treated as something that works reciprocally, in all directions. Thus if communication is to be facilitated between groups, then English or Afrikaans speaking groups should also be required to learn an African language.

The choice factor also presents serious challenges. To the researcher, the fact that under the new linguistic dispensation the learners have the right to choose the language of learning and teaching, is seen as more of a reaction to the top – down centralized decision – making process of the apartheid government and as such is intertextually related to apartheid discourses. It has to be noted that the ability of individuals to exercise this right is dependent upon the individual having access to information concerning such decisions.

A similar point is also taken up by Webb (2001:361) who is critical of the policy concerning the ability of School Governing Bodies in making decisions with reference to the development of a language policy for schools. Thus Webb (2001:361) comments, "whilst the philosophy of individual choice and the devolution of decision – making accords nicely, it is essential that decision – makers be enabled to make informed choices".

It is of importance to indicate at this stage that no matter how progressive a policy may look, it is crucial to understand how it is actually implemented at the level of the classroom. What is apparent at the moment is that systematic discrepancies between policy intention and actual implementation can be identified within the education system.

It is, however, admitted by the researcher that, for the status quo to change, a strong political will on the side of the government is needed; as encapsulated in the OAU's language plan of action which states thus: *"The…practical promotion of African languages…is dependent primarily and as a matter of absolute imperative on the political will and determination of each sovereign state"* (OAU, 1986: 2).

The following chapter (Chapter 3) will focus on the educational setting of learners as part of the learning environment of this study. In particular, the researcher will describe the environment from which the target research group comes, that is, their primary school setting, the home background and other related factors as can be seen hereunder.

CHAPTER 3

A PROFILE OF THE ENVIRONMENT UNDER WHICH SECONDARY SCHOOLS SCIENCE LEARNERS STUDY

3.1 Introduction

The previous chapter served to explain the role of language in the learning of Science. The theories of learning in a second language and for teaching disadvantaged learners were aptly scrutinized in order to provide a conceptual framework underlying this study. The discussion on theory appropriateness and the weakness of certain theories, namely, the behaviourist theory, brought about the realization that some approaches to teaching may or may not be suitable for specific group of learners. This information also brought to the researcher's attention that the educator's perception about the approaches is very crucial and that how they are related to the learning process can either make or break the student's learning.

The aim of this chapter is to discuss the educational setting of learners as part of the learning environment of this study. In particular, the researcher wishes to describe the environment which the target research group comes from, that is, their primary school setting, the effects of history on their educational setting, home background, geographical location as well as the general cultural factors impacting on their learning of Science in relation to their past educational experience.

To heighten the validity of this study, the researcher elected to describe the environment of the research area in a wider context than simply at Grade 8 level. The first and obvious reason for this is that very often the secondary school educator inherits his primary school colleagues' limitations which he has to address in a much shorter time than the former. The second and perhaps less obvious reason is that if the Science educator hopes to design a programme tailored to meet the specific needs of a particular target group, s/he cannot do so without recourse to the background of such a group.

This chapter, is therefore, concerned with how and to what extent factors referred to above are responsible for producing the so-called "disadvantaged" or "underprepared" learners, and how these factors affect their ability to use English as a vehicle for learning Science. The researcher will examine these factors in so far as they relate to education among historically disadvantaged secondary schools.

The researcher would further submit that the concept of environment, as applied to educational settings, is not only restricted to issues raised above. It refers to the atmosphere, ambiance, tone, or climate that pervades the particular setting (Dorman, 2002:10). Studies over the years have shown positive associations between school environments and attitudinal outcomes, especially attitude to Science and that educators, who provide support, demonstrate equity in the school premises, ensure student cohesion in Science classrooms, are more likely to enhance their learners' academic efficacy in Science and attitude to Science (Aldridge & Fraser, 2000:134; Dorman, 2001:140; Fraser, 2000:65).

The researcher would assert that history has also played a big part in the situation described above. The fight against apartheid, poverty and dominance whose site was basically the urban township areas, was instrumental in shifting focus away from the rural sector of the South African society. Hereunder follows a discussion of environmental factors affecting the research area of the present study.

3.2 The Effects of History on the Research Area Environment

The research area of the present study is tied up with long histories of authoritarian and patriarchal rule. The researcher acknowledges that the advent of democracy has opened up the possibility of a better life for all through rural development. In the short term, formal democracy has not resulted in development in these areas, whose histories have been to serve as labour reservoirs for the mines and factories of the urban centers.

Consequently, the primary schools from which the research subjects of the present study come are still being dogged by an unpleasant legacy of apartheid education which is commonly known as "breakdown of the culture of teaching and learning". Even though some learners proceed to secondary schools, they do so without a firm foundation in all subjects, including English and Science.

Hence, Christie (2001:283) observed that these schools "share a number of common features such as, disputed and disrupted authority relations between principals, educators and learners; sporadic and broken attendance by learners and often by educators; general demotivation and morale of learners and educators; poor school results; conflict and often violence at and around schools; vandalism, criminality, gangsterism, rape and substance abuse; school facilities in a generally poor state of repair". All these factors have adverse effects that do not encourage resourcefulness on the part of the educator or self-reliance on the part of the learner.

Stakeholders at these schools have a general feeling of being unfairly treated by the system and of being unable to perform their tasks. Their anxieties, fears and dissatisfaction are then masked by blaming others and performing their tasks at a minimum level. They also show no interest or initiative in breaking out of these demoralizing patterns and schools seem to stifle proactive opportunities there are.

The researcher is of the opinion that the situation is as it is because during the 1970's and 1980's the schools became a site of struggle in the resistance to the apartheid system. The consequent disintegration of learning environments and the concomitant death of a culture of learning in many Black schools led to the neglect of quality in education. For this reason there has also been a total breakdown of professional development in many schools in the country.

3.3 Poverty and Unemployment

Poverty is the "600 pound gorilla" that is sitting on rural primary schools (from where the research subjects of the present study have graduated). The researcher has come to the realization that poverty and unemployment are starkly present in the everyday realities, speech and activities of the research area of the present study. There is a high dependency on social grants and pensions. Land and livestock are viewed as a means of survival and a form of insurance against misfortune. Most families use the labour of their children to fetch water, tend livestock or support small-scale farming. The absence of parents due to labour demands leads to absence from home and non-commitment in their children's school demands. Parents in the research area tend to be less involved in their children's lives, and more intimidating in their child rearing tactics. This lends rural schools' environment pedagogically disadvantaging because "sufficient parental involvement leads to children performing better in school and children will be less able to drop out of school despite socio-economic status (Castle, 2003:56; Collins, 2000:13).

Most of the parents are illiterate because they lacked schools during their time. Consequently, parents find it very difficult to assist their children with homework because of their own poor levels of education.

The researcher is of the opinion that the dilemma of Black education is evident in the research area of the present study than anywhere else in South Africa. Schools in the research area appear to be dependent on national and urban economics, and if the economy is not prospering, they find it difficult to succeed (Brown, 2003:66). This has a direct bearing on the welfare of the research subjects of this study because the economic meltdown implies that resources become scarce and learning Science through the medium of English becomes very difficult under those circumstances.

The researcher will further posit that influx control, erstwhile apartheid legislation, which was meant to regulate the movement of Blacks from one area to another, led to the heightening of unemployment which exacerbated rural poverty. Inadequate and often corrupt homeland governments were also instrumental in bottling up rural communities in poverty and deprivation. Viable strategies to improve the quality of life for the rural constituency had always been an exception rather than the rule. The building of schools is effectively relegated to communities who were already burdened and hard-pressed by poverty and unemployment (Cameron and Spies, 2002:244; Lockhead and Verspoor, 2001:43).

It must be demonstrated that Grade 8 learners in the Natural Science in particular at secondary schools in rural areas are likely to experience difficulties in which are integrated different perspectives such as a result of poor teaching by poorly qualified Science educators, or problems presented by the subject itself. One need only page through any national newspapers to find that over a number of years attention has been focused on the inability of learners in the historically disadvantaged Black schools with subjects such as Mathematics and Science.

3.4 Geographical Location

Rural primary schools are often geographically and culturally isolated due to their locations. They usually lack the conditions that non-rural schools have. This makes it very difficult for schools to arrange for school excursions to support Science learners. Further, the absence of industries in the research area makes it difficult for learners to have an opportunity to relate what they learn in class to the more chemically inclined apparatus found in the industries.

In addition, the location of these schools forces them to use more effort in order to network with people and to get materials needed for educators and learners. The research area doesn't help learners with English language exposure because amenities such as bill boards, television and other areas of leisure are non-existent. The implication of these deficiencies in the environment translates into a situation which is not conducive for education in general and Science learning via the English medium in particular.

3.5 The Physical Environment of Schools

There is a strong correlation between learner performance and the quality of the facilities available to learners. Good infrastructural environment of a classroom is very important to efficient student performance. Research has proven time and again that a controlled and good infrastructural environment is necessary for satisfactory student performance learning Science especially in a second language like English (Macworth, 2001:245; McConnell and Yaglou, 2000:239; Osborne, 2005:133).

The situation as it obtains in primary schools that are producing the research subjects of this study is that they hardly have desks, tables and chairs in them. Either this furniture was removed or was vandalized because of lack of security in such schools. Many of these schools have poor physical fabric and are dilapidated, dangerous and unfit for human habitation.

Hence, Lanham (2001:150) asserts that “after the socioeconomic status of the learners, the most influential condition that influences student achievement in Science, is the infrastructure variable”. The above assertion has implications for Science learning via the agency of English because lack of proper infrastructure like desks will limit teaching strategies like group work. Stifled communication would inevitably have unpleasant consequences in the learning of any subject including English and Science.

In addition, schools lack laboratory facilities and other learning support materials. The researcher is of the opinion that laboratory experiences promote central Science education goals including: understanding of scientific concepts, the development of scientific practical skills and problem-solving abilities and interest and motivation. Laboratory activities offer important experiences in the learning of Science. They promote intellectual development as well as the development of observational and manipulative skills. The laboratory is the essence of Science, a metonymy (or central defining attribute of a concept) that can be used to make sense in the context of Science teaching. From a constructivist perspective, laboratory activities can be seen as a means of allowing learners to pursue learning autonomously, having varied multi-sensory experiences” (Lunetta, 2003:251; Tobin, et al., 2002:57).

It is sad to report that in spite of the above assertions, all the feeder primary schools in the research site i.e. Vlakfontein Circuit don’t have laboratories. In other words, learners are registered in Grade 8 without prior knowledge of experimental work. In order for learners to learn Science with understanding, it is essential that they should get the necessary experience and exposure by working and functioning in the laboratory with equipment and materials as scientists would in real life.

If one considers the fact that laboratory experiences are important in developing conceptual understanding as well as practical skills, especially if they are integrated with other metacognitive learning experiences such as “predict-explain-observe” demonstrations, one can understand why learners in the research area perform so poorly in Science. Most learners learn Science by rote and some of them complete their primary school education without having seen, let alone handled a beaker. The teaching of Science remains at a theoretical level without any experiments to enhance understanding and application of knowledge (Department of Education, 2000:13).

The researcher would further submit that the availability and retention of learning support materials is a vital ingredient in keeping with learning up and yet all feeder primary schools of the research site are characterized by a severe shortage of textbooks. The situation is exacerbated by the fact that "the reason for this severe shortage is not so much that the Department of Education is not supplying the necessary learning support materials but that learners abuse them, lose them, and fail to return them at the end of the academic year" (Ralenala, 2003:128).

The researcher would posit that this non-availability of resources could result in a topic being avoided; it could determine how a topic is taught and also determine the actual activities the learners engage in (Goodrum, Hackling and Rennie, 2001:7).

If one takes seriously the observation that in developing countries the availability of textbooks is associated with student performance and pass rate, then lack of learning materials in schools clearly points to our learners not performing well in their studies. It is disheartening to note that most rural schools are plagued with extreme poverty and therefore, it is that there could be extra funds for buildings and resources (Jennings & Everet, 2000:83).

The government claims not to have sufficient funds to address this problem. Indeed as long as this situation is not given the attention it deserves, Science teaching and learning in black schools will remain dismal. One can only deduce that educators who are at present teaching in the research area of this study are finding it very difficult to teach learners who have never been exposed to a basic Science commodity like a laboratory.

3.6 English Teaching in the Primary Schools of the Research Area

3.6.1 Orientation

The majority of learners (if not all) in the primary schools in the research area receive their tuition in a language that is not their first language. These learners (if they were attending schools in affluent areas, would be frequently inappropriately referred for Speech-Language Therapy (SLT) for a 'language disorder' (Stoffels, 2004:35). Therefore ESL learners, as found in the primary schools of the research area are being 'pathologised' because educators may interpret language differences as deficiencies.

The widespread preference for education in English has resulted in the Revised National Curriculum Statement's (RNCS) language policy only being partially implemented (Vesely, 2000:5). The Language in Education Policy of South Africa promotes an additive approach to bio/multi-lingualism, whereby the first language is maintained and used as a basis for the learning of another language (Chick & McKay, 2001:163). This approach has benefits for the learner as "continued development of both languages into literate domains … is a precondition for enhanced cognitive, linguistic, and academic growth" (Cummins, 2000:37). Due to the partial implementation of the language policy, South African educators face the challenges of large numbers of ESL learners in their classes (PANSALB, 2000:5).

The researcher has observed that primary school learners of the research area struggle academically and this lowers their self-esteem and confidence, in turn perhaps affecting other areas of learning and functioning through frustration, social isolation, and disciplinary problems (Du Plessis & Naudé, 2003). Time spent to resolve these can interrupt the flow of lessons and add to the learners' difficulties which are often exacerbated by poverty, hunger, and fatigue through travelling long distances to school (Stoffels, 2004:35). The following scenario is prevalent in the research schools in as far as the teaching of English is concerned.

Unsatisfactory Educational Performance by Learners: Educators report that all learners have Sepedi as a first language. Learners are most of the time forced to repeat a year, or proceed to the next grade without adequate grasp of the previous grade's work. Having very little exposure to English at home, and tending to speak in their home language to peers at school, many learners may not even have had adequate BICS in English, thereby affecting their CALP in English (Cummins, 2000:20). So as not to affect their self-esteem, learners who had not coped academically in a grade are being promoted to the next grade where they should receive additional support.

The researcher is of the opinion that the practice described above is not always in the best interests of the ESL learners since they may always remain behind academically. Although the schools have access to rehabilitative support such as psychologists and learning support educators (Department of Education, 2002:8), these multifunctional teams are often understaffed and unable to see all the children who needed help, except the Grade twelves (12) who also receive service once a year.

Discipline and behaviour problems amongst primary school learners due to large class sizes are compounded by language issues. Educators frequently experience discipline problems with these learners — with larger classes being notably more difficult than smaller classes, due to limited comprehension skills of ESL learners and linguistic and cultural mismatches between them and educators (Du Plessis & Naudé, 2003:122).

Socio-emotional Problems: This is associated with learning in a language that is not one’s first language and it leads to learners feeling that they lose their home language and culture. For example, educators in the primary schools from which the research subjects come, are of the opinion that their learners lose their first language vocabulary by replacing some words with English equivalents. This could be the effect of learners not using their first language for high level cognition or due to the predominant use of English in the media and in urban areas (Vesely, 2000:5). The learners’ limited English language skills lead to a difficulty with expressing themselves, and confusion from not understanding instructions, and this contributes to a low level of confidence.

Lack of Parent Involvement: Parental involvement, especially as it relates to parents helping their children with their homework is found to contribute to good progress of ESL learners. Lack of it affects learners adversely. Even though educators in the primary schools of the research area are aware of the benefits of encouraging parents to use their first language when helping children with homework as well as creating opportunities for their child to listen and interact in English, most of the time parents could not assist with their child's schoolwork as they themselves do not understand English, or are illiterate or unable to read and write in English. However, the researcher is aware that social circumstances such as long hours of work, transport, or finances may also be coming into play to affect parents' involvement.

Frustrated Educators: In spite of feeling sympathy towards ESL learners, educators feel *frustrated* working with them, because of heavy workloads. They first have to teach the language and vocabulary for specific content and thus they find it impossible to complete the syllabus for the year. Also having learners in the class with better English abilities, educators report that they have to teach on diverse language and academic levels.

Educators are being required to give extra attention to learners who are not keeping up, as well as adequately challenging stronger learners, in order to ensure that all learners in their class had an equally effective education. This by itself is a huge task on the part of educators who are always pressed for time to finish the syllabus. On the other hand, the size and demographics of classes also serve as sources of frustration for educators and learners alike. As class sizes increase, the frequency of problems increases: lack of knowledge of second language acquisition processes; lack of knowledge of bilingualism and problems with discipline due to limited comprehension of ESL learners. Educators with large classes (more than 30 learners) are more likely to experience these problems frequently than educators with smaller classes (less than 30 learners).

Further, another source of frustration is caused by learners' first language which also influences their development of English, for example, pronunciation affect their phonics in their writing, and concepts such as gendered pronouns confused the majority of Sepedi speakers where personal pronouns for male and female are the same.

Lack of Support: Educators and learners in the primary schools in the research area feel unsupported and alone; they feel that they bear all the responsibility for tuition in their classes without support from key contributors. Educators in particular feel disempowered because they have to refer decisions about learners repeating grades to an external team who would make the ultimate decision. In spite of the Limpopo Province Education Department being aware of the large classes and large numbers of ESL learners, the educators feel that their needs are not being heard and met.

Resources for Teaching English: Both educators and learners express the need for specific language teaching resources for ESL learning and teaching. They need simple picture vocabulary theme books and objects and pictures to demonstrate vocabulary, as well as home programmes and worksheets to assist learners to work with an English proficient, literate adult at home. Fundamentally, educators need basic resources for their classroom. Owing to their social circumstances, not many learners have their own stationery and unless educators provide out of their own pockets, they are unable to do creative activities with the learners. Educators also need bigger classrooms since classes are very crowded.

Training: Lack of training is significantly associated with the frequency of problems experienced in the classroom because of a lack of knowledge of bilingualism. Educators in the primary schools in the research area have learnt through own, gathered experience about teaching ESL learners, and a majority of them are in dire need of more formal training, mostly practical. Although they had attended workshops on teaching ESL learners, educators want to observe practical demonstrations on how to implement the strategies they had learnt, preferably with their own learners.

Educators express openness to learning from and collaborating with SLTs on an ongoing basis as ‘language experts’ in the classroom: This would also assist ESL learners who are struggling academically, simultaneously alleviating educator frustration, as found earlier. Besides practical training, the educators want training in Sepedi, the home language of most ESL learners in the research schools. Educators know basic Sepedi words-learnt through “*desperation*” — and they meet a good response from -first language ESL learners when trying to speak Sepedi. It is the view of the researcher that educators know that they cannot provide optimal education for ESL learners without being able to speak their home language, in line with Alexander (2003:55).

The researcher is of the opinion that from the above, it is clearly shown that educators and learners face numerous challenges in their English classes. Besides the academic and socio-emotional difficulties of ESL learners, educators in the research area of this study are frustrated by a considerable workload and large classes with many ESL learners per class. Educators call for increased resources and departmental, professional and parental support as well as practical training in teaching ESL learners and in Sepedi language and culture.

More in-depth knowledge about the needs, experiences and coping strategies of educators teaching ESL learners can lead to better training for educators, and better preparation for SLTs for their roles in supporting educators. This knowledge can also initiate further research leading to possible policy changes to meet educators' needs. With many ESL learners attending school in English, meeting the challenges of educators, partially through the involvement of SLTs, will ensure that learners achieve their academic potential and have the same opportunities in life as their peers who are learning in their first language.

3.7 Science Teaching in Primary Schools of the Research Area

3.7.1 Orientation

The current Science curriculum in primary schools was introduced with the purpose of providing learners with knowledge and skills and participating in modern day scientific society. The curriculum purports to be learner-centered, skills-oriented and based on discovery learning (Ralenala, 2003:132).

However, in the actual classroom situation, the researcher observed that there were considerable discrepancies between curriculum intent and actual practice. Learners are very passive whilst the educators dominate by talking all the time. Science is often taught and learnt without clear understanding resulting in learners' rote learning. This is partly due to inadequate educational facilities, poor subject competence on the part of the educators and the language difficulties for both educators and learners. The following factors characterize Science teaching in the primary schools of the research area. The educational effects of these factors, conditions and influences become evident when these learners move on to secondary schools and need extensive academic support especially in the Senior Phase.

Poor Quality of Educators: No education system is higher than the level of the educator. Thus, standards in Science classrooms may fall because of the shortage of properly trained Science educators. Deficiencies in practical skills and conceptual understanding are passed on from educator to learner who then becomes an educator - from one generation to the next. This cycle perpetuates incompetence and can lead to a deterioration of standards over time.

The researcher is of the opinion that poor teacher education could be accounting for the educators' rampant verbatim reliance upon textbook notes and practical instructions, the practice of chalkboard teaching and the educators' inability to use equipment that is not familiar (e.g. 'new' equipment not drawn in their textbooks). Educators do not show interest in understanding how 'new' equipment works, for example by reading instructions that accompany equipment.

Practicals are non-existent: According to White (1996: 591), there ought to be clear goals of laboratory teaching. Unfortunately, there are no laboratories in all the research schools visited. Even the textbooks used do not outline the objectives of a practical exercise or the Science processes which the practical ought to enhance. This degenerates practicals to routine exercises that produce data mainly for calculations or for verifying textbook information, and nothing else. Experiments outlined in learners' textbooks hardly relate with the learners' environment and real life, and do not tease the learner intellectually and practically. It is the researcher's opinion that overall, practical work is meant to enhance interest in Science and increase manipulative skills, as well as memory of content. However, the scientific value of practical work in the primary schools of the research area classrooms is questionable because of the laboratories' non-existence.

School Environments: The primary schools' environment demotivates learning. There are poor physical structures such as dilapidated buildings and the environment which is devoid of examples of 'school' Science, and there is a general lack of facilities such as Science equipment, laboratories and libraries. Learners have to do with imagination all the time. The Science in the streams and in the bush around the rural learner is rarely a part of the syllabus i.e. school Science is not part of the learners' life.

The researcher is of the opinion that a well-equipped laboratory would probably stimulate learners' interest and practical tuition in Science. Not so for Vlakfontein Circuit primary school learners. There is also a shortage of alternative resources at schools. For example, none of all the primary schools has a library. Thus, the learners' constructions of knowledge are limited to textbook information.

Unusual Science Equipment: The situation in the primary schools of the research area is such that even where Science equipment is available, albeit in short supply, it is often strange to learners. The researcher observed that learners would spend much of the time interrogating the Science equipment rather than the concepts they were supposed to learn from using that equipment. The researcher could only deduce that the educators believed that learners gained from 'touching' and from 'seeing' the Science equipment. The situation as explained above arises from the fact that the learners experience Science and Science equipment in schools as foreign, and highlights the problem in using equipment that is complicated and unusual to learners. This is evidence that the country has not developed its own Science knowledge and has not customised the Science equipment. Furthermore, learners are rarely given a chance to study the equipment before it is used to help them.

Change to Curriculum 2005*:* Science education in the primary schools of the research area seems to have suffered from changes in the curriculum and syllabi, which have changed almost every two years. A shift to Curriculum 2005 (C2005) has not been accompanied by a change in resources (including textbooks, which normally simply change covers). Hence, the researcher found educators with an assortment of syllabi not knowing which one to follow or whether C2005 in fact uses syllabi. Educators still had many questions about C2005, which were amplified further by the temporary change to Curriculum 21, and by the removal of some terminologies before reintroducing C2005. Curriculum 2005 uses Outcomes-Based Education (OBE) as an approach to facilitate learning.

However, the OBE was hastily passed on to educators. As the OBE did not evolve from within the South African cultural systems, educators lack its philosophical background and practical know-how. Hence, OBE as practised in the primary schools of the research area is still modernist, involving the usual information transmission model, where knowledge is selected, organized into a lesson, and transmitted in a one-way flow to mainly passive recipients. For example, educators are expected to recognize and measure rather than abstract outcomes such as critical thinking, and group work has become a 'must' even where it may not be necessary. Similarly, practical work and projects, still structured in the form of worksheets, in which 'the right' methods, language, structure and answers are followed or demanded, are claimed to be OBE. These examples show the looming danger of educators adopting a hybrid between OBE and traditionally structured classroom approaches, similar to an undefined position between orbitals. This hybrid has been found to be difficult to identify and correct.

On the other hand, structured approaches are often devoid of constructivism and inhibit new discoveries in Science. Structured approaches also discourage divergence, and so do not cater for African cultural belief systems in a Science largely Western (often wrongly said to be 'global') such that a cultural - Science divide may develop. Among the important factors of the divide is language.

3.8 Class Size

The type and kind of an educational programme offered in a school has relevance for the capacity of the building. When the capacity of the building is exceeded, extreme pressure is exerted upon all of the facilities and areas that educators, administrators and learners need to use for an effective educational programme. The situation in almost all the feeder primary schools of the research area of this study is that their classes are grossly overcrowded. This makes group work difficult and learning Science through English becomes cumbersome.

Informal conversation with primary educators in the research area reveal that overcrowded classes are noisier, creates more non-instructional duties and paperwork, and without question inhibits teaching and learning. The researcher is of the opinion that the situation as explained above will inevitably lead to educator burnout, less time to cover the basic material as well as less learner/educator interaction.

The researcher posits that it goes without saying that a teacher-learner ratio of 70 or 80 learners in an ESL class is too big a number for effective teaching and learning. Individual attention becomes very difficult and demonstration by the educator is virtually impossible. Wilson (2004:45) observes that "…No doubt seventy is too many and one is too few, but the real problems arise with classes that are too large than with those that are too small… In a large class it is very difficult for every individual to have the intensive contact with the language (especially spoken language) that is necessary for his inductive process to operate effectively in Science".

Common-sense appeal and considerable research evidence suggest that smaller classes contribute to improved learner performance in Science, especially for secondary school learners and learners who are at risk or disadvantaged.

3.9 Conclusion

The factors comprising the learning environment, from which the research subjects are produced, as discussed above, indicate that teaching and learning in the research area schools, is far from satisfactory. What becomes evident as one considers all these factors is the fact that society and education have made certain demands which educators and learners are expected to satisfy. The demands are that academic tasks be rendered more true to discipline; that they require more cognitive skills from learners; that they connect subject matter to other aspects of life, and that they incorporate more and more diverse learners (Kelman, 2001:126). These new demands are being placed on schools to improve and derive more meaning and quality from their teaching and learning, whilst on the other hand they are not being reciprocated by resources and personnel to enhance their achievement. The researcher would posit that, based on the above, teaching Science through English is fraught with difficulties.

Further, it is important to acknowledge that learners' cultural backgrounds will always affect their ability to fully comprehend and manipulate scientific concepts. Thus, cultural processes should be involved in the acquisition of Science culture. When the culture of Science harmonizes with the learner’s life-world culture, Science instruction will tend to support the learner’s view of the world and the process of enculturation tends to get actualized (Baker and Taylor, 2005:698; Yager, 2003:44).

In the next chapter (Chapter 4), the researcher will present the empirical research design for this study. Through this, the researcher will highlight the research approach and research instruments that were employed to gather the necessary information concerning English as the language of learning and teaching Science in rural Limpopo.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 Introduction and Context

The foregoing discourse on the various environmental factors has highlighted ways in which learners approach their academic tasks. It has demonstrated that rural learners' tuition is largely influenced by their previous academic backgrounds and unsupportive learning environments and therefore, it was important to discuss these before engaging in any research methodology.

This chapter provides a brief discussion of the research approaches which were adopted to investigate English as a language of learning and teaching Science in the research area. Initially, the research approach is described. This is followed by an outline of the techniques used to collect data in the field, as well as document and data analysis. The steps taken to ensure the validity and reliability of the research findings are also explained. Finally, ethical measures are explained. This is in keeping with what Leedy and Ormrod (2005:133) refer to when they assert that "to answer some research questions, we cannot skim across the surface. We must dig deep to get a complete understanding of the phenomenon we are studying". Before dwelling into the details of this chapter, the researcher will briefly repeat the stated research aim(s) of the study:

- To investigate the problems emanating from the use of English by rural secondary Science learners to understand Science.
- To suggest a programme which will develop these learners' command of English within the context of scientific discourse.

The study thus investigated how English as a LoLT can influence the successful learning of Science in the research schools in Vlakfontein Circuit in the Capricorn District of the Limpopo Province.

4.2 Research Approaches

4.2.1 Orientation

The decision that finally influenced the researcher to select a particular research approach and research instrument depended on what the researcher wanted at the end of the investigation. After a close perusal of existing literature on research methodology, the researcher was of the opinion that the ideal research approach to use in this research was to be a combination of quantitative and qualitative research approaches. In the following paragraphs the researcher will describe them and also offer justification for selecting them.

4.2.2 The Quantitative Approach

In the past, behavioural Sciences conformed to the scientific epistemology which advocated that any phenomenon could be described and reduced to its statistical or numerical elements and collated and attributed to causal powers (McMillan & Schumacher, 1993:56). In this research the issue of LoLT in Science was investigated by using the bar graph and pie-chart for educators and for the learners a chi-square was used.

Leedy and Ormrod (2005:94) explain that quantitative research is used to answer questions about relationships amongst measured variables and testing hypotheses with the purpose of explaining, predicting and controlling phenomena. For this study, questionnaires were used to establish the relationship between learners' English competence and their understanding of Science. The hypothesis used was itemized as follows:

- The majority of Science learners enter secondary schools without the necessary mature and efficient reading and thinking skills and strategies needed for learning on their own.
- Grade 8 learners' English knowledge lacks sufficient and specific concepts that promote competence in Science learning.
- Grade 8 Science learners are unaware of the full range of functions and registers required for scientific English and would therefore benefit from a support English language programme whose content is specifically tailored to meet the requirements for secondary school level Science learning.

According to Babbie (1998:154) when a researcher uses a quantitative approach, he seeks to find relationships by means of established sets of procedures. During this process, the researcher remains distant and detached while trying to establish generalizations that are context-free. In this study, the researcher distributed the questionnaires to educators and learners and left them to respond in a relaxed manner away from him.

4.2.3 The Qualitative Approach

This study also used a qualitative approach for the investigation. The approach yielded descriptive and narrative data that provided in-depth information that would otherwise not be wrought through any other means. The qualitative data emanating from this investigation assisted in answering the research question and in realizing the aim of the study.

Researchers (Ary, et al., 2002:424; Cresswell, 2003:181; Gay and Airasian, 2003:173; Hammersly, 2002:67; Henning, van Rensburg & Smit, 2004:6-7) are in agreement that the qualitative method is a research approach that is characterized by a concern for context, natural setting, participant observation, field study, descriptive data, emergent design and inductive analysis. It also studies sites and contexts in which the group interacts in real life setting. In this study, the researcher used participant observation and interviews to get information from the respondents.

In this way the researcher gained a deeper understanding of the research objects (Silverman, 1993:34). It also enabled him to capture the respondents' point of view and to interpret phenomena in terms of meanings respondents bring to him (Denzin & Lincoln, 2000:56). Since it was the researcher's understanding that information about people's opinions and ideas could be obtained easily by talking and engaging with the individuals, the qualitative approach was deemed to be the best vehicle to glean information about issues related to the use of English as a language of learning and teaching Science.

Moreover, Fairclough (2001:43) argues that qualitative research is concerned with understanding the context in which behaviour occurs. The researcher in qualitative research does not focus on one theme only but on the interaction of multiple variables which occur in real life situations**.** In this study, the researcher engaged the respondents in in-depth interviews regarding the use of English as a LoLT in the learning of Science, how it influences interaction among them and how it impacts on their understanding of Science concepts.

The researcher used the qualitative approach to collect data in the classrooms (i.e. real life contexts) because of an understanding that if measurement instruments are used outside the context, a great deal of information might be lost. This research approach was used to understand the language of learning and teaching phenomenon about which little was yet known and also to gain a new perspective on what was already known in order to gain more in-depth information that could be difficult to convey quantitatively (Martin & Rose, 2003:103; Mouton, 2004:135; Struwig & Stead, 2002:203).

A criticism that is commonly levelled at this approach of inquiry is that it fails to adhere to the principles of validity and reliability (Le Compte & Goetz, 1982:31). Adler (1996:115) for example, describes qualitative research as "undisciplined" and "sloppy" because every researcher brings with him a certain amount of personal values, opinion, choices and power relations to the research situation. And so according to him every research situation is unlikely to be exactly the same as previous.

In reply, many qualitative researchers claim that the genuinely and distinctive human dimension of education cannot be captured by statistical generalizations and causal laws (Walker & Evers, 1999:23). They argue that human knowledge is not irreducibly subjective. It must grasp the meanings of actions, the uniqueness of events, and the individuality of persons. This approach accepts that the meaning of any event is constructed with different interpretations arising from differing points of view. This can only be achieved through the use of qualitative approach and not quantitative approach.

However, in the midst of all this debate, Soudien (2000:9) is of the opinion that it is not so much a question of whether quantitative research is better than qualitative research. In his view, there is no one "best" way to carry out educational research**.**

Thus, in this study, both approaches (quantitative and qualitative) were used to compensate for individual shortcomings referred to above and at the same time to capitalize on individual strong points. The researcher was interested in obtaining inputs of the research subjects regarding the use of English as a language of learning and teaching Science. This enabled him to build descriptions and judgements based on the research subjects' perceptions**.**

4.3 Population

According to Cozby (2007:19) population is composed of all individuals of interest to the research. The learner sample was drawn from a population of 150 learners who were registered in all the Science classes of the village schools. The educator population on the other hand consisted of 7 educators who were teaching Natural Science in all the sampled schools.

4.4 Sampling

The sample comprised 70 learners randomly selected from each school i.e. ten from each school.The researcher chose random sampling because he was of the opinion that it was the type of sampling in which each element had an equal chance of selection, independent of any other event in the selection process (Babbie, 2007:191). The researcher was also aware that in qualitative research, there was always a danger that the researcher selecting cases on an intuitive basis might very well select cases that would support his or her research expectations or hypotheses (Salkind, 2006:86). Random sampling erased this danger.

Purposive sampling was used to select the seven research schools from a total population of 13 schools in the village. These were all the schools in the village that taught Science as a subject. Each of the schools had one Science class and all the seven educators from the different schools formed part of the research subjects. This was done because researchers (Gay & Airasian, 2003:115; McMillan and Schumacher, 1993:404) are in agreement that purposive sampling is a strategy identified from prior identification and is meant to enhance data quality and that it is selected in a deliberate and non-random fashion to achieve a certain goal.

It could therefore be concluded that the sample was representative in terms of schools, educators and learners. It is in line with what researchers (De Vos, 2002:13; Du Plooy, 2002:54) advocate when they assert that the main reason for doing sampling is to have a fair representativeness of the respondents to use in order to draw a conclusion based on a general consensus.

4.5 Data-Gathering Techniques

4.5.1 Orientation

Three types of data gathering techniques were used to gather data for this study. A brief description of each technique and the number of respondents involved in each case are presented below.

4.5.2 Observation

Classroom observation was a particularly suitable technique for the collection of data because through its use the researcher was able to observe the research subjects' behavior directly as well as making face to face interaction with them in a natural setting. These observations were deemed necessary in order to get the "feel" of the research subjects' learning processes and skills in Science. Consequently, the researcher was able to obtain valuable data on activities and processes which the subjects were engaged in but were not consciously aware of**.**

Merriam (1998:94) states that observations, although highly subjective are "first hand encounters" with the phenomenon one is investigating and as such are a valuable research tool. Observation in the research setting is nevertheless planned intentionally to record behaviour as it happens.

Bogdan and Biklen (1992:53), and Hoepfl (1997:15) are in agreement that "the researcher can immerse himself in the research situation as a fully active participant (complete participant); he can engage in limited interaction with the research subjects during observation (participant observer); or he can observe subjects without their being aware of it (complete observer)".The researcher therefore immersed himself in the research situation so that he could experience events personally.

That was done in line with Glesne (1999:44-45) who describes participant observation as a process whereby the researcher becomes part of the research setting in order to observe firsthand the actions and interactions of the participants. She further asserts that researchers must decide for themselves how involved they will become in the setting i.e. whether their observation technique will be largely ‘observer’ or largely ‘participant’. She suggests that one might find oneself fulfilling different roles on this continuum at different times during the observation sessions.

In keeping with the aim of this study, the researcher was included in the description of the research methodology and was an active participant in the research. For example, in all the schools the researcher used to take care of learners while the educators were attending to other things (e.g. attending workshops or being absent)At one point the researcher found himself helping educators with marking learners’ work in Science. Helping in the classrooms as a researcher is in line with Woods (1986:39) claim that it is difficult to avoid being involved in some way in the life of the group in any long-tem research. So the researcher found himself participating somehow in classroom activities, and the learners treated him as one of their educators as he continuously visited their class.

Furthermore, the researcher decided what he was going to focus on during observation. This researcher decided to sit at the back of the class and observed the interactions between each educator and the learners during Science lessons. It was explained to each participant that the observation was for intentions of the inquiry only and that it would not be used for any other purpose.

What has been observed must be carefully recorded by means of extensive field notes. The researcher made abbreviated notes in a notebook that described the activities and interactions taking place (in the classrooms). He also wrote down certain direct quotations. These were later typed out in more detail as suggested by Glesne (1999:49-50). The researcher’s reflections and comments as participant observer were added during the transcribing process.

According to Jorgensen (2000:45), the observation technique is a straight forward technique: by immersing himself in the subject being studied, the researcher is presumed to gain understanding, perhaps more deeply than could be obtained, for example, by questionnaire items.

Observations can be overt or covert; in covert observation the observer is not known by the people he/she observes and he/she does it in secrecy while in overt observation, the observer is known by the people he/she observes (Patton 1990:88). In this study the researcher used participant observation/overt where he basically observed lessons in progress. Thus, he interjected himself into an actual situation in an effort to draw out and document the subjects' reactions. In doing so, the researcher was guided by the research question (see Chapter 1) so that the observation was not just haphazard but theoretically selective. This enabled him to become part of the group and interacted with them; it created an atmosphere in which he interacted freely with subjects in their class activities thereby developing mutual trust. This is because "if the researcher is to get an accurate and complete account of what deviants do, what their patterns of associations are, he must spend at least some time observing them in their natural habitat as they go about their ordinary activities" (Wisker 2001:85; Fontana and Frey, 1994: 370).This in turn enabled the participants to treat the researcher as "one of them" i.e. a real, historical individual with concrete, specific desires and interests" (Denzin & Lincoln, 2000:143). More than anything else, the purpose of the observation was to add rigour to the investigation when combined with the interviews (Ralenala, 2003:167).

The researcher used the observation technique as a supplementary method/data collection technique to the interview method. He used this method purposely to get a clear and direct establishment of facts from the learners and the classroom educators regarding the subject under study.

Furthermore, the lesson observation process aimed at helping the researcher to see the reality of 'how' effective teaching and learning in English is in a rural setting of Vlakfontein Circuit and how it influenced the educators' and learners' abilities to perform their tasks in Science. In the process of observation the researcher used structured form of observation, whereby he focused on the same features in all the classes and the lessons he observed. For this technique he designed questions which guided what he saw and heard (see Appendix 4) (Spradley, 1980:4). In the classroom observation, therefore, the researcher focused on establishing the language of learning and teaching used by educators in practice, learners' possible participation in the teaching and learning process and how the use of English as the language of learning and teaching (LoLT) influenced learners' abilities to learn Science concepts.

An attempt was made to observe educators on different days of the week to avoid observing activities that might have been repeated on the same day each week. All observations recorded was primarily descriptive in nature and was captured as field notes and used to identify any emerging patterns. Seven educators took part in the observations.

The following classroom situations were observed:

- The classroom environment: school buildings in general, number of learners, resources for learners so as to establish their effect on the teaching and learning of Science.
- Laboratory facilities: to establish their contribution in the learning of Science.
- Libraries: to look at their impact language wise on the part of learners.
- Classroom interactions i.e. educators' English competence, learners' English proficiency.
- Educators' teaching style: educator's pace, educator's approach, link with prior knowledge**.**

4.6 The Educator Questionnaire

4.6.1 Aim and Rationale of Questionnaire

Six questions were distributed to the seven educators who were teaching Natural Science in Grade 8. These questionnaires sought specific data on the Natural Science educators rating regarding the learners' level of competency and performance in the use of English as a language of learning and teaching Science within the confinement of classroom discourse; the nature of the problem experienced, and the educators' own suggestions as to how the problem might be solved.

A further important aim was to determine the degree to which the test-subjects' self-rating in English (for purposes of learning Science) corresponds (or otherwise) with the educators' overall rating of them. These data provided a useful springboard from which to plan, organize and administer whatever remedial programme might be needed to render both teaching and learning in Science more effective.

4.6.2 Questionnaire Administration and Supervision

Since the aim was not to gather data on specific language areas but rather on overall performance in English or overview, it was not considered important to control variables such as time of day, venue and specified time within which to complete the questionnaire. For this reason educators, unlike learners, completed their questionnaires at their own time, pace and venues convenient to them, for example, offices, home and so forth.

4.6.3 Reliability of Data Collected

The researcher is satisfied that the data collected was reliable enough for use as research data because he had personally observed phenomena as they were unfolding before his eyes and had personally heard the respondents' views. Science educators are concerned with their learners' performance especially in their first year of secondary schooling and feel the need for a programme that would alleviate the situation (see Chapter 6 below).

4.7 The Learner Questionnaire

In this study, the quantitative data was collected by means of a learner questionnaire. A questionnaire was most suitable because it captured a detailed description of the experiences of participants within a setting, the underlying processes which influenced those experiences, and the perceptions of participants regarding their experiences. This questionnaire was constructed on the bases of:

a) Detailed consultation with a sample of principals and their Grade 8 Natural Science educators.
b) Consultation with the Circuit Manager of the Vlakfontein Circuit through a letter.
c) The researcher's own research data which was collected as part of the language challenges and linguistic needs analyses of Grade 8 Science learners.

The questionnaire was short and straightforward to avoid it overwhelming the respondents with many items that might intimidate them and in the process precipitate unreliable responses.

4.7.1 Content of the Learner Questionnaire

Structured questions were selected for the questionnaire. This was because closed questions were regarded as most appropriate for obtaining demographical information and other data that could be categorized easily (McMillan & Schumacher, 1993:241). Furthermore, closed questions tried to eliminate bias during the collection of data and subjectivity during the analysis of responses. This is because closed questions require all the research subjects to answer within the same framework. This questionnaire therefore sought specific information regarding the Grade 8 learners' challenges about using English as a language of learning Science. Specifically, the questionnaire sought specific information regarding the learners' linguistic self-analysis in a number of important situations within the context of learning Science at Senior Phase level.

The questionnaire sought specific details on the following items:

- The learners' frequent use of the English language skills of listening, speaking, reading and writing in their Science lessons;
- The learners' overall linguistic level of ability, that is, their general competence and performance in English as rated by the learners themselves;
- The learners' ability on specific English language functions that have been identified as problem areas in the learning of Science at Grade 8 level;
- Whether they experienced any difficulty in understanding the language of prescribed texts?
- To complete the picture, the researcher included an item which elicited information on what the learners themselves thought should be done to help them learn Science better through the medium of English.

4.7.2 Rationale for Questionnaire Design

As can be seen from the above questionnaire content, this questionnaire was designed in such a way that it did not only inform the researcher about the study group's perception of their language challenges in studying Science but also to suggest to the learners that, for once, someone was interested in their specific language challenges and was prepared to go to some trouble to find out about them in advance. This motivated and encouraged the learners to give free and thoughtful responses to the questionnaire deviser.

4.7.3 Procedure

The questionnaire was distributed among the 70 Grade 8 Science learners. The researcher personally hand-delivered the questionnaires to the sampled learners at their schools. This had to be done to ensure the reliability and authenticity of questionnaire elicited data which can otherwise be invalidated by consultations among respondents. The researcher remained available throughout the exercise to give instructions and answer any questions that might arise. There was no time limit allocated to this exercise. A sampling of the learners was then selected using a table of random sampling. In this way a possible discrimination based on sex and age was ruled out.

4.7.4 Questionnaire Administration and Supervision

The research sample was housed in a classroom which was well ventilated and adequately lit. The researcher was assisted by two educators at each school who not only assisted with the distribution of questionnaires and pens and pencils, but also acted as "supervisors" if only to make absolutely certain that what the learners filled in was in fact individual responses to the questionnaire items. This had to be done to ensure reliability and authenticity of questionnaire-elicited data which can otherwise be invalidated by consultations among respondents. This was in line with what Cohen, Manion and Morrison (2000:93) advocate when they assert that an ideal questionnaire is one which is "clear, unambiguous and uniformly workable. Its design must minimize potential errors from respondents … and coders. And since people's participation in surveys is voluntary, a questionnaire has to help in engaging their interest, encouraging their co-operation, and eliciting answers as close as possible to the truth".

To encourage objectivity, the respondents were not required to fill in their names on the questionnaire but were nonetheless encouraged to take the task very seriously as results would help the researcher to mount not only a relevant and effective remedial programme for them but one that is interesting as well. The sheer novelty of the exercise generated interest and heightened motivation while the comparative simplicity of the questionnaire-design off-set possible comprehension problems resulting from second language factor. The researcher and the “supervisors” were nonetheless on hand to assist any comprehension problems that might arise in the course of the filling-out of the questionnaire.

The completed questionnaires were collected immediately and stored safely until scoring.

4.7.5 Scoring the Questionnaire

Since the sample used was not unduly large, scoring was done by means of the Statistical Programme for the Social Sciences (SPSS) through the chi-square significance test, the test for the differences of proportions and percentages to display the frequency of occurrence. To ensure reliability, however, the researcher was assisted by the same colleagues who helped in the administration and supervision of the questionnaire completion.

4.8 The Interviews

This was the most common form of data collection. Merriam (1998:71) describes interviews as a “conversation with a purpose” where the interviewer elicits information from the participant. This type of information generally comprises participants’ describing of opinions, feelings, experiences, meanings and intentions during the interview. Such information cannot be directly observed but must be brought out through dialogue. The researcher chose seven educators who were teaching Science at the research schools and randomly selected seventy learners for individual interviews as he believed that they would be an information-rich sample. Individual interviews were conducted with these educators and learners in the form of semi-structured interviews.

These interviews promoted dialogue with each participant and obtained the participant’s own perceptions of their experiences in multilingual classrooms. The questions were also semi-structured in accordance with McMillan (2000:166) who states that open ended questions can be specific enough in intent to explore the research question while still allowing for individual responses. To this end a list of guide questions related to the research question was compiled. Flexible wording was used as each interview progressed to allow for emergent questions and responses.

The strength of qualitative interviewing according to Glesne (1999:69-74) is that in listening to a participant, one learns about what one cannot see and one obtains explanations of such experiences. Questions were not posed in any specific order and in each interview the participant's response led to further questioning that could not have been anticipated before. Glesne (1999:74) also suggests that a researcher should pilot her questions. This was a very valuable exercise as it allowed for the refining of questions; some were reworded others completely rephrased to gain the understanding of the participant's world that the researcher was aiming for.

After the observation period, individual educators and learners were interviewed in an effort to understand some of the observed behaviour. In qualitative research, the most common form of interview is the person-to-person encounter in which one person elicits information from another. This was the dominant form of data collection that the researcher used in the present study as it has been found to be the mostly used in the social Sciences, providing for efficient collection of data over purposively selected populations, amenable to administration in person.

According to Henning, Van Rensburg and Smit (2004:55) interviews are used if one is looking for information based on emotions, feelings and experiences, information on potentially sensitive issues, and information based on insider experience and privileged insights.

The researcher preferred the oral interview method because it was evident that there was some information that he could not be able to gather through observation. The best way the researcher could get this information was to be through face-to-face interviewing. The intention, through interviewing, was to find out about the participants' emotions, perspectives, attitudes and thoughts regarding English as a language of learning and teaching Science in rural secondary schools. In so doing, the participants were "accounting" for their position and experience in relation to the research question (Henning et al, 2004:55).

Fontana and Frey (1994: 374) emphasize the importance of interviews properly by arguing that "we all think we know how to ask questions and talk to people, from common, everyday folks to highly qualified quantophrenic experts. Yet, to learn about people we must remember to treat them as people, and they will uncover their lives to us. As long as many researchers continue to treat respondents as unimportant, faceless individuals whose only contribution is to fill one more boxed response, the answers we, as researchers, will get will be commensurable with the questions we ask them. The question must be asked person-to-person if we want to be answered fully". The interview questions were guided by the research question and aim of this study.

The nature of the research problem and the aim of my study necessitated the use of the interviews as a data collection method. In order to obtain the learners' own views, it was important to include oral interviews with the learners. Oral interviews as a data gathering method have the advantage of providing wider background to the problem on a person-to-person basis. Such a background helps to put responses in better perspective for data analysis and interpretation.

4.8.1 Types of Interviews

There are several types of interviews ranging from highly structured and focused to open-ended, unstructured conversations. In focused or structured interviews, the interviewer asks questions which are specified beforehand and sticks to them in the given order.Thus "the range of possible answers to each question is known in advance" (Wimmer and Dominick, 1997:139).

On the other hand, in open-ended, semi-structured interviews there are no fixed questions and the interviewer can explore whatever topic in any given order. Semi-structured interviews are conducted with a fairly open framework which allow for focused, conversational, two-way communication. They can be used both to give and receive information. Wimmer and Dominick

(1997:156) define a semi-structured interview as "an informal interview, not structured by a standard list of questions where the interviewer generally has a framework of themes to be explored”. The semi-structured interviews also reveal to what extent the research subjects are in touch with their internal disposition towards a particular topic.

4.8.2 The Type of Interview used in this Study

The interviews undertaken in this study were of a semi-structured nature. They were conducted during the period of April to June 2009. The interviews were used mainly to supplement and illuminate the questionnaire data and to bring out each research subjects’ metacognitive strategies during the teaching of Science. These allowed for a “more flexible approach that could be adapted to the personality and the circumstances of the person being interviewed” (Cohen, et al., 2000). Also, semi-structured interviews were useful in that they facilitated freedom of expression and allowed the interviewer to probe or clear up misunderstandings. For the purposes of this study, the researcher interviewed seven Science educators.

Because the language of learning and teaching is English, the interviews were conducted in English. However, because of limited English proficiency, some research subjects struggled to make their meaning clear but this was not too severe as to make the information incomprehensible. Where educators struggled to make their meaning clear, they were allowed to code-switch from English to mother tongue and vice-versa.

In this study, data was collected through a non-scheduled standardized manner in that the order and phrasing of questions were guided by the research subjects’ responses only to the extent that they did not deviate from what the researcher wanted to know from them. Therefore, questions were flexible and depended on the subjects’ responses. Meaning was explored and the researcher and the participants together co-created meanings through conversations.

Furthermore, because these interviews followed immediately after classroom observations, the researcher was able to make immediate follow-ups on some clarity on statements made previously and the kind of behaviour observed. The amount of time spent on each step as well as on each research subject depended on several factors, including their elaboration on the answers given but on the whole, each interview was expected to take on average twenty (20) minutes. Finally, with the consent of the participants, interviews were lap top recorded and transcribed verbatim so that data was not skewed.

4.8.3 Procedure in Conducting Interviews

The interviews were conducted in the classrooms using an audiotape laptop which was placed in front of the research subjects. For the most part the research subjects ignored the laptop during the interview. In order to provide a non-threatening an environment as possible, and to ensure reliability of data, the researcher explained to the educators that they would be asked questions about five Science related factors; that there are no right or wrong answers and that all he was interested in was knowing what they think. The researcher also encouraged them that if they did not know any particular answer to a particular question they should say so and the researcher would go on to the next question.

In each case, educators were interviewed individually, and each interview was audiotaped. The same core questions were asked in all cases, with opportunity build in to allow both the educator and the interviewer to seek clarification and extension where necessary. By pursuing responses to individual questions and looking for emerging patterns, the researcher obtained a fuller and more detailed picture of strategies adopted by the subjects.

4.8.4 Field Notes and Transcriptions

Brief notes were made throughout the interview. As it was not possible to write down everything, the interviewees' responses were also recorded in the audio laptop as raw data with the permission of the subjects thus ensuring a much fuller record of the sessions. The recorded data was listened to soon thereafter, to consolidate the notes taken. Because the researcher was known to the research subjects, they felt at ease with and trusted one another thus ensuring the researcher of authentic and valid data.

Interview items posed to educators were as follows:

- How does English as a language of teaching influence interaction in your Science classroom?
- What proportion of Sepedi v/s English do you use in teaching Science in your lessons? Under what circumstances do you use (a) Sepedi, (b) English and (c) mixed code in your teaching?

- How do you help your learners to learn scientific/technical terms in English? What methods do you use?
- What methods do you think the learners usually employ in learning and thinking about Science?
- What do you recommend to facilitate your teaching Science through English?

4.9 Validity and Reliability

Validity and reliability are key concepts in any form of enquiry. For a research study to be accurate, its findings must be reliable and valid. The issue of validity and reliability has been addressed differently by different writers. According to Lincoln and Guba (1985:290), the most important question addressing the notion of validity and reliability is "how can an inquirer persuade his or her audience that the research findings of a study are worth paying attention?" If a measure is valid, it is reliable; however, reliability is a necessary but not a sufficient condition for validity. It is important to distinguish between these two concepts and to keep in mind that a measure may be reliable without being valid. Hereunder, the researcher explains how these concepts operate in the context of research methods as explained above and as applied in this study.

4.9.1 Validity

Validity is without question, one of the most important characteristics of a test. Therefore, it is very important that every research instrument that is used in a study be considered for its validity. Validity measures truth, in other words, it measures the extent to which data and findings present an accurate account of the events they claim to be describing (Silverman, 2000). For example, if a test successfully measures skills, strategies and content knowledge that a school programme deems important for a particular group of learners' academic success, it is a valid instrument (Flippo & Schumm, 2000:418).

According to Maxwell (1996:87), "validity is generally acknowledged to be a *key* issue in research design". Validity stands out as an important component in answering questions like: *How will readers know that the conclusions are valid? Why should they believe the results? What if the researcher is wrong?* Therefore, validity is the degree to which a choice of a research method investigates what it is intended to investigate. Validity, in other words refers to the truthfulness and trustworthiness of findings. Validity is a key concept in any form of enquiry (Ralenala, 2003:157). According to Lincoln and Guba (1985:231), the most important question addressing the notion of validity is "how can an inquirer persuade his or her audience that the research findings of a study are worth paying attention to?".

In conventional usage, the term validity refers to the extent to which the instrument measures what it is supposed to measure (Leedy & Ormrod, 2005:28). In order to reach informed conclusions from the collected data, the researcher will strive throughout to ensure internal and external validity. Thus validity measures the truth, viz. the extent to which data and findings present an accurate account of the events they claim to be describing (Silverman, 2000:75).

Validity, furthermore, is concerned with whether the researcher is actually observing and measuring what he thinks he is observing and measuring and one way to assess how valid an instrument is, is by comparing its results with other sources of data (De Vos, 2002:132; Du Plooy, 2002:124).

Ralenala (2003:157) asserts that "individuals must be interviewed in sufficient detail for the results to be taken as true, correct, complete and believable" in order to establish validity.

Considering the above, the researcher did not entirely depend only on the available literature in the University library about his study, but in addition he went to the people and gathered information about the phenomenon from its natural setting, after he had designed appropriate research questions for his study. This helped him to get first hand information concerning the prevailing situation in relation to his study. In addition, the researcher increased the validity of the findings gathered through oral interviews by cross-checking it with the participant observation as described above.

Validity, in this study, was catered for by the use of multiple methods of data collection, namely the use of the quantitative and qualitative approaches and a comprehensive document analysis to back the study's thesis.

The researcher also relied on constant peer review of data collection methods, analysis and findings. The review yielded helpful feedback that shaped the study even further. Hereunder follows a discussion on Internal Validity and External validity.

4.9.1.1 Internal Validity

The internal validity of a research study is the extent to which its design and the data it yields allow the researcher to draw accurate conclusions about cause-effect and other relationships within the data (Leedy and Ormrod, 2005:97). A research study has internal validity if the outcome is a function of the variables that are measured, controlled or manipulated in the study. It is the approximate truth about inferences regarding causal relationships. What this means is that the researcher must have evidence that what he did in the study has caused what he observed (outcome) to happen. It does not tell him whether what he observed was what he wanted to observe.

Since in this study the researcher observed the research subjects "in situ", and allowed them to give answers to questions asked according to a particular research instrument, this study surely satisfied the requirements for internal validity. Further, internal validity was addressed by eliminating possible other explanations for the results, through conclusive stipulation of the aims and by using triangulation (where multiple sources of data was collected to investigate English as a language of learning and teaching Science in rural secondary school contexts (Leedy & Ormrod, 2005:28).

4.9.1.2 External Validity

The external validity of a research study is the extent to which its results apply to situations beyond the study itself - in other words, the extent to which the conclusions drawn can be *generalized* to other contexts (Leedy and Ormrod, 2005:99). A research study or experiment has external validity if the results obtained would apply to other similar programmes or approaches (Richards, 2001:12). In Chapter 1, the researcher indicated that although this study was restricted in terms of scope and stakeholder beneficiaries, he was convinced that the results emanating from it can be generalized to other similar groups, settings or situations. This research study therefore would undoubtedly satisfy external validity.

4.9.2 Reliability

Reliability refers to whether the research instruments are consistent (Silverman, 2000: 188). A central question in order to secure the reliability of a study is hence to ask whether a research instrument would measure the same when used in other occasions. Reliability is therefore the degree to which research findings reflect consistency when repeated on several occasions in the same social setting. It is the consistency with which a measuring instrument yields a certain result when the entity measured hasn't changed. The aim thereof is to minimize errors and biases (Bryman, 2004:97; Leedy & Ormrod, 2005:29).

The generally accepted definition of reliability is an investigation whose results are stable, accurate, predictable and consistent (Vacca & Vacca, 1999:126). In determining the reliability of a research instrument, the researcher must ask the question: "Can similar test results be achieved under different conditions?" (Flippo & Shumm, 2000:417). For example, if learners were to take a test on a Monday, and then take an equivalent form of the same test a few days later (assuming that no learning would take place between test administration and that the learners would remember nothing about the test at the next administration), would their scores be about the same? If so the test may indeed be reliable.

If a test is highly reliable, one can assume that test scores are probably an accurate measure of learners' performance and not a fluke. Reliability therefore raises questions about predictability, dependability, stability, and accuracy. However, if a test produces different results for the same group of people each time it is used, then the questionnaire lacks reliability; is not accurate and one cannot depend on it (Fontana and Frey, 1994:65).

Lincoln and Guba (1985:154) follow through with the advice that in order to demonstrate the trustworthiness of data collected, one must realize the limitations of one's study. That is why it is important for the researcher to be constantly alert about his own bias and subjectivity. For this reason, the researcher was continuously alert of his own biases and subjectivity to ascertain more trustworthy interpretations. To further cement the reliability of this study, the researcher approached this investigation from combined methodologies through a process called "triangulation" which is described hereunder.

4.10 Triangulation

A combination of research methods increases the validity of findings, as the strength of one method compensates for the weakness of another method. This is called triangulation. It is important to triangulate research methods in research because all methods have strengths and weaknesses. The most important use of this method is that it checks out the validity of findings generated by different approaches, sources, time periods and theoretical schemes involved (Blaikie, 2003:112; Denzin and Lincoln, 2000:145; McMillan & Schumacher, 1993: 23). It also helps the researcher to reduce possibilities for errors that may result from using one technique and to increase the strength of findings in a study (Bryman, 2004:132).

Therefore, for the purpose of this study the researcher used multiple techniques of data collection which included semi-structured interviews (educators and learners), questionnaires (educators and learners), supported by participant observation as an additional technique. The multiple techniques of data collection helped the researcher to cross-check the trustworthiness in the findings gathered through the different sources of information employed in the study. The main aim in employing the triangulation method was to reduce the weakness of the different sources and to emphasise the strength of each technique used in the study, which consequently increased reliability and validity of the findings.

4.11 Ethical Considerations

Ethics plays a major role in judging qualitative research because qualitative researchers spend a great deal of time with participants and should treat them with dignity (Silverman, 1993:27). According to Bryman (2004:140) ethics increase credibility of a study. Because the objects of inquiry in interviewing are human beings, extreme care must be taken to avoid any harm to them. Traditional ethical concerns have revolved around the topics of *informed consent* (consent received from the subject after he or she has been carefully and truthfully informed about the research), *right to privacy* (protecting the identity of the subject) and *protection from harm* (physical, emotional, or any other kind) (Fontana and Frey, 1994:372).

Before the process of data gathering commenced, the researcher communicated first with the Circuit Inspector of Vlakfontein Circuit. A letter was written to him to ask for permission to conduct interviews with the Grade 8 Natural Science educators and their learners.

During fieldwork, the purpose of the research as well as the data collecting procedures were explained to Grade 8 Science educators who were the main participants in this study. The researcher explained the need for a tape recorder and gave the educators the option to accept or refuse its use in the investigation. In this study the following ethical issues were observed:

4.11.1 Informed Consent and Permission

To satisfy the above, the researcher sought a letter of introduction from the Department of Didactics from the University of South Africa to be presented to the concerned officials and authorities in the Circuit from which the research data would be gleaned i.e. at the site where the researcher spent a considerable amount of time doing field work. This was done because it was considered ethical to introduce one to the Government officials, who then gave the researcher permission to undertake the research.

When the researcher deemed it suitable to start with field work, he made appointments with the participants on the time and venues of their own choice and convenience. On the onset of the study, the researcher explained to the participants the purpose of his visit and study and then, full consent to conduct the study was obtained in all cases. Informants need to be given informed consent to participate in the study (Kvale, 2006:96). Most of the study was carried out in the participants' places of operation. The researcher worked closely with the Circuit Inspector at the Vlakfontein Circuit to make appointments with the principals of schools, who introduced the researcher to the educators who would enable the researcher to access the learners.

First of all the researcher went to the Vlakfontein Circuit Office where he approached the Circuit Manager. After being welcomed, the researcher presented his introductory letter, from the University of South Africa, to him. The researcher then explained to him the purpose of his research. The Circuit Manager willingly allowed the researcher to carry out his field work in any schools of his preference depending on the research design.

The researcher was ready to exercise patience in as far as the conditions he might find at the research site because "creating a good impression requires a flexible approach to first meeting and the willingness to adjust according to the needs of others. In order to create a good first impression, however, we may have to practise patience and discretion" (Scheyvens and Storey, 2003: 102).

4.11.2 Respect for the Insider's Perspective

In this study, the researcher made face-to-face contact with the research subjects. He informed the research subjects that he would be conducting research about the use of English as a language of learning and teaching Science. He also made it very clear that such knowledge was in the past obtained mainly from literature that did not have enough background knowledge about the situation in rural schools and that as a result of this; a gap exists because accounts of local educators and learners were not included. This study would therefore give them the opportunity to give their inputs as they had first hand experience.

4.11.3 Anonymity and Confidentiality

The researcher believes that protecting the school and the participants' anonymity was paramount and also assured the research subjects of privacy and confidentiality with information revealed. This approach reduced anonymity of the study, but it surely increased the ecological validity to the study as claimed by Scheyvens and Storey (2003: 134) that “In order to ensure high ecological validity it is necessary that as many characteristics as possible about the school in question are given. This means the number, training, age, gender composition of the teaching staff, the number of students, subject combinations, grades, resources at the disposal of the school, and so on”.

Bryman (2004:120) explains that the more characteristics are given, the easier it becomes to identify the research sites and the more difficult it is to secure the anonymity as required by some institutions. In the present study the researcher avoided this threat by giving a few characteristics to the schools and the participants, which reduced the possibility of their identification. This increased ecological validity to the findings.

The next days the researcher embarked on the oral interviews. The researcher assured all participants of the confidentiality in the whole exercise. To strengthen the researcher’s adherence to confidentiality, still with the participants’ consent the researcher asked that he be provided with a special room where he could conduct his interviews without interference. The rationale for making such a request is based on Scheyvens and Storey (2003: 146) assertion that “confidentiality recognizes that a researcher may be entrusted with private information. For example, field notes, tapes, or transcripts should be stored in a safe place and information contained in them be used only for the purposes of the research. A researcher should also be prepared to destroy information provided by someone if he/she requests that it be withdrawn”.

Having a special room for his study helped the researcher to keep information more private and to maintain confidentiality of records. The researcher discussed with every participant and strove to agree with them that all written information would not to be exposed to any other participant, but would only be used for the purpose of his research. The participants liked the idea and they felt relaxed to reveal information.

The researcher is of the opinion that this increased the ecological validity to his findings, because participants did not influence one another in the information they revealed to the researcher. All institutions, including schools, are characterized by a hierarchy of credibility.

However, they rarely work as intended because they employ people with different interests. This means that if a research report contradicts the interests of the leadership of the institution, then it will be inevitably threatening. Hence the need for the researcher to maintain confidentiality and to protect the anonymity of the institution involved in the study. This would consequently lead to high ecological validity (Scheyvens and Storey, 2003: 134).

In the process of the study, the researcher used verbatim recording of all the data from the participants. After collecting data from the learners and educators who were the main informants, the researcher sought consent from the educators to observe their lessons and this was done at their convenient time.

4.11.4 Objectivity

Since the researcher is a practicing educator of ESL and Natural Science at a rural school in the Capricorn District of the Limpopo Province, he has certain ideas about the challenges facing learners (the research subjects). The researcher's knowledge of the research subjects and the setting yielded an important consideration of trustworthiness. This he did not deny or attempt to hide. However ideas and opinions which were presented by the research subjects were taken seriously even if such ideas could contradict the researcher's. Therefore conscious efforts were made to ensure that the investigation remained as objective as possible (McNiff, et al., 2003:50).

4.11.5 Post Research Relationships

At the end of the fieldwork, the researcher informed the inspector (who in turn informed principals of the research schools) that a research report would be made available at the Circuit Office for easy reference and perusal. It is important to indicate that the researcher promised to give feedback about his findings and a copy of his thesis on his return to the circuit. Giving feedback to participants was deemed by the researcher to be a good idea because it would serve to prove if their consent, confidentiality and anonymity would be respected and maintained. This was done in order to heed a piece of advice given many years ago by Miles and Huberman (1994: 293) who stated that "Our deceptiveness and broken promises, especially if benefits and costs have been inequitable or harm has occurred, will make any continuation of inquiry problematic. We will have wronged not only our respondents but also our colleagues".

4.11.6 Plagiarism

Plagiarism is the adoption or reproduction of the ideas or words or statements of another person without due acknowledgment. This can range from borrowing without attribution a particularly apt phrase, to paraphrasing someone else's original idea without citation, to wholesale contract cheating. When plagiarizing, students will often turn to the Internet, due the ease of copying and pasting from websites (Jones, 1987:13). To offset plagiarism, the researcher reported his findings in a complete and honest fashion, without misrepresenting what he has done or intentionally misleading readers about the nature of his findings. The researcher did not fabricate data to support conclusions. The researcher further ensured that full acknowledgement of sources used was made because he (the researcher) was aware that to appropriate the thoughts, ideas, or words of another without acknowledgement is unethical and highly circumspect (Leedy and Ormrod, 2005:102).

4.12 Document Analysis

Document analysis was another research technique that was used to collect data for qualitative research (Bryman, 2004:64; Silverman, 2005:44). The researcher used document analysis as an additional method as it was necessary to look at some of the policy documents which explain the language policy being followed in the secondary schools of South Africa (see Appendix 2).

Documents like the Language in Education Policy (LiEP) and learners' mark schedules were perused because documents can influence the direction taken in interviews and suggest what should be observed in the setting. This is also because in qualitative research documents are analyzed in order to produce reliable evidence about the phenomenon under investigation (Silverman, 2005:123). (see Appendix 1 for the Language in Education Policy and Appendix 12 for the Grade 8 Mark Schedule).

The documents gave the researcher an insight into the problem and supplemented the information which was gathered through oral interviews and classroom observations. The documents provided the "official" view point which helped the researcher to contextualize the individual voices.

4.13 Data Analysis

Data analysis is the sifting, organising, summarising and synthesizing of the data so as to arrive at the results and conclusions of the research (Seliger and Shohamy, 2003:19; Owino, 2002:84).

4.13.1 Qualitative Data Analysis

Qualitative data was analyzed using interpretational analysis, which is "a process of close examination of data in order to find constructs, themes and patterns" (Winegardener, 2001:5) that address the researcher's research goal. Miles & Huberman (1994:21) and Patton (1990:372) have written about reducing the volume of information, identifying significant patterns and constructing a framework for communicating the essence of what the data reveals. The researcher further analyzed the data using concrete flows of activities: data reduction, data display and conclusion drawing/verification as suggested by Miles & Huberman (1994:21). This involved the gleaning and reducing of information in the process of finding out how the results of the analysis could be cross-checked and validated.

According to Ary, et al. (2002:465) "qualitative data analysis is a process whereby the researcher systematically searches and arranges the data in order to increase an understanding of the data, and later presents what was learned to others". Further, Gibbs (2002:75) defines Qualitative Data Analysis (QDA) as the range of processes and procedures whereby we move from the qualitative data that have been collected into some form of explanation, understanding or interpretation of the people and situations we are investigating. To them, QDA is usually based on an interpretative philosophy. The idea is to examine the meaningful and symbolic content of qualitative data.

In the context of this study, it is useful to tender the following principles on the conceptual framework of the analysis, that is, the thinking that informs this approach. These will also help in casting light on the processes this study followed in collecting and analyzing data. These principles are:

- Categories, which emerged during data analysis, were not predetermined nor preconceived before the analysis could unfold. This is called inductive analysis; a process that implies that categories and patterns emerge from the data rather than being imposed on the data prior to data collection (Holliday, 2002:51).
- The data analysis in this study followed cyclical phases, namely, discovery analysis in the field, identification of topics that became categories and synthesis of patterns among categories (Holliday, 2002:51).
- Furthermore, data management in this study was done manually and with computer assistance. The latter system was used to retrieve data sets and to assemble coded data in one place (Creswell, 2003:145; Rhodes University Qualitative Research Workshop Manual, 2003).

It is worth mentioning that the data was interpreted using an empiricist interpretive approach. In terms of the repertoire, qualitative data was interpreted within the frameworks of the research design and conclusions were drawn from the research findings (Silverman, 2000:180; Wolcott, 2004:120).

4.13.2 Quantitative Data Analysis

Data analysis for the quantitative data sets was done by means of the Statistical Programme for the Social Sciences (SPSS) as follows:

- The chi-square significance test was performed for the categorical data set. This applied to the areas where responses were summarised using contingency tables. The test was performed in order to ascertain with some pre-determined degree of precision (significance level) if row and column variables have a significant influence on each other.
- For the data sets for which proportions were calculated, the test for the differences of proportions was performed. Where two proportions of similar variables were available, a significance test for the difference between proportions of two independent variables was performed. A predetermined precision level (significance level) was used in drawing conclusions for this kind of data set.

- Some data sets were summarised in the form of percentages to display the frequency of occurrence while other data sets were summarized graphically using bar and pie charts.

Each analytical method used, was followed by an interpretation of the findings in relation to the purpose and hypothesis of the study.

It is within the frameworks discussed above that the data analysis of the two sets of data (quantitative and qualitative) should be understood.

4.14 Conclusion

The aim of this chapter was to describe the research design to be used in this study by giving a detailed description of and justification of the selection as well as use of the various data collection methods. These included the selection and locating of subjects, and the data gathering by means of observation, interviews and questionnaires. The researcher also highlighted on the choice of the both approaches and explained why he opted to use the said approaches.

The researcher also highlighted differences between qualitative and quantitative approaches and explained why he opted to use both approaches instead of just one.

In the following chapter, namely, Chapter 5, the researcher will report on the findings obtained from each of the research instruments used during the constant comparative method. From these findings, a profile of the challenges emanating from the use of English as a language of learning and teaching Science will be created so that conclusions can be drawn from such findings and recommendations made.

CHAPTER 5

THE REPORT OF THE RESEARCH RESULTS

5.1 Introduction

Chapter 5 is a report of the research findings of the fieldwork conducted in the Grade 8 classes of the research schools. The fieldwork was undertaken to realise the aim of the study, namely; to investigate how English, as a language of learning and teaching (LoLT) influences the successful learning of Science. The classroom observation was conducted in all the seven secondary schools and the interviews with seventy learners and seven Science educators were also conducted. In order to validate the findings of the study, a triangulation was effected by administering a questionnaire to both the seven Natural Science educators and the seventy learners of the sampled schools.

Since this study used both the qualitative and the quantitative approaches, the tabling of research findings will be preceded by a brief narrative of the research area and of the schools in the research area as these bear significance to the outcome of the study. This is in keeping with what Robson (2002: 450) advocates when he asserts that “as ever, your research questions drive the form of analysis which you choose”.

The results of the classroom observations will be analysed first, followed by the analysis of the educators’ and learners’ interviews and finally, the questionnaire responses of the educators and learners will be analysed.

5.2 Background of the Research Area

Schools do not function in isolation. They are one of the social structures found within communities and are therefore influenced by the communities they serve. It is therefore important to take cognisance of the context within which education takes place before embarking on any research.

The research area, Vlakfontein circuit, is a circuit that falls within the Capricorn District of the Limpopo Province, under Aganang Municipality. The Vlakfontein circuit is made up of thirteen villages which are predominantly rural. The majority of learners in these areas live in small homes without running water or sanitation. Most homes are overcrowded.

5.3 Background of the Situation in the Schools

The present situation in the research schools "is shaped by the historical and political events and is directed by what takes place in the community" (Lenyai, 2006:135).

All the seven research schools were characterised by an acute shortage of resources. The researcher would maintain that the situation did not come as a surprise because according to the School Register of Needs Survey (Department of Education, 2000:47) the situation of schools in the research area is thus: 36% of schools have telecommunication facilities, 63% of schools have water, only 51% have electricity, at least 8,9% schools have no toilets, 90% of schools are without computers for teaching and learning, 49,4% of school buildings are in need of repair and acute shortage of classroom exists. City Press (2007:4) contends that some schools in the research area remain in a bad state and "pupils make use of unhygienic pit latrines, there is no library, no computer centres and there is a shortage of mathematics and Science teachers". Clearly, this situation has negative influence on the effectiveness of the schools.

Of the seven research schools, only one school had a telephone and three had staffrooms. Only one school out of the seven research schools had a photocopier. Thus, in the other six schools educators still used chalk and writing boards even for tests and examinations. This kind of a situation made it very cumbersome to teach English and Science because educators could not readily issue handouts for the learners. Only two of the seven research schools had a full compliment of computers i.e. they had computer centres while the others didn't even have one computer. The lack of computer facilities impacted negatively on the teaching of Science because educators found it difficult to organize their teaching materials and feedback was also affected as they relied on manual means to mark learners' work and compile mark schedules.

5.4 Findings of the Classroom Observations

5.4.1 The Classroom Environment

School Buildings in General: The general condition of all the research schools was not conducive to teaching and learning. The buildings were dilapidated. These had a negative impact on the learning climate at the schools. The learning climate is hereby defined as the ethos of expectations and perceptions of educators, learners, parents about self, learner achievement, organizational rules and policies and the facilities themselves.

The observations cited above had amply confirmed the fact that the conditions in the research schools do reduce the effectiveness of the educators and subsequently have a negative influence upon the ability of the learners to learn, especially a sophisticated subject like Science. They corroborate the views advocated by Macworth (2001:150); McConnell and Yaglou (2000:76); and Osborne (2005:133).

Number of Learners in Class: Some classrooms in the research schools were overcrowded and there was virtually no space for the educator to move around the learners' desks. This affected the arrangement of the classrooms as per the Revised National Curriculum Statement for Grade R-9. The situation was exacerbated by the fact that the classroom climate by itself demanded of the learner to develop a deep sense of self-confidence, a characteristic which proved difficult to develop because learners were treated as numbers. The researcher observed that overcrowding resulted in a high rate of absenteeism among educators and learners. On the other hand educators also reported that overcrowding resulted in stressful and unpleasant working conditions. This confirmed what research (HSRC, 2002:56; Lewin, 2000:29; *Sunday World*, 13 April 2003) had revealed; that overcrowding causes a variety of problems such as learners not scoring as high on achievement tests as they normally would (see Chapter 1, paragraph 1.2).

Resources for Learners: The availability and retention of learning support materials is a vital ingredient in keeping learning up and yet all the research schools are characterized by a severe shortage of resources. Learning materials such as textbooks and pens were in short supply. The research schools ran short of basic educational amenities like tables, chairs and other learner resource materials. Even though Ralenala (2003:128) asserts that in an interview with the Director General of the National Department of Education in the year 2002 "it became clear that the reason for this severe shortage is not so much that the Department of Education is not supplying the necessary learning support materials but that learners abuse them, lose them, and fail to return them at the end of the academic year", the researcher would posit that from his observation, the supply had never been enough. Thus, the above assertion, notwithstanding, the researcher would still maintain that the non-availability of resources is a serious issue and could result in a topic being avoided; it could determine how a topic is taught and also determine the actual activities the learners engage in (Goodrum et al, 2001:7).

It is noteworthy that concerning the use of Learning and Teaching Support Material (LTSM) the researcher observed that most of the educators consulted their textbooks on a regular basis during lessons. Although these educators did not read all the text from the textbooks, it seemed that they did not have the confidence to desert the textbook at all. Most of the educators did not use any other learning support material. It was also evident to the researcher that textbooks were limited in supply in most of the ESL classes. The learners had to share textbooks – in some cases up to four learners shared one textbook. The only books that all the learners had in their possession were writing books for classwork and tests.

If one takes seriously the observation that in the research area, the availability of textbooks is associated with learner performance and pass rate, then lack of learning materials in schools clearly points to them not performing well in their studies. It is disheartening to note that most rural schools are plagued by extreme poverty and are therefore unlikely to have extra funds for buildings and resources (Jennings & Everett, 2000:83). The textbook that was available in most classrooms observed is called *Spot on Natural Sciences* by Maureen Vermaak and Belinda Soopramoney, published by Heinemann in 2006. Most of the educators felt it was one of the best textbooks for learners to use in their learning of Science.

Further, the researcher observed that in all the research schools, there were no laboratory facilities. Everything was learnt theoretically. When one considers that in order for learners to learn Science with understanding it is essential that they should get the necessary experience and exposure by working and functioning in the laboratory with equipment and materials as scientists would in real life, one cannot help but sympathize with the research subjects of this study. Thus, the research subjects lacked the necessary laboratory experiences which promote central Science education goals including: understanding of scientific concepts, the development of scientific practical skills and problem-solving abilities, and interest and motivation. As a result, the research subjects would be limited in their intellectual development as well as the development of observational and manipulative skills.

Finally, all the research schools had no libraries. What was observed was that in all but one, a classroom which had been converted as a storeroom also contained piles and piles of books. This (shortage of libraries) inevitably put educators in an unenviable position where they faced a near-impossible task of creating and promoting a reading culture among their learners without the very basic facility (i.e. a library). Quite understandably the use of English as a language of learning and teaching in such an environment cannot but be poor. One can always conclude that the learning of a complex subject like Science, with its specialised vocabulary, will suffer if a basic resource like a library is missing. The situation was made worse by the finding that learners who attended at the research schools came from homes that were similarly disadvantaged.

5.4.2 Classroom Interactions

The Educators Dominate Classroom Interactions: The mode of communication was generally one-way, from educators to learners. This style of communication could be taken as a reflection of the educators' preferred general teaching approach, apparently influenced by their conceptions of the nature of and teaching of Natural Science. This manner of control of the lessons was considered a style of classroom management in the face of the amount of content in the Science curricula that educators had to cover in a given time. Within these constraints on educators of Science, the educator-learner interactions in the (secondary school Science) classrooms in this research were reflections of understandable modes of classroom interaction that might be prevalent in similar classrooms across the country.

In all of the lessons observed, the educators did most of the talking and the learners in most instances, talked only when they were expected to respond to educators' questions. Examples of the participant educators' approaches to generally control the talk during the lessons included: *(a) selecting who to talk among those whose hands would be raised up to answer a question; (b) learners not being expected to verbalize any concerns but to instead raise up the left hand for the educator to know when there is a difficulty; (c) educators refusing to give answers to questions asked; (d) educators rushing through the lessons, hence giving no time for any questions; and (e) educators deciding who to ask a question irrespective of whether a learner had his/her hand raised up.* This was in addition to educators deliberately ignoring to explain meanings of certain words in the context as used during the lessons observed.

The above observation is very much in line with the 'input theory' (Mitchell & Myles, 1998: 126) where comprehensible input is enough for learning to take place (see Chapter 2,). However, these methods work against the constructivist 'output theory' (Hinkel, 2005: 471-480) on second language learning and learning in general because there was no room for the learner to reflect and actively create their own knowledge by reflecting and testing.

Tsui (1996:152) has this comment about teacher talk that dominates classroom communication:
"The teachers have the misconception that an effective teacher should be able to solicit immediate responses and that responsible teachers should be talking all the time…. When there is more teacher talk, there will be less student participation, resulting in long silences in the classroom that prompt the teacher to talk more".

The Educators' Pace: The pace at which educators delivered their lessons was too fast for most of the learners, thus affecting interaction in Science classes. For example, at one time one learner raised his hand with the intention of slowing the educator's pace by asking a question. This was met with an impatient look from the educator. Even without knowing what the question was going to be, the educator said something like *"the answer is in your textbook if* *only you could read more carefully".* To some learners, *"the answer is in your textbook…"* may be another way of saying *"Don't bother me"* or *"I really do not have the time to assist you".* Of course this may not be true at all. However, from an instructional point of view, that rare moment is lost whenever educators routinely tell learners to look up information in the textbook. Such remarks, as one can imagine, are not helpful.

Almost immediately after entering the classroom, the educators would occasionally say something like *"by the way do you have any questions?"* followed seconds later by *"ok, so let's continue"* without giving learners any time whatsoever to formulate their questions. One could see from the casual manner in which they asked this question that it was meant to be a rhetorical question. As soon as the lesson started in complete earnest, the educators would move swiftly from one section of the text to another, from their files to their personal notes to the textbook in a matter of seconds without due consideration to whether or not learners understood.

Code-Switching: This was a mode of interaction which characterised classroom discourse**.** The researcher observed that code-switching was rampant and an already established practice among the learners in the research schools. The form of code-switching in most classrooms was as follows: *in the public domain, learners used their languages predominantly and they switched to English when they got to their classes.* In many classrooms, this spoken English was limited to short phrases, single words or recall of procedures.

Furthermore, the researcher observed that learners had more discussions with each other in their groups or in pairs in their main language, or in their main language and English, creating more possibilities of learning talk in many classrooms. However, group work as it occurred across many of the classrooms and the accompanying harnessing of learners' main languages as a learning resource and thinking too resulted in some unintended consequences. Considering Krashen's Theory of Input Hypothesis (i+1) dealt with in chapter 2, the more learners interact with Sepedi, the better they understand the lessons, but at the same time the more they lose in getting authentic English input. Thus a majority of them end up with very limited academic proficiency in English.

The researcher would posit that in each of the Science classes observed, learners engaged with each other in their main languages while working on an experiment in Science (e.g. exploring magnetic substances). However, the movement from this exploratory talk was directly related to exposition by the educator, typically in English, or to written worksheets in English. The data that the researcher has, however, does not enable him to make firm claims about consequences for learners of this abbreviated journey. However, it is likely that the *meanings* of the formal concepts and/or symbols they came to write down were not sufficiently elaborated either through more explicit moves from informal talk to discourse-specific talk, or from spoken to written Science language.

***Assessment and reinforcement of performed tasks*:** Tasks given to the learners were limited to copying questions and writing answers either from the textbooks or the chalkboard. Group discussion and even frequent questioning by the learners rarely took place. Learners mostly completed the written work individually, either from the textbook or the chalkboard. In some instances, the time allowed for learners to execute given tasks was limited. Most of the educators seemed inclined to treat as much content as possible in a given time frame as to ensure that all the content was covered.

A concern for the researcher was that little time was allocated for corrections to be made on performed tasks. This might have a huge impact on the assessment scores that these ESL learners would obtain in continuous and summative assessment. Most of the time homework involved only writing tasks. Creative thinking was not stimulated by most of the educators, as many of the tasks asked only of learners to copy the work directly from the textbooks. In many instances homework succeeded incomplete corrected and sometimes uncorrected written class-work (tasks). Learners were also not given homework regularly after each task. It is the view of the researcher that the tasks that were not properly corrected may result in a lack of proper knowledge to build on. Working from the known to the unknown becomes impossible, as content that is assumed to be known, is not. Learners may experience problems in attempting any new tasks.

Assessment was mostly done towards the end of the lessons. Learners were asked to read questions from the chalkboard or their class-work books and had to respond verbally. Learners who appeared to know the answers indicated it as such by raising their hands. Most of the learners who responded to the questions had difficulty in expressing themselves in English. The construction of proper sentences seemed to be the major problem. It also happened that some learners raised their hands only to keep quiet when they were asked to answer. Activities such as dialogues, debates, and discussion were very rarely observed. These are the type of activities that can actively involve the learners and should form part of the OBE approach to teaching and learning in the ESL Science classroom.

When one considers that of late educators are reported to be resorting to the controversial practice of "pass one, pass all" in their classrooms, the future of our ESL learners cannot help but be bleak. The *Mail & Guardian* newspaper ran an article on the 20th February 2009 entitled *"Pass One, Pass All Makes Comeback"* in which it was reported that primary school educators were resorting to the controversial practice of "pass one, pass all" in their classrooms because the paperwork they must complete and the procedures they must follow to fail learners were so time-consuming. Even if an educator recommended that a learner repeat a year, parents could lodge an appeal, which could be overturned by the principal or the district education office. The result was that educators didn't want to put forward the names of learners who had to repeat. This was based on a policy that no learner should stay at the same primary school phase-foundation, intermediate or senior-for longer than four years. The aim was to ensure that learners finish their compulsory schooling at the end of grade nine by the age of 17 or 18 (Mail & Guardian, 2009:12).

The researcher therefore maintains that, if secondary schools keep receiving these 'severely underprepared' learners, they (learners) will pull very hard indeed. The educators themselves admitted that the burden of paperwork and the age policy encouraged them to try to beat the system. In the end (educators concede) "it works against the learners themselves, because they struggle as they progress to higher grades" (Mail & Guardian, 2009: 12).

The following section deals with the report about the interviews conducted.

5.5 The Outcome of Interviews

Table: 5.1 Educators' Responses to Interview Questions

QUESTIONS	RESPONSES	
	YES	NO
Question 1: How does English as a language of teaching influence interaction in your Science classroom?	7	0
Question 2: What proportion of Sepedi v/s English do you use in teaching Science in your lessons? Under what circumstances do you use (a) Sepedi, (b) English and (c) mixed code in your teaching?	7	0
Question 3: How do you help your learners to learn scientific/technical terms in English? What methods do you use?	7	0
Question 4: What methods do you think the learners usually employ in learning and thinking about Science?	Language Across the Curriculum Model (LAC)	Traditional Skills Model
	2	5
Question 5: What do you recommend to facilitate your teaching of Science through English?	Assistance from Department of Education	Provision of Learning Resources
	5	2

5.5.1 Educators' Interview

The questions that were listed in chapter 4 formed the major categories for data analysis.

Question 1: How does English as a language of teaching influence interaction in your Science classroom?

In response to this question, all the seven (7) educators affirmed that English as a LoLT was influencing interaction in their classrooms. They indicated that their lack of ESL specialist knowledge was their major undoing. They maintained that learners did not participate in the class lessons because they did not comprehend what was being taught effectively and attributed this problem to the language of learning and teaching used (English) being a barrier to learning. This view confirms findings that education and restoration of the African children, of which South Africans are inclusive, is handicapped through ambiguous language policies which emphasize colonial languages as media of instruction (Brock-Utne, 2000).

There was a unanimous position held by the Science educators interviewed that assisting linguistically deficient learners in Science education was an enormous task. The situation, as it obtained in rural secondary schools in particular was very frightening. It is very clear that in the majority of schools (if not all), ESL specialist education was inadequate. Consequently, for most of the learners, mainstream classes were the only place where the development of academic language was being addressed.

Educators' beliefs and attitudes also surfaced many times during the interviews and proved to be very influential. A number of educators held the notion that Science subjects were too difficult for learners with language difficulties and that failure was inevitable. One could not help but ascribe the high failure rate of a majority of rural secondary school learners, to the said attitude. This corroborated Rennie's (2003:88) view that the educator's approach to learning also affects the frequency of learner interaction. The interviews revealed that mainstream classrooms could be harsh places for ESL learners. It is the researcher' s opinion that the situation could have been a lot better if the educators heeded Levine's (2001:35) simple advice of being hospitable to ESL learners.

Furthermore, all of the educators in the study supported Lee and Luykx's (2003:22) proposal that they felt inadequately prepared to meet their ESL learners' learning needs particularly in academically demanding subjects such as Science. The interviews confirmed Gutierrez's (2002:157) view that secondary school educators' main loyalty was to their subject area, with the learners' needs a secondary concern. One of the strongest pieces of evidence produced in the study supported Bryan and Atwater's (2002:821) finding that educators' beliefs had a profound influence on learners' success.

Lack of training in the use of English as a language of learning Science also surfaced as a reason for not being able to use English to teach Science. From the interviews conducted, the researcher got the impression that there was a dire need to have English educators retrained in the use of English as a facilitating tool to impart knowledge in the classrooms.

The educators' gripe about their inadequate training in the use of English as a LoLT corroborates what the City Press (27th May 2007) referred to in an article entitled "*New Curriculum is Failing the Test*". According to the article, the education department wanted to evaluate how the National Curriculum Statement (NCS) was being implemented in the foundation phase of schooling especially in the teaching of Science. City Press reported that the findings revealed that 85% of educators in the foundation phase of schools in South Africa were not trained well enough in the new curriculum and were finding it difficult to use its teaching methods in their classes.

The report further intimated that the new curriculum was to ensure that once learners "leave the foundation phase, they are expected to be equipped with above average reading, writing and counting skills. This includes knowing how to tell the time, how to count, read and write in a second language (City Press, 2007:1). The report is perceived to be damning because revelations that "educators underwent about two to four weeks of training to prepare for the curriculum, while principals were not trained at all" do not do our country's education system any good at all.

The "Daily Sun" newspaper of the 28th May 2007 was even more scathing in its article about the above cited report. Its article was entitled "*SA Pupils can't Read Because Teachers Lack Proper Training*". The paper aptly put it: "Our kids can't read, write or count well enough! And it is all because teachers are not trained properly". According to the "Daily Sun", research has revealed that many educators don't have a clue.

The researcher is of the opinion that if educators were not adequately trained as the above cited articles attest; learners would continue to struggle in the learning of complex subjects like

Science. It's worth mentioning at this point that the new curriculum statement was designed to ensure a broad, high level education for all. It was meant to revolutionise teaching and learning by centering the educator's focus on the holistic development of the learner. It was also meant to help capacitate educators with skills to enable them to provide support to learners experiencing barriers to learning. Such curriculum requirements would inevitably require intense training on the part of the educators. That is why, of late, even teacher formations like the South African Democratic Teachers' Union (SADTU) have entered the fray and are begging the Department of Education to give educators proper training. Unfortunately, according to Sadtu former general secretary, Thulas Nxezi, their "pleas for proper training of teachers fall on deaf ears". According to Nxesi, schools don't even have facilities such as laboratories (to use in Science experiments) and libraries where learners can go and read books. 'So how will they get quality education', lamented Nxesi (Daily Sun, 2007:4).

"The Star" (28 September 2007) newspaper ran an article entitled '*OBE Still Best Despite Training Lapse*" in which the former education minister Kader Asmal was said to have admitted (while addressing a conference of the South African Society of History Teachers at the University of KwaZulu Natal) that the OBE training of educators had not been extensive enough. The article intimated that Outcomes Based Education "was rushed into South African Schools, and teachers were inadequately prepared to cope with the curriculum changes".

Rob Sieborger, Deputy Director of the School of Education at the University of Cape Town, who was involved in the work of the committee appointed to draw up the new curriculum, puts the whole blame on the many changes which suddenly swarmed the education system after the advent of democracy. He is quoted in the abovementioned article as having asserted that *"OBE was just one of quite a number of policies and administrative decisions which influenced schools and teachers. Teachers were punch-drunk with the changes".* He went on to remark that *"if OBE had been the only change, and even if they hadn't been well-prepared, they (teachers) could have got over it. But put together with all the other things that have happened, it has been too much for schools to handle".*

It follows therefore, from the above, that the failure of the OBE methodology was exacerbated by the introduction of a whole lot of policies which were implemented at the same time without being thought through and without having the proper resources for implementation. It is the researcher's belief that methodologies (OBE included) fail because there is always a tension between expectation and actual delivery.

It is disheartening to note that instead of addressing the issue of educator development as a matter of national concern, the education department seems to be shifting the goal posts. In an article entitled "*Teacher Licensing: Putting the Cart before the Horse*" (the Educators' Voice, August 2006), Thulas Nxesi, the then General Secretary of SADTU *(Now he is the Deputy Minister of Rural Development and Land Reform)* (The Times, 2010:2) indicated that "the Minister of Education is panicking". Instead of addressing educator development, "she has turned to gimmickry and spin".

The implication for the above statement hinged on the Minister's solution to teacher underdevelopment, viz. licensing and expulsion of the bad apples. According to Nxesi (the Educators' Voice, August 2006), the key to delivering quality education is quality educators; well-trained and well-motivated.

It is the researcher's view that, as educator unions have long advocated, the remedy for underdevelopment hinges on a two pronged approach, namely, appraisal with development. We need credible procedures and instruments so that educators-and education bureaucrats for that matter-can be regularly appraised, individual weaknesses identified and then addressed through mentoring and appropriate retraining and re-skilling. Crucially, we need a national strategy for ongoing educator development and support which upgrades the educators and ultimately benefits the learners. The researcher feels that it is cheaper and easy to issue licenses than to address the underlying need for educator development. Hence the researcher submits that priorities should include:

- Talking to the profession and other stakeholders and stop relying on consultants with little experience of conditions on the ground.

- Reviewing the functioning of the current Integrated Quality Management System (IQMS), stop tying every development strategy to remuneration.
- De-linking development strategies from pay progression.
- Fast tracking the national debate on educator development and commit resources to a national strategy and plan. Thus, converting district offices into hubs of educator development and support.
- Providing relevant training and skills geared to the needs of the individual educators and the demands of the curriculum and the real conditions faced by educators in the schools.

Hence, the Department of Education (2000:19) states the needs in the National Strategy for Mathematics, Science and Technology Education, thus:

"Programmes that can equip educators with competences to teach at all levels of the schooling system….Programmes for educator preparation, strengthening both subject matter expertise and pedagogical mastery. An upgrading programme that focuses on both subject content knowledge and teaching skills will be introduced as a matter of urgency".

The researcher reckons Prof Kader Asmal (former Minister of Education) was acknowledging the importance of implementing a programme for scientific professional growth in his speech at the Teacher Education colloquium when he said that "We must prepare teachers to keep pace with technology, curriculum, teaching methods and social realities, and to predict the future needs of their students and the education system" (Asmal, 2003:3).

Question 2: What proportion of Sepedi v/s English do you use in teaching Science in your lessons? Under what circumstances do you use (a) Sepedi, (b) English and (c) mixed code in your teaching?

The educators indicated that they use English as the medium of teaching Science 20% of the time and Sepedi 40% of the time while code-switching from English to Sepedi and vice-versa take 40% of the teaching time. They explained that it was easier for the learners to understand the scientific terms and concepts through their mother tongue after they had initially introduced the terms and concepts in English.

The educators saw major weaknesses in the learners that they taught as being a general lack of industriousness and willingness to memorise. They further indicated that their learners viewed Science as ‘just an exam opportunity’ and, therefore, had no awareness that Science was linked to life itself and also to other subjects. This led to a lack of general knowledge in the learners which means that they could not effectively apply Science to relevant areas of life.

Educators viewed the major learning difficulties in their learners as a low level of English proficiency, the lack of understanding of scientific key-words and the fact that scientific terms were more numerous and more difficult than those terms used in other subjects.

Based on the above, the researcher would posit that the 40% use of code-switching had been adopted as an escape route from the dilemma the educators were finding themselves in. Whatever the reason, the reality is that the majority of educators use code-switching to facilitate learning.

It is of course true that in Science classes, code-switching can be used to explain, rephrase, illustrate, exemplify, elaborate, or relate concepts and procedures to learners’ experiences (Ralenala, 2003:144). This can be particularly useful in introducing and explaining the formal scientific terms and concepts the majority of which do not exist in African languages. However, the researcher is of the pinion that while code-switching was an effective method of introducing English second language learners to these terms and concepts, it was of no help in progressing into the conceptual domain if the educators themselves were unsure of this strategy.

What however complicated the reality cited above was the fact that learners were expected to read and study their content subjects and write examinations in English (not their mother tongue) and if their teaching and learning was conducted in a mixed mode as the educators indicated, they would not be fluent in either of the languages. It is therefore important for educators to identify strategies for code-switching that will advantage and not disadvantage learners. To the best of the researcher’s knowledge, such strategies that would be applicable especially to a multi-lingual country like South Africa have yet to be documented.

Question 3: How do you help your learners to learn scientific/technical terms in English? What methods do you use?

In response to this question, five (5) educators indicated that they still relied on a traditional skills model to develop learners’ proficiencies. They indicated that they used the traditional skills model which encompasses the behavioural approach and promotes codes-witching. The educators indicated that they code-switched from English to Sepedi on a daily basis.

However, the researcher found the skills model inadequate for a number of reasons: it deprived learners of the linguistic and intellectual immersion necessary for language acquisition and cognitive development to take place, and it particularly hampers ESL learners (whose primary, English-medium schooling have been poor) from developing the deep literacy on which their academic success depends. Only a content-oriented curriculum could meet these needs.

The researcher is of the opinion that the approach used was teacher–centred i.e. by implication ignoring the possibility that the perception of learners might be different from their own. Thus, the approach adopted by the educators ignored that learners were individuals who came into the classrooms with a particular background and special needs. Educators indicated that they were in favour of the traditional skill model because they were required to cover a lot of facts quickly and efficiently. They also indicated that they code-switched from English to Sepedi most of the time in class. This corroborated what the researcher observed in their classes as has been explained above.

Thus, it is the researcher’s submission that the approach employed by the educators may have the following disadvantages, namely, learners:

- May not be able to distinguish what is important from what is not important
- May have trouble listening to new information and simultaneously taking notes

- May get confused by unfamiliar vocabulary
- May get bored from just sitting and listening; and
- If they do not understand a particular concept or idea, may get “lost” for the rest of the lesson.

Despite the approach’s popularity among educators, the researcher’s experience is that although a lot of work can be covered through this approach, it remains a learner-passive teaching strategy because it provides relatively low learner feedback. Also, it is not as effective as some other teaching approaches for challenging learners to think for themselves, especially in a subject like Science which requires a fair amount of metacognition. Consequently, where it is used, like in the research subjects’ classes, learners commit themselves to memorising rather than questioning what has been taught to them.

Only two out of the seven educators indicated that they use the Language Across the Curriculum Model which helps them to move from exploratory talk to discourse specific talk in classroom communication. They reported that the model serves to encourage interaction and communication in their Science classes by emphasising what they call *discourse specific talk*. They indicated that the rationale behind this kind of an approach was based on the understanding that Science had elements that bore similarities to learning a language since, these subjects, with their conceptual and abstracted forms had very specific registers and sets of discourses.

Educators reported that the challenge they faced, however, in implementing this kind of approach was the fact that learners had to be initiated into specific ways of talking. Most learners come into the school with informal ways of talking and the challenge that educators asserted they faced, was to encourage movement in their learners from predominantly informal spoken language to formal language, both spoken and written.

Further, educators indicated that they made use of extensive use of scientific terms in English to ensure that their learners were exposed to the English terms regularly. The use of effective questioning skills to assist learners’ learning process was also mentioned by the educators.

Question 4: What methods do you think the learners usually employ in learning and thinking about Science?

The educators stated that their learners used much rote learning as their favoured way of learning terms and concepts in Science. They asserted that this method of learning was due to the learners' poor English proficiency. Educators indicated that the learners were unable to effectively present their ideas in English when writing.

It is interesting to note that the educators thought that the learners could only understand the concepts and terms because of the mixed code approach they took in the classroom. They believed that Science was more 'abstract' than other subjects such as Mathematics.

However, the researcher would posit that given that Science is abstract and involves a lot of terms, to learn by rote would only allow learners to 'pass' examinations and not completely understand the subject.

Educators reported that learners spent more time on quantitative categories such as formulas and practice problems, and less time on qualitative categories such as concepts and real-life examples. To a large extent, these distortions stemmed from their views about exams.

The researcher is of the view that the reason learners ''overemphasize'' formulas and problem-solving algorithms, was habit. For many learners, rote learning strategies become deeply ingrained in primary schools. Some learners may feel unable or unwilling to change their habits substantially.

Educators indicated that learners spent disproportionate time focusing on formulas and problem solving algorithms, even when they ''know better,'' partly because they believed that exams *rewarded* this behaviour. When learners were overwhelmed by the pace of the subject, they reverted to rote learning in order to get through the assignments and exams.

It was the researcher's observation that secondary schools often rewarded rote understanding. Consequently, many secondary school Science learners entered the classroom with the deeply-entrenched view, supported by years of experience, that rote learning would be rewarded. It would be strange for these learners to abandon these long-held beliefs solely because an educator told them to.

Furthermore, the first few graded assignments that Science learners typically encountered were homework problems selected from the textbooks. A learner could approach these problems by struggling to obtain a real understanding, scanning the textbook for relevant formulas and problem-solving algorithms. If a learner's prior and current experiences pointed towards the effectiveness of rote learning, he or she was perfectly rational to disbelieve the educator's claim that only deep understanding will be rewarded. Along the same lines, the researcher would posit that some introductory Science exam questions could be solved by rote application of problem solving algorithms.

Question 5: What do you recommend to facilitate your teaching of Science through English?

To offset the challenges that they faced on a daily basis while using English to teach Science, educators suggested varying recommendations as can be seen below:

Most of the educators (five to be precise) seemed to be worried about the lack of learning support material. They therefore, recommended that the Department of Education should assist them by supplying modern learning support materials, such as charts and transparencies as they had electricity nowadays.

Some of the educators (two) lamented about the non-availability of Science dictionaries. They therefore, recommended that the Department of Education should supply schools with Science dictionaries as they (dictionaries) would assist learners to look for the meanings of difficult Science words. These educators seemed to think that such dictionaries should be bought for every learner by the Department of Education, in order to enhance the understanding of Science concepts. (Appendix 10 is an example of verbatim interview responses from the educators)

5.5.2 Learners' Interview

Table: 5.2. Learners' Responses to Interview Questions

<table>
<tr><th rowspan="2">QUESTIONS</th><th colspan="3">RESPONSES</th></tr>
<tr><th colspan="2">YES</th><th>NO</th></tr>
<tr><td>Question 1. Do you experience challenges/problems while using English to learn in your Science class? What are those challenges?</td><td colspan="2">70</td><td>0</td></tr>
<tr><td>Question 2. Are you able to interact confidently in English with the educator during the Science lesson?</td><td colspan="2">10</td><td>60</td></tr>
<tr><td>Question 3. Does English as a language of learning and teaching affect your understanding of Science concepts?</td><td colspan="2">70</td><td>0</td></tr>
<tr><td rowspan="2">Question 4. How does the educator use English to make sure that you understand Science?</td><td>Explanation of difficult English words</td><td>Explanation of contextual meanings of words</td><td>Explanation of difficult Greek and Latin words</td></tr>
<tr><td>50</td><td>10</td><td>10</td></tr>
<tr><td rowspan="2">Question 5: What do you recommend could be done to help you learn Science successfully using English as a language of learning?</td><td colspan="2">Assistance from Department of Education</td><td>Provision of Learning Resources</td></tr>
<tr><td colspan="2">60</td><td>10</td></tr>
</table>

The Grade 8 learners responded in the following manner to the questions.

Question 1: Do you experience challenges/problems while using English to learn in your Science class? What are those challenges?

Overwhelmingly, all the seventy (70) learners responded in the affirmative to this question. Although this was not unexpected, to have a 100% "YES" response was unthinkable at the beginning of the interviews. This then prompted the researcher to further probe for those challenges as can be seen hereunder.

The responses were varied and very compelling. Learners identified challenges ranging from unavailable learner support materials to poor facilities as part of the challenges that they face on a daily basis. According to them the teaching and learning environment needs to be supportive. The following categories emerged:

Code-Switching: All the 70 learners interviewed conceded to the fact that code-switching was prevalent in their Science classrooms. As seen earlier in Chapter 1, Cognitive Academic Language Proficiency as espoused by Cummins (2000:55) is more involved than conversational language. According to Cummins, it takes 5-7 years to develop proficiency in academic language. According to the Macdonald's Threshold Project (1990:5) the deficiency in academic vocabulary can be accounted for by the early transition from the use of mother tongue as medium of instruction to English. This happens at Grade 4. At this stage, according to this groundbreaking research, learners do not have adequate academic vocabulary to deal with Science offered through the medium of English.

The learners contended that educators were using code-switching to their detriment because they were expected to be assessed in English only. The assertion by the learners confirmed what was observed in the classes and during the educator interviews. Therefore, the researcher concluded that code-switching was used on the one hand as an economic institution by the educators i.e. to expedite learning by helping learners to check their vocabulary understanding, while on the other hand it served to disadvantage learners who were to be subjected to an assessment in English only. The implication here is, learners found it more economical to use, for example a Sepedi word, rather than to try to offer a more complex explanation in the English language. As one learner aptly declared that it was "an escape route", it is the researcher's finding that code-switching always came in handy when learners experienced frustration and difficulties in handling linguistic demands of learning. Thus, code-switching became the only pedagogically viable strategy of counteracting English linguistic inefficiencies (albeit with its concomitant downsides).

The researcher is of the opinion that although there were many opinions either for or against code-switching, this study focuses on this phenomenon from the premise of it being used as a ‘survival’ strategy by learners in response to the challenges posed by English as a language of learning and teaching Science. Thus the researcher considered it appropriate to engage learners directly on this practice as this was prevalent in many classrooms-as classroom observations also revealed.

However, it is the researcher’s opinion, that in Science classes for example, code-switching can be used to explain, rephrase, illustrate, exemplify, elaborate or relate concepts and procedures to learners’ experiences. This can be useful in introducing and explaining the formal scientific terms and concepts the majority of which do not exist in African languages. This is consistent with what Lwazi Mjiyako, acting head of the University of the Witwatersrand African languages, said, when he wrote that code–switching will only become beneficial as long as indigenous languages are not “viewed as a problem but a resource” (City press, 11 September 2005).

Language of the Textbook: The respondents also cited the issue of the language of the textbooks as a challenge that they faced everyday as they use English as a language of learning Science. Predictably, the technical language of Science caused all learners difficulty. Words which were similar or pairs of words were confused by many of the learners. It appeared from the interviews held with the learners that learning a term or concept required contrasting the term with other terms within classes. Learners indicated that educators tried to mediate with new language and even attempted to refer to their prior language.

That confused them even more and this corroborated what Jarret (2001:23) points out when he said that “there is a danger that new labels in a second language may refer to a different set of features associated with a concept”. Furthermore, learners revealed that when explaining new concepts and terms, some educators used idioms and slang in order to make the Science more accessible. Predictably, this caused difficulties for ESL learners.

Motivation: Respondents also mentioned the fact that they felt discouraged to do Science because of lack of proficiency in the language of learning and teaching. It must be borne in mind that factors like motivation, background and study skills were also involved in the development of communicative competence. Motivation affects coping strategies, and so overall proficiency.

The learners' responses confirmed what Collins (2000:31) contends when he asserts that there is a link between motivation and proficiency even for advanced language learners. He suggests that the type of motivation language learners have may influence their success as learners. A distinction is however, between integrative and instrumental orientations. The former is a genuine interest in the L2 community, which amounts to a desire to integrate into it. The latter is a desire to advance in one's career. Integrative motivation is associated with above average success and instrumental, with below average success.

Question 2: Are you able to interact confidently in English with the educator during the Science lessons?

In responding to the above question, only ten out of the seventy learners interviewed indicated that they were confident to interact with the educator using English in their Science classes. It is the researcher's belief that confidence in one's competence in the L2 medium is an important variable; especially in Science education.

Learners indicated that they were ridiculed most of the time in their Science classes as they were trying to communicate with the educators and among themselves. It is worth mentioning that ridicule (which in this case comes as a result of trying to communicate in English, being an African rural learner) has detrimental effects on the learner. Learners found themselves becoming reserved and resorting to withdrawal from classroom activities. It is the researcher's conclusion that the learners' tendency to withdraw and to be overly anxious was a direct result of a lack of confidence which was a result of an inability to articulate themselves well in the language of learning and teaching.

Therefore, the researcher came to the conclusion that an issue pertinent to the achievement of the research subjects was the relationship between language proficiency and academic achievement. Learners in ESL situations (like the research subjects) were not only learning English as a second language to add to their repertoire of languages spoken, they were also called upon to entirely use it as LoLT. Then they faced the dual challenges of learning the language which was new to them and still used it for academic content. It was therefore not surprising that the overall majority of such learners ran a greater risk of underachievement, school dropout and an outright erosion of a sense of self-worth. In other words, learners' self-feeling about their self-worth and the ability to accomplish tasks was eroded through lack of proficiency in the language of learning and teaching as advocated by among others Awad (2007:188); Flynn (2003:2) and Rosenberg (2003:17).

It is the researcher's opinion that, notwithstanding the amount of ridicule that ESL learners suffer in Science classrooms, learner participation in classroom activities should be encouraged and entrenched, and the unbecoming and unconstructive behaviour be discouraged in order to achieve effective learning in Science classrooms.

Question 3: Does English as a language of learning and teaching affect your understanding of Science concepts?

Responses to the above question brought the issue of conceptualisation into proper perspective in Science learning of the research subjects. Through this interview item the researcher was interested in eliciting the learners' ideas and opinions on whether English as a language of learning affects their understanding of Science concepts. Follow up questions included the following: *"what do you do when you come across a word you do not understand?"*. Learners were unanimous in their comments that they were not able to cope with the language (English) used as a medium of learning Science. They unanimously put the blame squarely on the language used in their textbooks. Responses were often very definite although good examples were few.

The learners indicated that due to the complex nature of the scientific language, they just used what can be called *"associative thinking"* i.e. explanations which do not involve a clear statement about the physical change that is occurring. For example, they indicated that when they observed water boiling they often stated that the *"air is in the bubbles"*. The researcher could deduce that the learners did not so much give a clear indication of how they were thinking about the physical change from liquid to gas. The reason could have been the context and accessibility in choosing words.

Furthermore, the researcher could deduce from responses to this interview item that it was not clear as to whether learners were constructing meaning that was either similar to that intended by the educator or not. In the process of constructing the intended meaning, the researcher is of the opinion that learners were either ignoring teacher-talk or just made noises which sounded scientific. This, the researcher would posit, was a direct result of the inability to understand Science concepts as communicated through English.

The researcher is also of the opinion that learners were influenced by traditional thinking derived from folklore, myths and legends when they provided explanations to phenomena. As a result, when asked to explain phenomena in a second language, a learner would tend to simply provide explanations using familiar words which may not necessarily be appropriate, or may not convey the intended meaning. This, (the researcher is of the view) was caused by the fact that learners often brought to Science classes their ideas and beliefs about the natural world that often were not in conformity with the accepted scientific notion because they came from tribal groupings where cultural ideas and beliefs were a reality in their minds, thus making the teaching and learning of Science a dilemma in schools. These learners already had a set of well-developed concepts of indigenous classification systems. The beliefs which they brought to Science classes included the understanding and interpretation of natural phenomena which they possessed before the systematic study of Science with its highly developed descriptive and explanatory systems (Driver, et al.2004:15).

Thus, the researcher is of the opinion that learners' cultural background may often have a greater effect on their learning of Science content because they may interpret new information from a traditional perspective. It causes learners to become involuntarily selective when making observations-thus being forced to explain natural phenomena through non-rational means.

According to Brown (2003:60), "the belief of an explanation brings out the acceptance of the truth by the learners of the information that is presented. The acceptance or rejection of any explanation depends on whether it agrees with existing values and attitudes". Therefore, Baker and Taylor (2005:696) maintain that it is educationally unsound to present Science education to rural learners in developing countries without careful consideration of traditional perceptions through which they interpret phenomena.

The use of English as a language of learning was explained by the learners as an additional complication when their understanding of scientific concepts was already uncertain. This challenge corroborates Vygotsky's (1986:148) claim that "the difficulty with scientific concepts lies in their verbalism".

Question 4: How does the educator use English to make sure that you understand Science?

In as far as responses to the above question were concerned, the researcher found that the learners were generally of the opinion that their educators seemed to view their difficulties in learning Science to stem only from the difficulty of the subject and not from difficulties encountered with the contextual meanings of the non-technical words when used in the Science context. According to them non-explanation of the meanings of non-technical words may have been the first indication of their educators' level of awareness of the extent of the difficulty of the non-technical component of their classroom language.

Perhaps glaring evidence was the opinion of one of the participant learners, who even indicated that their educators more often told them that the non-technical words would become known by the learners after being used repeatedly for two to three years. He said:

"The educator says we know most of the words in English and some of these need not be explained to us. Some words like, 'illustrate', 'define'; we will come to know after being taught for two or three years".

It is the researcher's view that the learners' responses corroborate what Bloom's Taxonomy (1956) advocates, namely, that learning can either be shallow or deep, superficial or meaningful. The taxonomy shows that deep or meaningful learning involves progress to the higher levels in the hierarchy i.e. as a learner assimilates a piece of knowledge; s/he begins manipulating and utilizing the knowledge in successively more complex and sophisticated situations.

The researcher is therefore; of the opinion that, the educators did not know that most secondary school learners were capable of performing the full range of intellectual activities. That is why the educators concentrated only on an assessment which probed only the lower levels, and usually that meant recall of memorised facts. Thus, learners tended to utilise only those skills needed to succeed in the examination. According to Bloom (1956), that is shallow learning.

The researcher is also of the view that the educators' heavy bias in favour of testing lower order knowledge skills (rote learning or remembering), at the expense of the higher order understanding abilities, is symptomatic of Science teaching which ignores or pays little more than lip service to the originality, creativity and critical thinking skills that are essential for a rounded education in Science. Just as rote learning is the easiest and simplest form of learning, so also didactic, fact-obsessive teaching which is the easiest and most limited form of Science teaching (see Chapter 2).

Question 5: What do you recommend could be done to help you learn Science successfully using English as a language of learning?

In responding to the above question, learners appeared oblivious about what could be done to enhance their learning of Science in English as a LoLT. Sixty out of the seventy interviewed cited issues of provision of laboratories by the government and interestingly, ten learners recommended constant educational excursions to institution of higher learning in order to be exposed to "Science at a higher level".

The researcher could deduce from these responses that the issue of resources was pertinent as the learners also confirmed what was observed and communicated by their educators during the interviews.

The following section deals with the educators' questionnaire.

5.6 Educators' Questionnaire

The data gathered through the questionnaires were classified and analysed statistically as follows:

Question 1: In a scale of 1 to 6, where 1 represents *very poor* and 6 represents *excellent* how do you rate the English proficiency of your learners?

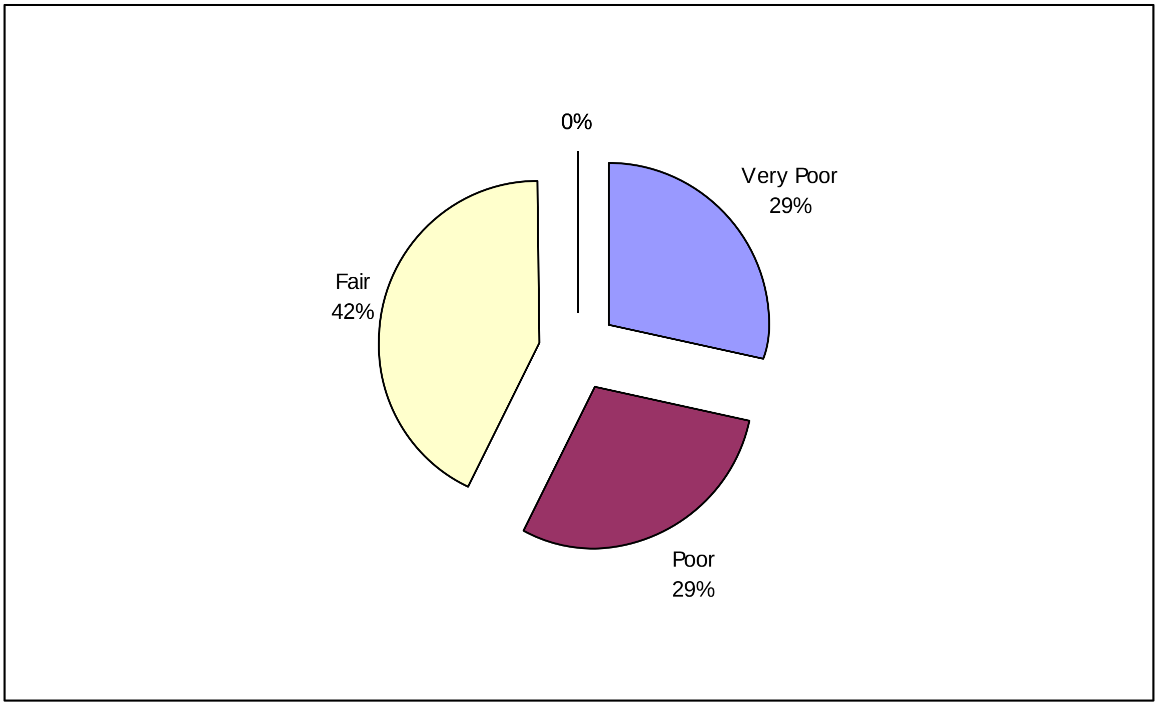
All the seven educators rated their whole classes of learners' English standard as between 1 and 3 out of six. This closely matched how the learners consider their own standard (see 5.5.2).

Table 5.3. below captures the educators' rating of their learners' English proficiency.

Table 5.3 Educators' Rating of the Learners' English Proficiency (N=7)

LEVEL OF ENGLISH PROFICIENCY	**NO. EDUCATORS**	**PERCENTAGE**
Very Poor	2	28,6%
Poor	2	28,6%
Fair	3	42,8%
Good	0	0%
Very Good	0	0%
Excellent	0	0%
TOTAL	7	100%

Figure 5.1: Educators' Rating of the Learners' English Proficiency



5.6.1 Interpretation of Table 5.3 and Figure 5.1

The results displayed on the figure above reveal the following:

- None of the educators who participated in the study have confidence that the learners' English is either good, very good or excellent.
- Only 3 educators (42.8%) consider the learner's English standard as fair i.e. being fairly adequate to follow lessons through the medium of English and capable of asking questions and commenting on the lessons with little difficulty.
- Two educators gave learners a poor (28.6%) rating that is being poorly adequate in coping with lessons through the medium of English to a point of not being able to ask questions (in English) and even comment on the content of the lesson under way.
- The remainder gave the learners a very poor (28.6%) rating i.e. being so incompetent at English that they are too handicapped to follow lessons presented through the medium of that language.

The researcher is of the opinion that lack of proficiency in English (as depicted by the educators) often translates into lack of proficiency in the four language skills of listening, speaking, reading and writing which are traditionally associated with language learning and use.

The educators indicated that they often used English for scientific terms and key-words and used Sepedi to deliver the concepts but emphasised to the learners that they use English rather than Sepedi to learn the various terms. The reason for this was that scientific terms have a totally different meaning when translated into Sepedi and this confused and created misunderstandings in the learners' thought processes.

The researcher is of the opinion that the English medium is more restrictive due to the learners' poor language proficiency. The educators found themselves having to code-switch most of the time to ensure that the learners had the best possible chance to understand the terms and concepts associated with Science. However, the fact that 'direct' translation was not always possible created further limitations of the quality of teaching.

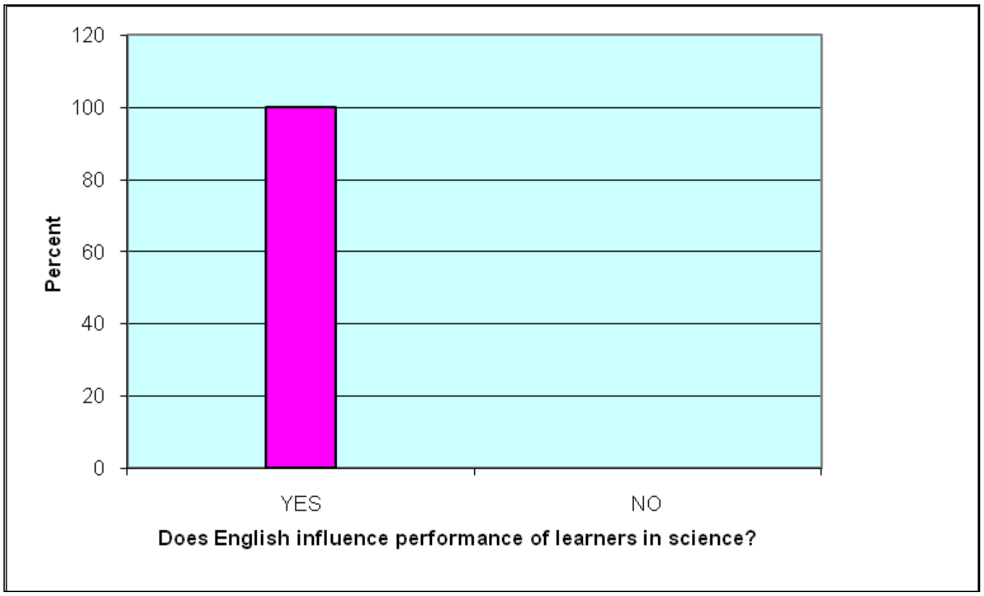
The researcher would posit that the problem was two-fold. Firstly, the learners had problems learning the terms associated with Science from the perspective of mother-tongue and second language instruction. Secondly, the learners had problems understanding the grammar and syntax associated with this subject. The latter serves to proof the hypothesis stated in chapter 4 above, namely, *that Grade 8 learners' level of English language negatively affects their learning of Science* and that *Grade 8 learners lack sufficient and specific language competence associated with their subject content.*

Furthermore, the researcher is of the opinion that the two problems alluded to above, had led to a general lack of study-skills strategy by the learners. The demands placed by the syllabus meant that the educators believed they had to ensure that all the topics were covered. This diminished the opportunities to concentrate on study-skills strategies.

Question 2: Does English LoLT Influence the Performance of your Learners in Science?

The bar chart below gives a picture of the situation as depicted by the educators regarding the questionnaire item cited above.

Figure 5.2: Influence of English LoLT on Science Learners



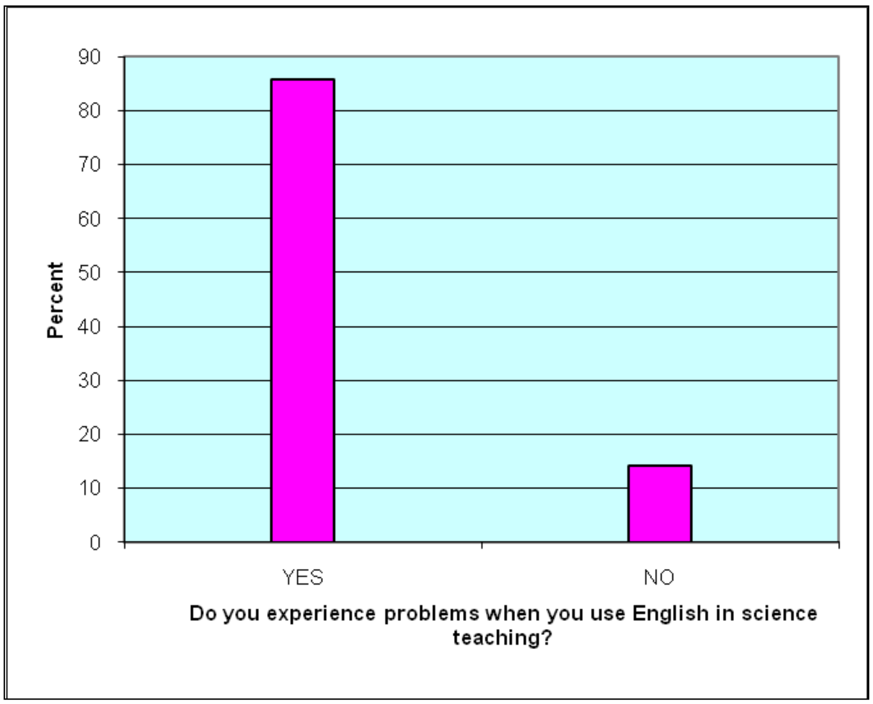
All the seven research subjects indicated that English LoLT did influence the performance of their learners in Science, thus suggesting that the problem was very deep and serious. All educators expressed a view that teaching Science using English as a LoLT disadvantaged the learners academically and that it was not in the learners' best interest to do subjects like Science in a second language. Educators indicated that their learners performed poorly because they had to satisfy two objectives in order to be academically successful: they must master academic content; but unlike learners using their mother tongue, they must also learn the language of learning and teaching at school.

They (educators) indicated that the learners' results (see appendix 12) prove that the level of proficiency (fluency and literacy) in Science was not high, (*albeit done at second language level)*. The researcher is therefore of the opinion that the instrument (language medium) used for communication (and therefore learning) was not appropriate for these learners. Needless to say, this would impact negatively on any learning that takes place.

Question 3: Do you experience problems with your learners when you use English as a language of teaching Science?

The following bar chart captures the responses to the above question adequately.

Figure 5.3: Problems Experienced in Science Teaching as a result of Usage of English



In responding to the above question, six out of the seven educators that is 85% answered in the affirmative. Educators indicated that they did not have the requisite skills and techniques which they needed to use English to teach Science, as a result they found themselves inadequately prepared to assist learners academically.

This was not surprising as they did not receive much training on how to integrate the teaching of English as a second language with Science instruction at the Colleges of Education and Universities. They needed to address the needs of English language learners with regard to their academic language development which were not limited to vocabulary but which also included language structures and discourse features used in Science. As language is the primary means of instruction, the learners' ability to participate in Science is dependent on their language ability: talking, listening, reading and writing (Lee & Fradd, 1998). In addition, Science has its own genre and register. The ability to use Science register is essential for learners to understand, conceptualize, discuss, read and write in Science subjects.

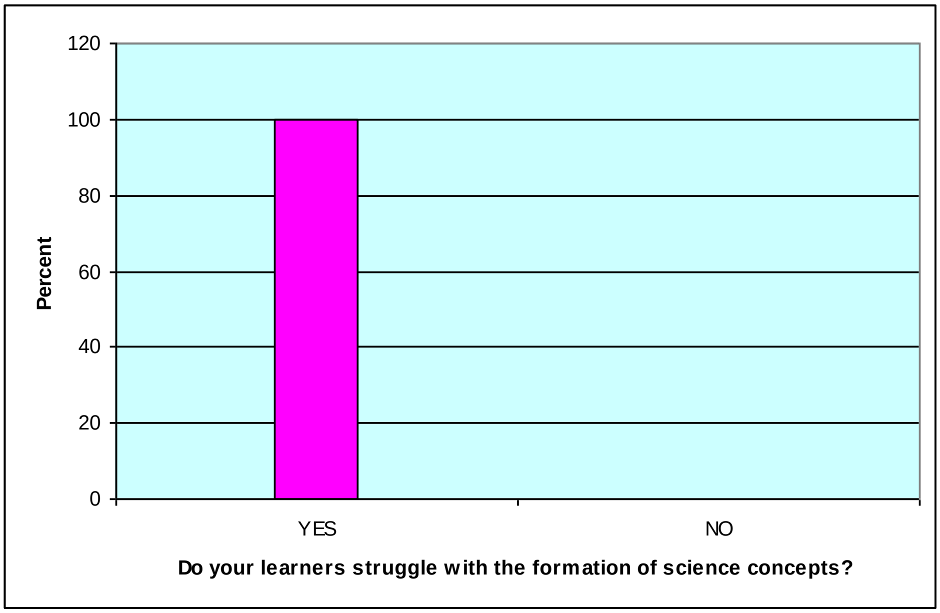
In response to pedagogical challenges associated with integrating language and Science instruction, the sampled educators in this study indicated that they employed various strategies, namely, teaching the scientific vocabulary before introducing the content and to encourage learners to use the dictionary to look for word meanings. Data gleaned from this questionnaire item showed that educators were aware that Science had its own distinct vocabulary and technical terms as well as non-technical terms that have meanings unique to scientific conctexts (Wellington & Osborne, 2001).

By introducing new vocabulary before teaching, the educators hoped that the learners would understand the use of these new words in context. This was important to ensure that learners' readiness for learning Science in English. Wellington and Osborne (2001) note that "the key to understanding a subject like Science is to understand its language". In other words, Science educators cannot ignore the fact that to some extent they are language educators. It is important to incorporate vocabulary development into Science lessons both to ensure that learners understand Science and to improve their English skills.

Question 4: Do your learners struggle with the formation of Science concepts?

Responses to the above questions are aptly captured by the following bar chart.

Figure 5.4: Learners' Struggle with the Formation of Science Concepts



Responses to the above question were more compelling. All the seven (7) educators admitted that their learners were struggling with the formation of Science concepts. The educators lamented that their learners lack the necessary skills to interpret, analyze, infer and apply appropriate criteria to make personal judgement on the lesson. They asserted that it was difficult for their learners to form concepts they (learners) did not have the capacity to process mentally on a number of things simultaneously.

To overcome the problems cited above, most of the educators indicated that they used both English and Sepedi during classroom talk. They would code-switch frequently in order to gain their learners' attention and to facilitate learners' understanding of Science concepts. Another strategy employed by the educators was translation from English to Sepedi. Most of them resorted to translation as a means of enabling learners to understand concepts without wasting much time. They claimed that the translation method was usually done with the weaker learners in the classroom so as to facilitate the flow of instruction and to make sure that learners could follow the lesson. These strategies are in line with what research (Pease-

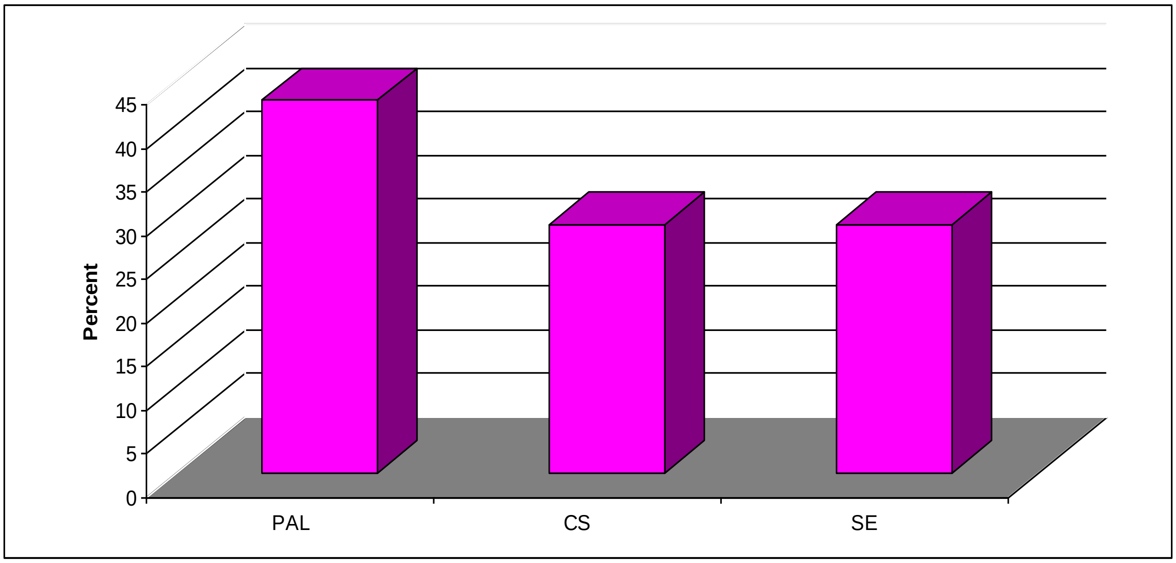
Alvarez, et al., 1991; Thomas & Collier, 2002) has shown that using learners' native language could increase the English language learners' understanding. As Lucas and Katz (1994:537) argue, a learner's native language serves several important functions: it gives learners "access to academic content, to classroom activities, and to their own knowledge and experience".

The other thing that the educators cited as making their learners struggle in using English to learn Science was that ESL language materials and language activities (aural-oral and written) were not always based on the language across the curriculum model (LAC) which would otherwise enable learners to learn English for, inter alia, Science and Technology at secondary school level. The researcher is of the opinion that the problem of inadequate ESL texts vis-à-vis ESL medium can be aptly traced to the primary schooling system learners have been exposed to.

Question 5: Which Language Approach do you use in your Science Class? Select from the following: Strictly English (SE); Codeswitching (CS) or Predominantly African Language (PAL)?

Hereunder is a bar-chart that captures what the researcher could deduce was happening in as far as the language approach is concerned.

Figure 5.5: Language Approach Used in Science Classes



Responses to the above question were varied. Only two educators that is a mere 28, 6% indicated that they were sticking strictly to English when teaching Science. This, the researcher would posit, is symptomatic of the dire straits the learning environments in the research schools find themselves in, when one considers the fact that English is the entrenched language of learning and teaching.

The majority of educators which is a whooping 42, 8% indicated that they were employing code-switching as a teaching approach in their Science classes. This response shows that the content knowledge focus of the Science lessons necessitated the use of code-switching to convey the message to learners. Educators indicated that frequent alternation between reiteration of key points and message qualification from English to Sepedi was targeted at ensuring learner comprehension. The researcher is of the opinion that the choice of code-switching as a teaching approach by the majority of the educators was an admission that the exclusive use of English as a vehicle for Science teaching was deemed superfluous and an inevitable recipe for disaster in as far as the teaching of Science was concerned.

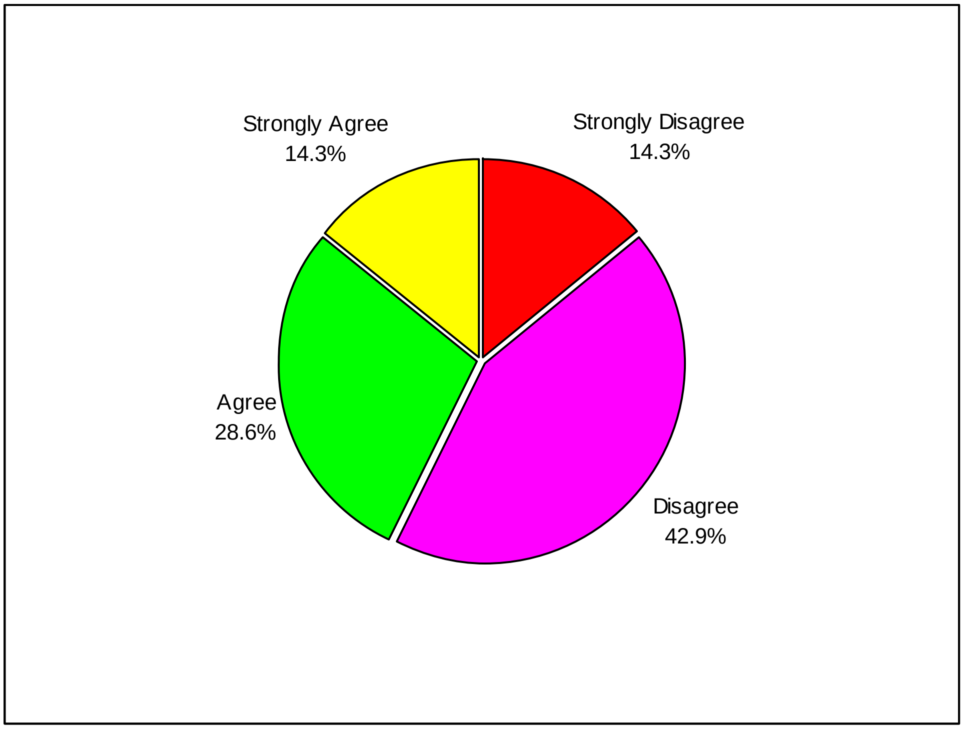
It is alarming to note that two i.e. 28, 6% of the respondents used the L1 (Sepedi) to explain concepts when learners faced problems in understanding Science concepts. These educators maintained that the learners' low English proficiency was the main cause for using Sepedi in class. They indicated that whilst the Ministry of Education has initiated nation-wide training to address language problems faced by educators teaching Science in English, the same could not be said for learners who were required to learn Science in English. Apart from the English lessons that were mandatory, these learners had not been given extra language support to help them deal with academic content that was in English. The kind of language associated with the learning of Science was very different from general English. Scientific discourses were less contextualised and require high cognitive levels of comprehension.

The researcher would therefore, posit that while it is necessary to some extent to draw upon background understanding and literacy in the first language, it is dangerous to rely on the L1 as a crutch. While the researcher understands that the limited use of Sepedi in the classroom might be of great benefit in helping learners meet the challenges presented by English, he is however of the view that total translation as an easy way out defeats the purpose of teaching this subject (Science) in English. Instead educators should be exposed to alternative instructional approaches that use a wide range of scaffolding strategies to communicate meaningful input to their learners. In this manner the content taught will be expressed to suit the proficiency level of their learners. Perhaps it is time for the educators to recognize that subjects such as Science should be viewed as an active process of developing ideas, rather than as a static body of already–existing knowledge to be passed on to learners.

Question 6: Would you then assert that English LoLT is a barrier to Science learning? Agree; Strongly Agree; Disagree; Strongly Disagree.

The pie chart below captures the responses adequately.

Figure: 5.6: English LoLT as a Barrier to Science Learning



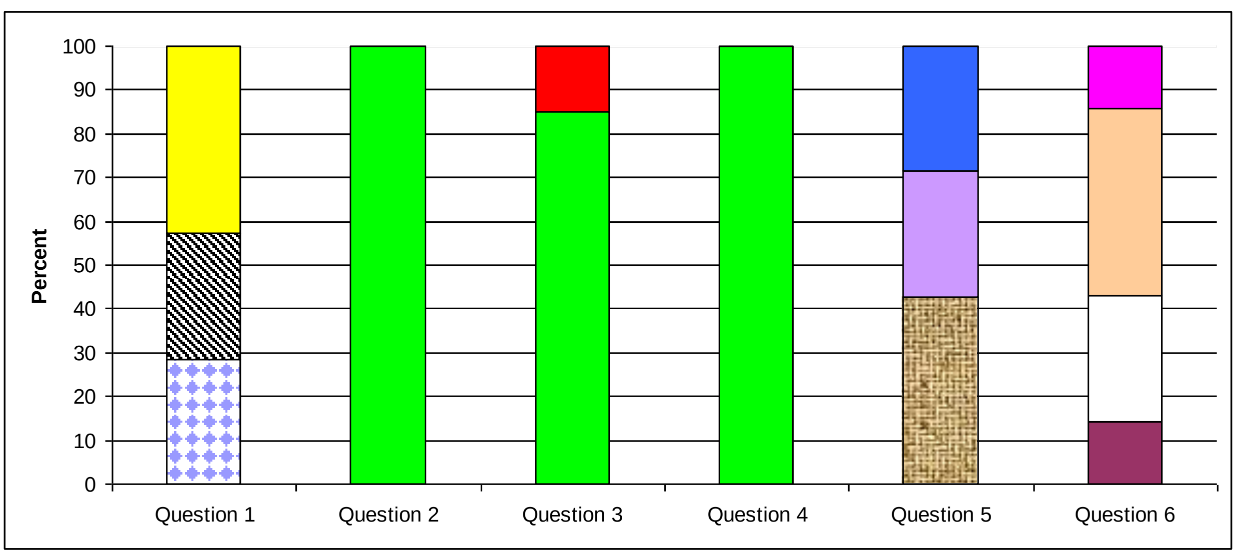
Three out of the seven educators, that is 42, 9% disagreed that English as a language of learning was a barrier in the academic achievements, while one which is 14, 3% strongly disagreed. It is interesting to note that only two (28.6%) of the respondents agreed that English as a LoLT served as a barrier to academic achievements and one (14, 3%) strongly agreed.

However, it is worth noting that an overwhelming majority, 57, 2% did not perceive English as a LoLT to be a barrier in academic performance. This result suggested that educators might not have been aware of the fact that the language medium had an impact in academic performance. Their lack of insight might actually prevent them from offering the language support their learners so desperately needed.

In conclusion, the researcher would posit that the responses to the questionnaire items cited above indicate that the language continuum in Science learning is a contentious issue that needs to be dealt with if performance in Science education is to be improved. Further, the responses implied that educators needed to consider their teaching strategies in order to provide learners with classroom learning environments that they (learners) expected.

Figure, 5.6. below captures a summary of the responses and graphically displays the anomalies inherent in rural Science learning in Limpopo Capricorn District. The summary clearly reveals that statistically, the Science learning environment in the research schools is far from being satisfactory. This fact could be confirmed with findings from the classroom observation (see paragraph 5.4.2. above).

Figure 5.7: Summary of Educators' Responses to Questionnaire Items



Legend												
	Fair	Poor	Very poor	YES	NO	SE	PAL	CS	Strongly Disagree	Disagree	Agree	Strongly Agree

(Appendix 6 is an example of Educators' Questionnaire).

5.7 Outcomes of Learners' Questionnaire

The data gathered through the questionnaires were classified and analyzed statistically as follows:

Question 1: How often do you use English in the following language skills in your Science class?

The table below captures the responses as given by the subject of this study.

Table 5.4: Summary of learners' responses on using English language skills in Science classes

Language Skill	English Language Sub-Skills	No	Always	%	Frequently	%	Sometimes	%	Infrequently	%	Never	%
Listening Skill	**1) Following lessons**	70	30	43	40	57	0	0	0	0	0	0
	2) Following question/answer sessions in class	70	10	14	20	29	20	29	20	29	0	0
	3) Listening to instructions for assignment	70	50	71	20	29	0	0	0	0	0	0
Aggregate for listening skill		***70***	***30***	***43***	***27***	***38***	***7***	***10***	***7***	***10***	***0***	***0***
Speaking skill	**4) Participating in discussions**	70	0	0	0	0	50	71	20	29	0	0
	5) Asking questions in class	70	0	0	0	0	50	71	20	29	0	0
Aggregate for speaking skill		***70***	***0***	***0***	***0***	***0***	***50***	***71***	***20***	***29***	***0***	***0***
Reading skill	**6) Reading textbooks**	70	25	36	23	33	22	31	0	0	0	0
	7) Reading study notes	70	25	36	22	31	10	14	13	19	0	0
	8) Reading instructions for assignments/projects	70	35	50	20	29	10	14	5	7	0	0
	9) Reading handouts	70	40	57	30	43	0	0	0	0	0	0
Aggregate for reading skill		***70***	***31***	***45***	***24***	***34***	***11***	***15***	***5***	***6***	***0***	***0***
Writing skill	**10) Writing Assignments**	70	30	43	40	57	0	0	0		0	0
	11) Writing notes in lessons	70	25	36	20	29	20	29	5	7	0	0
	12) Writing test/exam answers	35	50	35	50	0	0	0	0	0		
Aggregate for writing skill		***70***	***30***	***43***	***32***	***45***	***7***	***10***	***2***	***2***	***0***	***0***

In the above table, it is shown that for the listening language skill, only 30 learners out of the 70 learners, (i.e.43%) were *always* involved while 27 learners (38%) were frequently involved. Only seven (10%) were involved sometimes and infrequently respectively. When one considers that the listening skill is very paramount in the learning situation, it becomes apparent that the majority of the learners did not benefit from the Science classes of the research schools.

The above table shows that the speaking skill was the most deficient. A massive 71% used the skill sometimes. There was nothing on the frequently, and always columns. This was a serious indictment on the learning situation, especially in the Science classes where clarity on areas of difficulty could only come through asking questions and being engaged in discussions. One could only conclude that this situation would retard the effective learning of a complex subject like Science.

The aggregate for the reading skill painted a dismal picture. This was understandable because the reading skill can only be perfected after the basic skills (listening and speaking) have been mastered. It is difficult to read if one cannot speak appropriately.

The aggregate for the writing skill does not inspire any confidence either. Only 43% indicated that they were always involved in the writing skill. This was indicative of the abysmal nature of the classroom situation prevalent in the research schools. Writing forms the core of the learning activities in secondary school and if there were challenges pertaining to this foundational skill, one can only expect disastrous results at the end of the year, especially in a more demanding subject like Science.

5.7.1 Discussion of Table 5.4

Of the four language skills, the responses show that the listening skill had been perceived to be the most frequently used skill by the learners, followed by the writing and the reading skills. On the other hand, speaking skills have been viewed by the learners to be the least frequently used skills, as such skills received the lowest number of learners’ choice.

Among the sub-skills of listening, it was found that following lessons and listening instructions for assignments were perceived to be the most often used. The remaining listening sub-skill, that is following question/answer sessions in class was viewed to be used less.

Regarding reading sub-skills, the results indicated that the most frequently used skill was reading subject handouts, followed by reading study notes, reading textbooks and reading instructions for assignments/projects.

For the writing sub-skills, the results showed that the learners often wrote assignments and they sometimes wrote test/exam answers in their Science class and took notes during lessons. However, they viewed taking notes in lessons to be the least frequent sub-skill used.

The findings also revealed that while learners sometimes participated in discussions, they rarely asked questions in class. The findings also revealed that there were many English language sub-skills that the learners had to master in order to function effectively in their Science classes. Moreover, the findings of the current investigation confirmed the significant role the language of learning and teaching (LoLT) which is English as a lingua franca in Science learning, as demonstrated by previous researchers (Human Vogel and Bouwer, 2005; Kozulin, 2000; Kulkarni, 2001; Ross and Sutton, 2003; Prophet, 2001).

5.7.2 Statistical tests for relationships between English skills used in Science and the frequency of use.

For the data on the contingency table in the table above, a Chi-square test for independence between the frequency of usage of English skills and the skills used was performed. The null hypothesis assumed was that usage of various English skills was independent of each other in terms of usage in a Science class.

In essence the researcher wanted to establish, for instance, if usage of English for Science reading would have a relationship to usage of English for Science writing, listening and speaking. The table below provides results when all four skills are analysed for independence together while a table that follows focuses on sub-skills for each English skill that is being studied.

Table 5.5 Statistical tests for relationships between English skills used in Science and the frequency of use.

	Observed Chi-square value	Degrees of freedom	Critical Chi-square value	Significance level	Decision
All skills	9.89	(r-1)(c-1)=12	21.03	5%	Accept null hypothesis

At 5% level of significance, the critical Chi-square value was 21.03 while the observed or computed value was 9.89 which led to the conclusion that the skills used and the frequency of use were significantly independent from each other. This meant that learners used certain skills more frequently than others and there was no influence whatsoever of one skill or frequency of its use to the other skills.

The same test was repeated four times for each English skill studied. The aim in this instance was to see if frequency of use of a particular sub-skill had a relationship with usage of another sub-skill within a broader English skill in a Science class. The results displayed in the table were generated at 5% level of confidence.

Table 5.6 Repeated Statistical test for relationships between English skills used in Science and the frequency of use.

Skills	**Observed Chi-square value (calculated)**	**Degrees of freedom**	**Critical Chi-square value**	**Significance level**	**Decision**
Reading	56.04	12	9.89	5%	Null hypothesis rejected
Writing	113.93	8	15.507	5%	Null hypothesis rejected
Listening	173.0556	8	15.507	5%	Null hypothesis rejected
Speaking	No useful information since most cells on contingency table had frequencies = 0				

Rejection of the null hypothesis within skills (or across sub-skills of a skill) indicated that learners were consistent in the frequency of usage of sub-skills for each skill used with a 95% degree of precision. It further revealed that there was a strong relationship between sub-skills for each skill.

In order to explain this conclusion, let us for example, look at the reading skill where the null hypothesis was rejected. The significance test performed assumed the independence in usage of the four sub-skills within reading, namely reading textbooks, reading of study notes, reading instructions for assignments/projects and reading of handouts. The test revealed that the application of English in handling these sub-skills in a Science class was not independent, in other words, learners who were capable of using English for reading Science textbooks would equally be capable of using English to read instructions for Science assignments.

Question 2: In a scale of 1-5 where 1= very weak and 5= very good, rate your overall English proficiency

The purpose of this item was to establish the extent to which the Grade 8 Science learners rated their personal proficiency in English. To facilitate responses, the researcher decided to use familiar ratings of "very weak", "weak", "average", "good" and "very good". To achieve a higher degree of reliability, the researcher attached descriptions of these ratings and acquainted the research subjects with such descriptions. The descriptions were given as follows:

"Very Weak"	:	unable to follow lessons in English
"Weak"	:	barely able to follow lessons in English
"Average"	:	able to cope somewhat in English
"Good"	:	able to follow lessons adequately in English
"Very good"	:	no problem at all in following lessons in English

Table 5.7. below provides a summary of the Grade 8 learners self-assessment of their proficiency in the English language i.e. their capacity to cope adequately with lessons presented through the medium of English specifically scientific English.

Table 5.7 Learners' Self rating of their overall ability in English

English Language Skill	Very Weak	%	Weak	%	Average	%	Good	%	Very Good	%
Speaking	55	79	15	21	0	0	0	0	0	0
Listening	50	71	20	29	0	0	0	0	0	0
Writing	30	49	20	29	20	29	0	0	0	0
Reading	30	49	15	21	25	36	0	0	0	0
Grammar	50	71	20	29	0	0	0	0	0	0
Vocabulary	45	64	15	21	0	0	0	0	0	0
Communication	60	86	10	14	0	0	0	0	0	0

The researcher wanted to establish if there was a significant difference between learners' self-rating on their ability to use English in Science? To respond to this question, a statistical test was performed. Considering the responses on the contingency table above, ratings on the average, good and very good categories were mainly zeros except for writing and reading skill. Due to the dominance of zero responses in those cells, the statistical test was performed using the very weak and weak categories. However, to provide a technical explanation for the writing and reading skills with non-zero responses for the average category, the chi-square was repeated for these two skills.

It should be borne in mind that the significance of the test was not to determine how good or weak learners rated themselves on English skills, but to determine if learners' self-rating was consistent or not across all the English skills.

The results of the statistical test performed excluding the average, good and very good cells are summarised on the table below:

Table 5.8 Statistical test performed excluding the average, good and very good

	Observed Chi-square value	Degrees of freedom	Critical Chi-square value	Significance level	Decision
All skills	12.44	(r-1)(c-1) = 6	12.59	5%	Reject null hypothesis
All skills	12.44	(r-1)(c-1) = 6	10.65	10%	Do not reject null hypothesis

The results show that at 5% significance level, the null hypothesis is rejected which means that with 95% precision, learners' self-rating was significantly different from one skill to the other. The researcher went further to repeat the test at 10% significance level to see if the test would yield similar results. This was necessitated by the fact that the difference between the observed and the critical Chi-square values at 5% significance level was negligible (that is, 12.44 – 12.59 = 0.15). When the observed and critical test statistics negligibly closed, the null hypothesis may be rejected when it was indeed true, thus performing an error and eventually arriving at a wrong conclusion.

At 10% level of significance, the null hypothesis was not rejected. In other words, when the level of precision was lowered from 95% to 90%, learners' self-ratings on English skills were not significantly different. If a conclusion was arrived at based on the 10% level of significance, it could be concluded for instance that learners' self-rating on grammar did not differ significantly from self-rating on reading, writing, and so on.

The test was repeated for the writing and readings skills due to these two skills having yielded no-zero responses on the average category. The results of the test were as follows:

Table 5.9 Repeated statistical test for the writing and reading skills

	Observed Chi-square value	Degrees of freedom	Critical Chi-square value	Significance level	Decision
Writing and reading skills	1.43	(r-1)(c-1) = 3	7.82	5%	Do not reject null hypothesis
Writing and reading skills	1.43	(r-1)(c-1) = 3	6.25	10%	Do not reject null hypothesis
Writing and reading skills	1.43	(r-1)(c-1) = 3	4.11	25%	Do not reject null hypothesis

Since the observed Chi-square value was lower than the critical value, the null hypothesis was not rejected which implied that learners' self-rating for writing and reading was not significantly different. The same conclusion held at 5%, 10% and 25% levels of significance.

The researcher would therefore posit that if learners are not fluent in the language of learning, every academic class is also a language class. Learners are thus at a distinct disadvantage because of the limitations in what can be presented to them and their inability to grapple with complex and abstract ideas in a second language they have not yet mastered (Marsh et al., 2000:307).Thus, the researcher is of the opinion that learners find themselves having to pay a lot of attention to mastering the basic terminology and that may hinder them in gaining deeper conceptual understanding of the subject matter, in actively participating in classroom discussion and even in reading the textbook. Effectively, this points to a need for an English for Specific Purposes (ESP) programme to upgrade the learners' English proficiency. However, the researcher is of the opinion that under general the learners' notion of proficiency may be naïve or based on inadequate educational experience but their educators' assessment confirms that the problem of lack of English proficiency is genuine.

Question 3: Where do you have the most difficulty in English? (Mark with X)

Table 5.7 below summarizes responses on learners' self-assessment of the areas of difficulty (YES) or simplicity (NO) in using various English language functions. Seven language functions that were studied were assessed namely; defining, describing, classifying, discussing, explaining, comparing and contrasting and interpreting textual and diagrammatic illustrations.

Table 5.10 Learners' Areas of Difficulty in using the English Language Functions in a Science Class

English Language Functions	**YES**	**%**	**NO**	**%**
Defining	20	29	50	71
Describing	25	35	45	65
Classifying	30	43	40	57
Discussing	35	50	35	50
Explaining	10	14	60	86
Comparing and contrasting	40	57	30	43
Interpreting textual and diagrammatic illustrations	60	85	10	15

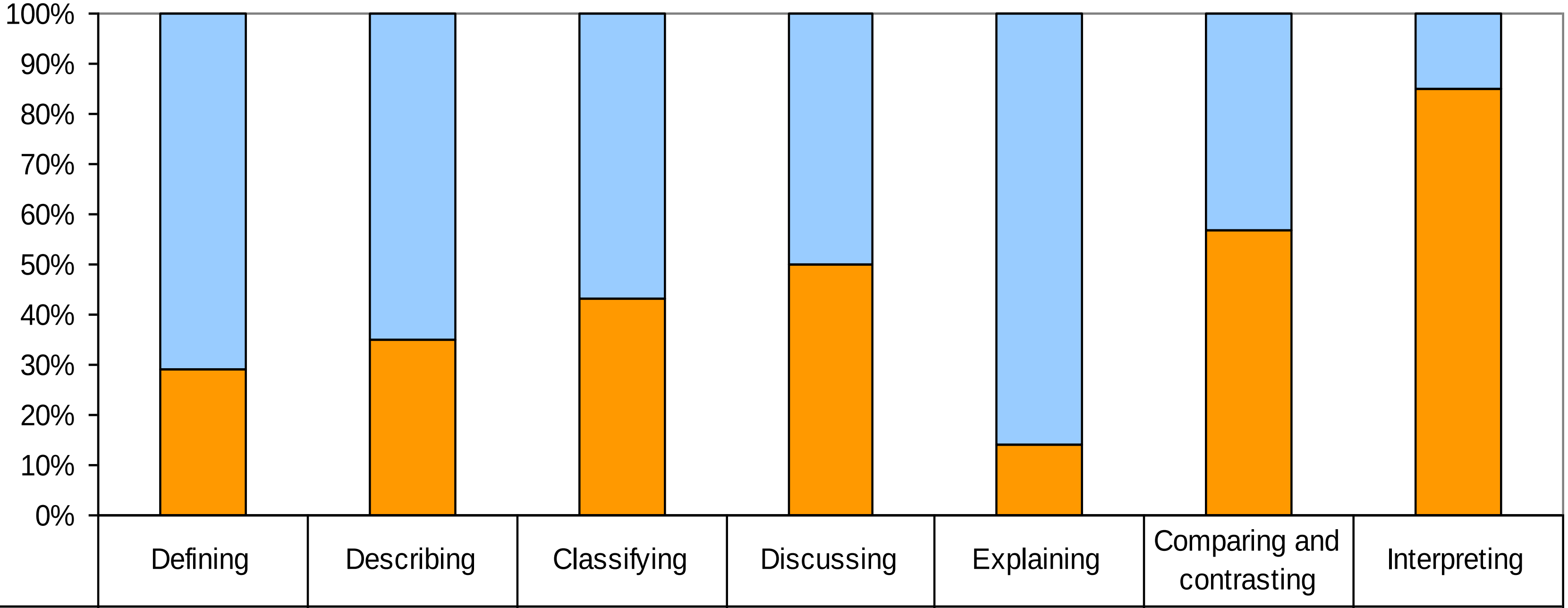
According to learners' own assessment, most difficulty was experienced in using the English language in interpreting textual and diagrammatic illustrations (85%). Comparison and contrasting was the second highest area of difficulty with 57% and it was followed by discussing (50%).

Learners found using English for explaining to be the least difficult function (86%) in a Science class. The second lowest area of difficulty was defining with 71% followed by describing (65%) and classifying (57%).

The above discussion proves the hypothesis described in Chapter 4, that *Grade 8 Science learners are unaware of the full range of functions and registers required for scientific English and would therefore benefit from a support English language programme whose content is specifically tailored to meet the requirements for secondary school level Science learning.*

Figure 5.8 below captures the scenario discussed above in an apt manner.

Figure 5. 8: Learners' Areas of Difficulty in Using the English Language Functions in a Science Class



	Defining	Describing	Classifying	Discussing	Explaining	Comparing and contrasting	Interpreting
% NO	71	65	57	50	86	43	15
% YES	29	35	43	50	14	57	85

Furthermore, a statistical test was performed to test if there was a significant difference between difficulty and simplicity among learners' self-assessment rating on the usage of English in various language functions in a Science class. The test required comparing proportions or percentages at 5% significance level for all seven English functions studied in the categories of simplicity (% YES) and difficulty (% NO). The results of the test are summarized on the table below.

Table 5.11 Comparison of proportions at 5% for all seven English functions

	Observed Chi-square value	Degrees of freedom	Critical Chi-square value	Significance level	Decision
English language functions	88.68	(r-1)(c-1) = 6	12.59	5%	Reject null hypothesis

Rejection of the null hypothesis was indicative of the significance of the differences between learners' self-assessment of the difficulty and simplicity of the various English language functions in a Science class. This conclusion supports the findings as displayed on Figure 5.8. where learners found Interpreting textual and diagrammatic illustrations to be difficult (85%) and in contrast found explaining to be quite simple (86%).

The results of Table 5.11 above confirm that many Science learners display certain lack of linguistic competence when producing the sort of texts that are central to their disciplines, in other words, texts such as those which are meant to exemplify the functions of classifying and making notes on textbooks, and so forth.

Further, the researcher would posit that the language functions in table 5.10. above form the basis for the learners' eventual success or failure in the different areas of Science education. For example, Science question papers always contain questions which test whether or not the learners understand the given key concepts of the subject matter and whether they can record information and use symbols, describe, state relationships, formulate hypotheses and interpret information.

For a successful execution of the above tasks, the learner would largely depend on his linguistic resources involving much of the vocabulary and many of the structures that would be used in presenting the solutions. However, the research sample group does not have an adequate knowledge of these necessary skills and therefore cannot cope or use them as well as they should. It is therefore not surprising that many of them experience difficulties in the said language functions. Strategies aimed at the teaching and learning of these language functions must be given due attention in any planned intervention programme (see Chapter 6).

Question 4: Do you have difficulty in understanding the language of prescribed texts?

Textbooks form a very important component of teaching and learning at secondary school level. As a matter of principle Grade 8 learners must have a textbook of their own if they are to navigate their way properly in their Science classes. Every textbook is written in the language appropriate to the area of Science it covers. It was for this reason that in this research project it was decided to establish the extent to which the language of prescribed Science textbooks is a problem area for the subject of the study. Table 5.12. below captures the participants' responses to the questionnaire item which read "Do you have difficulty in understanding the language of prescribed texts?" (See Appendix 7).

Table 5.12 Learners' Responses to Difficulty in Understanding the Language of Prescribed Texts

Difficulty	Frequency	Percentage
YES	55	79
NO	15	21
TOTAL	70	100

Although the outcomes showed a difference between learners with difficulties and those without difficulties in understanding the language on text books, it is important to note that the proportions of those with difficulties and those without difficulties were generated from one population where a sample of 70 learners was selected.

In order to draw a more sensible conclusion based on these results, the researcher had to assume that in any population, at least 50% of the learners (p=0.5) should not have difficulties in understanding language on prescribed text books. This assumption provided for the performance of a statistical test to establish at least 50% of the 70 learners (n=70) sampled from this population did not have difficulties in understanding language on prescribed text books. The statistical test was performed at 5% significance level. The results of the test are summarised below:

Table 5.13 Statistical Test at 5% level

Null hypothesis	**Observed Z-value**	**Critical Z-value**	**Significance level**	**Decision**
At least 50% of learners have difficulties in understanding language on text books	88.68	1.64	5%	Reject null hypothesis

The conclusion from the statistical test was the rejection of the null hypothesis that at least 50% of learners would not have difficulties in understanding language on a prescribed text books in favour of the alternative hypothesis. It can therefore be concluded from this test that learners from the population studied would have significant difficulties in understanding language on a prescribed text books since those with no difficulties would always be significantly below 50% with a 95% precision.

The participants' responses as indicated in table 5.12. above, sums up and confirms the hypothesis stated in Chapter 4 above namely, that *Grade 8 Science learners lack sufficient and specific language competence associated with their subject-content.* As can be seen from table 5.12. above, a total of 79% (that is 55 out of 70) participants admitted to this difficulty. In other words they admitted that they could not cope with the study material printed to them in textbooks. Effectively, this meant that there existed a discrepancy between the high level of linguistic ability assumed of the target group when they enter the Secondary school, and their actual competence and performance in English.

The situation as depicted by the responses to the questionnaire item cited above, indicate that Grade 8 Science learners do not just lack the Science vocabulary, but they could not cope with the language (English) of the textbooks. Since the learning of subject content is inextricably linked to its language, unless a certain level of language competence is maintained, only limited learning will take place.

If for example a learner's language proficiency fell under category weak or very weak as Table 5.12. above shows, he was likely to find it very difficult to draw from his language competence the linguistic philosophies demanded of him. As a result he would not be able to interpret for example, test and examination questions (written in appropriate scientific English) correctly and neither would he be able to formulate his viewpoint and put across in a coherent and meaningful way acceptable to the relevant areas of Science.

Literature (Lynch & Strube, 1985:16; Rodseth, 1987:35).allude to the fact that the language of the Science textbooks presents difficulties to underprepared learners because there is a fundamental difference between the nature of Science textbooks and the educational purpose those texts are meant to serve. The difficulty is further caused by heavy vocabulary load and exceptionally dense information found in Science textbooks. Indeed some Science textbooks used in the secondary schools introduce so many technical terms at a time that they essentially preclude a conceptualisation of scientific ideas and principles.

The researcher would therefore posit that the analysis of the data above confirms the hypothesis (see Chapter 1.6) that Grade 8 learners lack sufficient and specific language competence associated with their subject content. This is because unlike other materials they read, the content of the Science textbook is for the most part unfamiliar; the vocabulary is strange, and new words are introduced at a rapid rate. There is no temporal or predictable sequence to the unfolding of information nor are there familiar themes to which the reader can easily relate (Ralenala, 2003:58).

Question 5: What do you think your teachers should do to help you learn better through the medium of English?

The following is a summary of learners' suggestions on what they thought their educators should do to help them learn Science better through the medium of English:

(a) Teachers should involve learners in communication-based tasks so that the latter can develop more practice and more confidence in the English-speaking skills and writing skills.

(b) Teachers should vary their techniques for presenting content so that as they (learners) accumulate more subject knowledge they can at the same time learn more about the uses of English in various scientific contexts.

(c) Teachers should exercise lots of patience with learners who are unable to express themselves especially in the midst of a group.

(d) Teachers must be audible and friendly so that learners can hear them and feel free to comment and ask questions in English without fear of being proclaimed wrong or even ridiculed.

(e) Learners should be given an English Communication skills programme which is specifically designed around their needs and wants which will help bring them up to a level where they will be able to receive instruction, write, read, and use textbooks in their specific subjects with relative ease.

(f) Teachers should give learners more discussion-based tasks and assignments so that they (learners) can practise listening and exchanging ideas in English.

(g) Teachers should allow more group work sessions. In this way learners will get ample time and individual chance to express their own viewpoints in the presence of fellow learners.

From the above suggestions provided by the sample research group, it is clear that Grade 8 Science learners are not only aware of their limitations in English language proficiency as a medium of learning, but they also know what that they want in order to meet certain needs in communicative competence in English.

Whatever programme is mounted therefore, it must make provision for what learners perceive to be their needs: the programme must be seen to be theirs and not an imposition forced down on them by rules and regulations.

5.8 Conclusion

The aim of this chapter was to report on the research findings and make an analysis of the research results. The information for this purpose was based on the investigation conducted in chapter 4. The findings of the classroom observations provided baseline information that helped to answer the research question and establish to what extent English LoLT could influence learners' performance in Science.

It has become particularly evident from the observation of classroom practices that participant educators lacked explicit awareness of the functional value of non-technical words in the specific register of the Science subjects, separate from the Science terms (technical words). This was evident in how they generally seemed to undervalue explaining the meanings of the normal English words when used in the Science context, including metarepresentational terms. The everyday words in Science context were not thought to be sources of difficulties, despite the fact that, when used in Science context, these could assume different meanings; there are implications of these conclusions and findings.

The educators' interviews also confirmed what was observed, namely, that the classroom discourse is a major cause of learner non-performance in the research schools. Codeswitching is rampant and is used by educators as an 'escape' route to solve language related problems. On the other hand, learner questionnaires brought issues of textbook language and concept formation to the centre of Science learning.

To triangulate and strengthen the validity of the findings, the learner questionnaire confirmed the findings of the observation and interviews conducted. The language of learning and teaching (English) has been found to have a prime influence on learner achievement in the research area. The researcher would further posit that according to the data analysed and interpreted above, Grade 8 Science learners represented by the target research group are greatly handicapped when studying through the medium of English and therefore need an alternative programme to compensate for their linguistic limitation. The learners are limited in the basic skills of listening, speaking, reading and writing which have spin-offs into their communicative competence as a whole.

In particular, the analysis of the data revealed that what is needed is a programme designed to develop the target group's specific skills and command of English within the context of scientific discourse, that is, comprehending Science educators, understanding classroom instructions, reading the required texts and presenting verbally one's opinion or argument in a clear, precise but comprehensive manner.

In the following chapter (Chapter six 6) conclusions will be drawn about the research findings and will lead to recommendations on the implementation of Grade 8 Science-Based English Programme as an intervention programme.

CHAPTER 6

SUMMARY OF FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

6.1 Introduction

The study sought to answer the research question, namely, *how English as a language of learning and teaching (LoLT) can influence the successful learning of Science* with the aim of investigating how the use of English as a language of learning and teaching can influence the learning of Science at the secondary schools in the research area. In this regard, the foregoing chapter (Chapter 5) reported on the empirical data as a step towards answering the research question and fulfilling the aim of the study. The researcher is also of the opinion that the significance of the study (see Chapter 1) has been validated by the findings of the previous chapter (Chapter 5).

This chapter will conclude on the collected research data and make recommendations based on the analysis of chapter 5. It will also highlight the limitations of the study and conclude on the whole research.

6.2 Findings

The major findings yielded by the empirical research and literature survey in this study can be summarised as follows:

6.2.1 Contextual factors such as infrastructure development and societal economics have a bearing on the academic performance of Science learners.

6.2.2 Education of rural learners is disadvantaged and held to ransom by inadequate provision of learner support material.

6.2.3 Educator performance is hampered by their lack of proper training in the teaching of Science using English as a language of teaching;

6.2.4 The proficiency of educators' own second language proficiency needs to be assessed and upgraded where necessary;

6.2.5 English as a LoLT is a barrier to meaningful participation in the Science classrooms of rural South Africa. The English language proficiency level for African rural educators is below the expected level;

6.2.6 There was a need for educators to be embedded with the Science content within meaningful context by actively involving listening, speaking, reading and writing;

6.2.7 The standard of English proficiency at secondary school level is below the expected Level; it is inadequate and largely irrelevant to the specific needs of learners want to study Science through the medium of English at secondary school level.

6.2.8 Grade 8 Science learners' overall performance in English proficiency as reflected in their self-rating scores is below the level required to study Science at secondary school level. Only 28,5% of the participants were found to be linguistically "adequate" to cope with speaking in English (see Table 5.2 above).

6.2.9 Grade 8 Science learners as represented by the research sample are seriously inadequate in the basic language skills of speaking (79%), listening (71%), reading (49%), and writing (49%) respectively (see Table 5.2 above). The corollary of this serious inadequacy in performance in English can only be under-achievement in the various areas of Science. This is understandable since normal teaching and learning are language bound and language in action manifests itself in these four basic language skills.

6.2.10 Over and above limitations of communicative competence in English in general and scientific English in particular, Grade 8 Science learners also experience severe difficulties with certain English language functions commonly associated with written scientific discourse such as interpreting textual and grammatical illustrations, comparing and contrasting, discussing and so forth (see Table 5.3. above). This limitation in language functions associated with scientific discourse is more serious in that it handicaps the learner to function linguistically to maximum advantage in the Science classrooms. Most importantly, it can prove a severe handicap in the examination room.

6.2.11 The language of prescribed texts is a problem area by itself for Grade 8 Science learners (see table 5.4). This is an important finding since textbooks constitute the very back-bone of secondary education.

6.2.12 Code-switching as a strategy to help access the Science content should be managed because language, learning and thinking are three closely related concepts more so that code-switching practices are intentional but dilemma filled, particularly in the face of the dominance of English in the South African context.

6.2.13 Unless educators consider their teaching practice, methods and media which they use for the effective teaching of Science, they will bear less fruit.

6.2.14 There is a need to dis-aggregate schools and classrooms along three different axes and tailor programmes according to whether they are within English Foreign Language or English Additional (Second) language infrastructures; whether they are primary or secondary; whether they are about language as subject or language for a subject. Without such specific contextual attentions, educational inequalities will be exacerbated further and some educators and learners will be left ‘stranded’ at some point on their educational journey.

6.2.15 If a teaching and learning process lacks problem posing, then there is no dialogue and without dialogue there is no communication. Without communication, therefore, there is no effective teaching and learning.

6.2.16 There is an unawareness (among learners) of other strategies that may be helpful in Science learning, viz. making use of the context, prefixes and suffixes, educated guesses, using explicit in-text definitions and being aware of restatements and examples.

6.2.17 There is a realisation that learners tend to develop negative attitudes towards the language of learning (due to affective tendencies) to an extent that their academic progress is grossly affected and are likely to start exhibiting wayward behaviour that is symptomatic to people of low self-esteem.

6.3 Recommendations

On the basis of the summary of the research findings outlined in Chapter five, the following recommendations are made. For ease of reference, these recommendations are divided into three: (a) those made in reference to educators; and (b) those made in reference to learners and (c) those made in terms of the design and implementation of Science-Based English Programme strategy.

6.3.1 Recommendations for Educators

Virtually all the Science educators who completed the questionnaire and with whom the researcher had discussions indicated that they were dissatisfied with the standard of English of their Grade 8 learners. As a result of this they welcomed and supported any move intended to provide an appropriate support English programme which would largely give additional insight into, and practice of those characteristics of English which are found in scientific discourse. Of particular interest to the researcher is that all the educators were of the opinion that the envisaged programme must be undertaken by someone with the proper training in English for Specific Purposes to ensure maximum service to the identified needs and wants.

The following are the broad guidelines that the researcher posits are at ensuring that educators help learners with their identified language difficulties and to develop their academic skills generally.

6.3.1.1 Teacher Development

One of the findings of this study is the educators' limited Science content knowledge. The findings also show that educators still make use of traditional teaching methods where they dominate classroom talk. It is against this background that the researcher recommends educational programmes that focus on their overall development.

The researcher is well aware of the challenge posed by the outcomes-based curriculum which envisages educators who are "qualified, competent, dedicated and caring" (RNCS, 2002:3).Pre-service and in-service training should therefore aim at empowering educators with skills that will enable them to fulfill their roles as mediators of learning in this era. This may have to involve the revision of curricular in teacher training institutions to meet the demands of the present world.

As part of teacher development, the government should sponsor Senior Phase educators to take upgrading courses in Science. The current upgrading courses, the Advance Certificate in Education (ACE) IN Science and Mathematics Education and in languages which are offered to practicing educators should be evaluated and revised regularly to suit the needs of our disadvantaged educators. The proposed programme in this study could come in very handy in this regard.

6.3.1.2 Integrate Science Instruction with Language Instruction

This study has found out that second language learners studying Science in English are facing a dual task, that of learning the language in which Science is taught and, simultaneously, that of learning Science related content. Their educators are facing a dual task, that of teaching language as well as Science. The first strategy discussed here addresses this issue. The other strategies presented later in this paper are more specifically related to either language instruction or Science instruction.

Integrating Science instruction with language instruction is at the base of any successful Science programme for language underprepared learners. Practically speaking, this means that some of the classroom time allotted to language arts can be combined with that of Science. This will provide educators with more instructional time for Science and for language. More importantly, educators can use language related teaching strategies and methods during Science instruction.

If they do integrate them, then their effort is often limited to the introduction of basic vocabulary terms. Lemke (1990:1) helps us to see Science as language. He suggests that "learning Science means learning to *talk* Science". "Talking Science means observing, describing, comparing, classifying, analyzing, discussing, hypothesizing, theorizing, questioning, challenging, arguing, designing experiments, following procedures, judging, evaluating, deciding, concluding, generalizing, reporting ... in and through the language of Science" . Learners talking Science have to successfully perform the Science processes listed above relying on various cognitive skills, with language playing an essential role.

To perform these processes, learners must not only understand the scientific concepts involved and know the related vocabulary, but they must also be able to use the required language structures and manipulate the appropriate discourse features. In other words, they must be able to utilize the various genres of Science.

6.3.1.3 Adopting a Whole Language Approach

It has been the finding of this study that for educators to make meaningful contribution to Science learning, they should adopt a whole language approach for their Science instruction. Some of the distinctive teaching methods of this approach can easily be implemented. These include talking and writing about previous experiences (activities and experiments), individual or group reading of non-fiction texts, book talks, learner dictated stories and texts, collaborative and process writing, and working on personal word lists. The focus of these methods would be the Science theme being studied.

Language (just as Science) is a complex meaning making system, incorporating various modes (listening, talking, reading, writing and thinking), which are used to perform a number of different functions (interactional, heuristic, imaginative, informative, etc.). As such, it is greater than the sum of its parts. It is best experienced as a whole, as a process rather than a product. Language is most effectively learned when it is the vehicle of instruction; when students use it as a tool to create and share meaning in authentic and interesting learning situations (Cantoni-Harvey, 1987; Curtain & Pesola, 1988; Enright & McCloskey, 1988). In other words, children learn language when they actually use it to think and communicate in meaningful situations (Crandall, 1993).

6.3.1.4 Promoting a Language Environment Favourable to Second Language Development

The language environment created during Science activities should be favourable to second language development. In such an environment, learners are provided with numerous opportunities to actively construct meaning from the language input they receive from others, through their own meaning-making process and through interaction and negotiation of meaning when necessary. Snow (1990) describes some of the strategies used by immersion and second language educators to help slearners transform the linguistic input they receive into comprehensible input. These strategies include the extensive use of teacher talk, body language, explicit language modelling by the educator, realia, visuals and manipulatives in learning activities. These educators also establish predictable instructional routines and build redundancy into their lessons. The implementation of these strategies greatly facilitates the learners' task in constructing meaning.

Educators who adopt an interactionist view of language believe that two components of the language environment are essential to promote second language development: interaction and comprehensible output (Cummins & Swain, 1986; Wells & Nicholls, 1985). These educators realize that meaning is jointly constructed through the interaction taking place between the speakers. In a conversation, input is often made comprehensible through a collaborative effort of negotiating meaning (Snow, 1990). Swain (Cummins & Swain, 1986: 136) believes that this interaction can play another essential role. She argues that it is only when learners are forced through interaction to produce comprehensible output, that is, negotiate the meaning as well as the form of their output, that they "move ... from a purely semantic analysis of the language to a syntactic analysis of it".

Educators with an interactionist view of second language development take specific measures to promote interaction in their classroom and encourage the production of comprehensible output. Some of these measures are discursive in nature: questioning, drawing on learners' background knowledge, using clarification and comprehension checks, paraphrasing, enriching and elaborating students' utterances (or asking learners to do so), as well as encouraging learners to negotiate the meaning and form of their linguistic output. Other measures, affecting the organization of the classroom, include group work during activities and class-wide presentations, discussions and debates.

6.3.1.5 Introducing and Formally Teaching New Vocabulary Words

Another finding of this study has been that when exploring Science related themes, new words (such as "food chain") or ordinary words used in an unfamiliar way (such as "energy") are often required to define concepts, name and describe objects, or explain phenomena under study. The learners' needs in this regard should be addressed.

The study found that some educators believe that because they work within a communicative context, new vocabulary words do not have to be formally taught, that learners will understand the meaning of these words from the context and will use them appropriately when needed. That is not entirely true. As suggested by Saville-Troike (1984: 216.), "vocabulary knowledge in English is the most important aspect of oral English proficiency for academic achievement". Considering the large number of technical terms used in Science, it is unrealistic to expect learners to acquire them without any formal teaching in a purely communicative context.

However, simply providing a list of new words at the start of a new unit, before there is a real need for them and without their associated meanings, is not satisfactory. It would be difficult for learners to understand the meanings of words such as "magnetic pole" or "chemical properties" before they have had some hands-on experiments where these concepts come into play. It is only through such experiences (with concrete objects, pictures and visuals), followed by discussions that the scientific meanings of such words can be constructed (Fathmann, Quinn & Kessler, 1992).

Ideally, new vocabulary words should be introduced only when needed to clarify thinking and promote effective (Rutherford & Ahlgren, 1990). When introducing new words, whether in planned or unplanned teaching episodes, it is essential to clearly and effectively convey meaning to the learners, and then, to check for their understanding. Finally, to consolidate their learning, learners should be able to meaningfully reuse the newly acquired terms in different contexts.

6.3.1.6 Teaching the Minor and Major Genres of Science

As already discussed, talking Science involves using the specialised language of Science to observe and describe various objects of study, to hypothesize, theorize and explain natural phenomena, as well as to understand scientific texts and share findings (Lemke, 1990). These various processes of Science are intricately linked with language, and constitute the various genres of Science. The minor genres correspond to academic language micro-functions such as defining a concept, describing an object, and explaining a phenomenon (Kidd, 1996). The major genres, such as lab reports or research papers, correspond to academic language macro-functions. They "are usually longer, more complex, and more specialized to the work of Science" (Lemke, 1990:171). Therefore, these genres must be formally introduced and taught to learners if they are to develop the ability to use the specialized language of Science.

The most effective way for students to learn how to talk Science is to actually practise talking Science. Unfortunately, in many classrooms, learners are not spending much time actually talking Science and, when they do, "teachers tend to leave much of the semantics and grammar of scientific language completely implicit" (Lemke, 1990:170). Kidd (1996: 299) concurs and suggests that it would be quite unreasonable to think "that ESL learners automatically acquire control over macro-functions through linguistically unguided participation in content-area work".

In other words, learners should not be expected to discover for themselves how to function successfully within each of these genres. Eventually, learners should learn some of the more advanced language structures and discourse features used in Science (Spurlin, 1995) and develop a metalanguage to talk about the various language functions or genres used in Science (Kidd, 1996; Lemke, 1990).

6.3.1.7. Adopting a Constructivist Orientation in Teaching

This study's findings reveal that there are some educators who still adopt a realist view of knowledge. For them, scientific knowledge describes objects as they really are. They view knowledge not as constructed but as a given, as already out there. These educators often adopt a transmission orientation in their teaching. For these educators, verbal explanations of complex processes can be meaningfully shared with learners even if the learners are relatively unfamiliar with these processes. These educators see no need to take into consideration their learners' prior knowledge. If these educators adopt a hands-on approach with their learners, they expect the learners to see what they, themselves, see and to *un-cover* what there is to discover.

For the situation to improve, the researcher would recommend that educators should adopt a constructivist orientation in their teaching, i.e. acknowledge "the significance of learners' preinstructional conceptions (or prior knowledge) in the learning processes" (Treagust, Duit, & Fraser, 1996:7). In their classrooms, learners' ideas about topics under study are taken seriously; they are discussed and often challenged. Scientific views are presented. Similarities and differences between them and the learners' ideas are explored (Hewson, 1996; Lemke, 1990). Educators should view their learners as constructors of their own knowledge, as a result of their own meaning making activity while experiencing various phenomena and interacting with others (Driver & Scott, 1996; Hewson, 1996). Lemke (1990: 185) suggests that this is also what scientists are doing as "in Science, as in all other fields, it seems, we do not so much discover truths, as we *construct meanings*".

6.3.1.8 Focusing on Conceptually Based Science Themes

The study also found that for meaningful Science learning to take place, Science activities performed by the learners should focus, in depth and for some length of time, on themes such as the solar system, life cycles, chemical reactions, ecosystems or space. In selecting themes, consideration should be given to children's interests and background knowledge (Hart, 1987). Learning activities should help students to develop important scientific concepts at their level of understanding.

Some educators think that with second language learners variety is the key. They believe that if they stay on the same topic for too long, learners will lose interest. The same educators might also believe that content must be kept simple. These educators might conduct two or three activities on the same topic, then move on to something else. Alternatively, they might present a series of interesting activities, neither thematically linked nor conceptually based. During their Science classes, knowledge is often anecdotal in nature and close to common sense. Little effort is made to scaffold learners' ideas. In particular, learners are not asked to reflect on their ideas in order to organize or expand them. Conceptual development is not promoted.

Hence Rutherford and Ahlgren (1990: 185), suggest that it is better to "concentrate on the quality of understanding rather than on the quantity of information presented" . And, for second language learners, the advantages are also apparent. A thematic approach allows more time to become familiar with and practise the language functions and the vocabulary needed to talk about ideas related to the theme under study.

6.3.1.9 Reflecting the Nature of Science in the Learning Activities

Many of the learning activities proposed to the learners should allow them to experience first-hand the objects or phenomena under study. Some of these activities should present discrepant events, thus challenging the students and engaging them in problem solving.

Other activities should permit them to raise their own questions, design and conduct experiments, observe, classify and measure, collect and analyse data, reach conclusions and share their findings. Learners should be doing Science as scientists do, working in small groups, exchanging information and discussing ideas. They thus reflect the collaborative nature of the scientific enterprise. Learners could be exploring magnetism with magnets and sharing their findings with their classmates. They could learn more about chemical reactions by mixing various chemicals together, researching information in books and actually talking with practising chemists.

According to Cleminson (1990:434), Science is "a system consisting of a body of knowledge, the process of continuous inquiry that produces that knowledge, and the scientific community of scientists that is engaged in the scientific enterprise". As such, an inquiry based approach reflects an essential aspect of the nature of Science. This approach helps learners to realize how scientific knowledge is actually produced. They become more rational thinkers and better decision makers as their process skills are used to deepen their understanding of scientific concepts (Hart, 1987). On the affective level, such an approach is most likely "to preserve a child's sense of wonder, joy, excitement, and curiosity" (Hart, 1987:16).

From a language perspective, an inquiry-based approach has many benefits. Because of a number of factors, such as hands-on materials, interaction between learners, and direct cognitive involvement of all participants, this inquiry-based approach can provide a rich language environment favourable to second language development (Kessler & Quinn, 1987).

6.3.1.10 Adopting an Approach Sensitive to the Cultures of the Students

As suggested by Spurlin (1995: 71), in classrooms where language second language learners are present, "language is only a small part of the picture" as these learners are representatives of other cultures.

Yet as illustrated by Atwater (1994), Barba (1995), Lemke (1990) Ovando & Collier, (1985) and Rosenthal (1996), they cannot be ignored. Barba (1995: 53-69) suggests that elementary Science educators move away from the prevalent Eurocentric/androcentric perspective of teaching and move toward a "culturally affirming perspective". Traditionally the teaching of Science has reflected an Eurocentric/androcentric world view and values. For example, "the basic assumptions of Science, as it is taught to South African children in textbooks" and "the basic epistemological beliefs of Science textbooks are tied to a European or white male way of viewing the world." (Barba,1995:8). As suggested by Lemke (1990: 177-178), Science is often presented as the monopoly of people who share values such as "individual effort and achievement, attention to detail, the separation of reason from emotion, respect for authority and following instructions exactly". Also, role models presented are mostly males of European ancestry and scientific discoveries made in South Africa are often ignored.

Barba suggests that educators should become aware of how “culturally syntonic variables” can affect their students’ learning. She defines these variables as the factors or influences that are in harmony with a particular culture such as the format of printed materials, the instructional language, the preferred mode of interaction, and the presence of familiar role models and cultural objects (Barba, 1995:13-17). In particular, educators should incorporate into Science instruction “culturally familiar role models”. This could be done by inviting guest speakers from the various cultural communities.

In their Science activities, educators should also include objects, contexts, and environments that are familiar to the learners from a cultural perspective. Educators should provide opportunities for second language learners to discuss complex ideas in their first language. This promotes better understanding (Saville- Troike, 1984), but it also shows consideration and respect for their home language as well as culture.

6.3.1.11 Changing Instructional Approaches and Assessment

Despite the fact that Outcomes Based Education approach emphasizes learner-centeredness, the majority of educators still employ the behaviouraist rather than the constructivist approach. This approach denies learners the experience of developing independent thinking skills and strategies for learning. Therefore, educators should be made to understand that the constructivist approach is the more acceptable approach to teaching Science today. A change in instructional approach should be reciprocated by a change in the way learners are assessed to prevent rote learning from taking place.

The recommendations summarized above are clearly meant to help remedy a not so conducive situation emanating from the fact that the learners are linguistically deficient. The researcher envisages that they (learners) would therefore be grateful to have an English support programme that is geared towards their specific academic needs so as to remedy the unfortunate pedagogical situation in which they find themselves.

6.3.2 Recommendations for Learners

The following is a summary of the recommendations made in respect of what measures can be taken to ease off the learners' linguistic inabilities in the study of Science. It has to be mentioned here that the following recommendations emanate from what the researcher could deduce while interacting with learners during classroom observations and while conducting interviews with learners. The recommendations are therefore suggested here as a means to help learners use English adequately to navigate Science intricacies on a daily basis. The recommendations are as follows:

- Learners should be taught the techniques of asking and answering oral questions based on scientific texts.
- Learners should be encouraged by their educators to co-operate with subject educators and with their peers in the extraction of information which can then be used for classroom discussion, oral presentation, and writing of technical reports.
- Learners should be given guidelines and exercises on the use of a dictionary (especially a scientific dictionary, which should be made available). This will enable them to obtain a thorough comprehension of what is being read.
- Learners should be able to write clear, acceptable English in their chosen academic fields. Such competence will undoubtedly be important even in their studies after leaving secondary schools.
- Content subject educators must involve their learners in verbal discussions by encouraging them to put their arguments and opinions across orally instead of limiting themselves to presenting information in Mathematical and Scientific formulae only.
- Learners should do various exercises to extract and exploit the information in relevant journal articles on topics related to their main subjects.

These recommendations, like those put forward for the educators, emphasise the need for an intervention programme as discussed hereunder.

6.4 A PROPOSED SCIENCE-BASED ENGLISH PROGRAMME

6.4.1 Introduction

The researcher maintains that the said recommendations can best be articulated within a programme with distinct outcomes, appropriate implementation strategy and a broad assessment plan. The programme below embodies this standpoint.

6.4.2 Theoretical Framework for the Programme

The programme will be based on the constructivist theory of learning. This theory of learning takes the learner to be an active processor of information (Brunner,1966). This perspective is currently enjoying popularity as a framework for both analysis and practice of Science and mathematics education.

At the core of constructivism is the belief that learning is an active process in which learners construct new ideas and knowledge based upon their current and past experiences. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so (von Glasserfeld, 1998). This view has become increasingly accepted as a viable theory of knowledge and for many, it replaces the more traditional view that claimed that knowing the subject is a pure entity unaffected by biological, psychological and sociological contingencies.

Osborne and Wittrock (1983) describe a constructivist theory adapted for Science learning as the ability to comprehend what learners are taught verbally, or what they read, or what they find out by watching a demonstration or doing an experiment. These learners must invent a model or explanation that organizes the information selected from the experience in a way that makes sense to them, that fits their logic or real world experiences, or both.

The process of building such a theory requires metacognitive strategies of evaluating the plausibility of the theory and revising hypotheses if necessary. The implication for this is that educators should abandon the notion that subject matter is something fixed and ready made in itself, outside the learner's experience; they should stop thinking of the learner's experience as something hard and fast, and they should realize that the learner and the curriculum are simply two limits which define a single process (Dewey, 1943:11).

It is envisaged that the theory adopted for the programme will encapsulate the following instructional approaches:

Co-operative approach: an approach in which learners are assigned to small groups and instructed to learn the assigned material i.e. learners are allowed to work in groups to solve problems-thus promoting scientific inquiry and developing in learners a feeling for “doing” Science.

Inquiry learning approach: an approach which is intended to teach learners to solve problems and meet challenges by manipulating materials and phenomena, making observations and collecting, comparing, analyzing, organizing, and interpreting data (Matsumoto, 1991:14).

Experiential learning approach: a process by which the experience of the learner is reflected upon and from which emerge new insights into learning (Kolb, 1984). Thus, learning begins with an experience, which is followed by reflection of what the learner is doing using abstract concepts and generalizations to make sense and this leads on to testing the implications derived from the abstractions in new situations. The cycle is finally completed by linking the outcomes of the testing phase back to the original experience.

The discovery learning approach: an approach based on the concept that the motivation of learners to learn Science will be increased if they experience the feeling scientists get from “discovering” scientific knowledge. Through this approach, the educator decides in advance the concept, process, law or piece of scientific knowledge which is to be “discovered” or uncovered by the learners.

6.4.3 The Purpose of the Model

The purpose of this model is to:

- Develop a Science-based second language programme that will improve the English proficiency of the Sepedi speaking research subjects and simultaneously teach Science concepts.

6.4.4 Outcomes of the Programme

At the end of the programme, the learner will be able to:

- use English effectively during Science lessons by showing the ability to explain Science concepts;
- understand Science concepts in English by explaining their meaning or carrying out activities related to the concepts;
- read adequately by handling his/her Science subjects with deep insight;
- write legibly by using appropriate English register as well as relevant content in a variety of writing situations;
- understand received communication about his/her Science subject by making both inferences and decisions in response to given contexts; and
- posses adequate language structures to enable him/her to communicate Science processes.

6.4.5 Duration of the Programme

The programme will run for a period of one academic year comprising at least two periods per week and a continuous class period of at least one hour. The rationale for this emanates from the fact that Senior Phase learners come to the Science-Based Programme with varying degrees of proficiency in English. It is not logistically possible to group these learners according to their levels of proficiency in English mainly because of constraints such as space, time-table, teaching staff, learners' study-load and learner-numbers at Senior Phase level. It is for these reasons that it is not possible to plan a programme-duration strictly on the basis of level of proficiency of learners.

6.4.6 Implementation Strategy

- The programme will use the four language forms, listening, speaking, reading and writing as the spine and use the communicative approach to second language teaching.
- The Science content will form the flesh of the programme.
- Actual Science concepts and processes will be dealt with.

6.4.7 Assessment

Assessment will be done through:

(a) regular class exercises or assignments;

(b) assignments done in the learners' own time and submitted for control and comment;

(c) informal assessment during small group discussions (on-going assessment controlled by some kind of mark schedule);

(d) quarterly tests to compile a year mark to assess the extent of success or failure of the programme;

(e) a 2 hour long comprehensive examination at the end of the year covering important areas that have been studied during the course of the programme throughout the year. The examination will have two components, namely, a written component and an oral component.

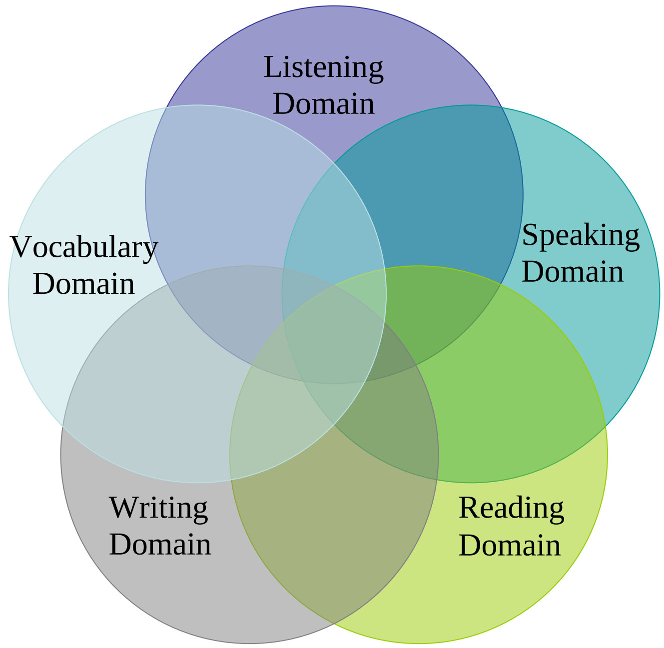
(f) finally, portfolios will be used as concrete evidence of learners' knowledge, skills values and attitudes.

The final assessment will seek to establish whether the learners:

- have developed an understanding of the nature and functions of verbal and non-verbal scientific discourse;
- are able to write a well-organized text in a clear and coherent manner to a given readership;
- are able to express themselves orally with clarity and precision to a given audience on a given topic;

The programme is represented schematically below:

Figure: 6.1 Recommended Structure and Design of the Science-Based English Programme



6.4.8 Explanation of the recommended structure and design of the Science-Based English Programme (SBEP)

6.4.8.1 The Recommended Learning Domains

A. The Listening Domain

The rationale for including this domain in the SBEP for Senior Phase (Grade 8) curriculum was motivated by the observation that learners spend a better half of the day sitting in classrooms *listening* to their educators giving instructions, explaining new concepts, explaining the difficult and complex areas of subject matter, asking for comment, and so on. Any handicap in the area of listening comprehension therefore, can only have deleterious effect on the learners' capacity to cope with the exacting task of mastering work prescribed for Grade 8 Science at a secondary school.

B. The Speaking Domain

The researcher is of the view that if a lesson is defined in terms of an interaction between the educator and his learner, then a low performance in the Speaking Domain must be a cause for concern, hence the recommendation to have it as part of the SBEP intervention strategy is so vital.

The rationale behind including this domain within the SBEP strategy is because Science learners have to engage in oral descriptions of objects or apparatus on a daily basis. They also have to justify their solutions to the educator and fellow learners. To realize all these and more, the learner needs to have the type of language skills that will enable him to express information explicitly, to distinguish between fact and opinion, to recognize as well as use indicators in discourse, to make references, to argue and to ask questions competently. All these acts are marked by appropriate register and style which need to be realised through speaking.

C. The Reading Domain

This is an important domain in an academic setting especially at secondary school level. The learners' entire learning and eventual success at secondary school level is largely dependent on his ability to read extensively and with understanding. Once this is achieved, the learner's quest for knowledge and therefore his level of awareness will increase thus enabling him to read pages of print accurately, rapidly and enjoyably. To do this, the learner must acquire particular skills and techniques which he will use to suit his needs and purposes, and which he will be able to adapt according to the nature and complexity of the material he is reading. The reading content will comprise Science content, well graded and well sequenced in simple English but aptly stated so as to promote meaning and understanding.

D. The Writing Domain

Learner performance in any academic task is gauged by how well the learner can put his ideas, responses, solutions, arguments, comments and so forth in a clear, concise (yet adequate) and logical piece of writing. The value of this skill for the learners therefore cannot be over-emphasized.

This domain will help alleviate the following anomalies that have accounted for poor performance in Science learning in many a disadvantaged community.

(a) Many Science learners do not seem to regard the training in writing skills to fall within Science subject content;

(b) Science learners do not take training in academic writing skills serious - it is simply outside their area of concern as learners in the various fields of Science education.

(c) In recent years, Grade 8 Science classes at secondary schools have grown in numbers because according to the new curriculum all Grade 8 learners have to do Natural Science as a compulsory subject. To compound the problem, growth in learner numbers is not always followed by pro-rata growth in staff numbers.

When one considers the fact that throughout the academic year, Science learners are mainly concerned with some form of expository writing which involves exposition of factual reports and projects, explanation of processes, description of experiments and apparatus, analyses of purposes, causes of results, evaluation or arguments and conclusions, one cannot help but realise how important the teaching of this skill is towards the academic success of the research subjects. To facilitate the writing of all these tasks, learners must also possess adequate linguistic ability so that they can do so in some clear, effective and organized way.

The researcher is of the opinion that the solution to the learners' writing problems can only come if sufficient practice is given in at least two areas:

(a) In tasks largely similar to those that are required of them in their prescribed Science textbooks, assignments and tests; and

(b) In writing tasks which are linked to multiple characteristics of vocabulary types as well as listening texts.

E. Vocabulary Domain/Concept Formation

The recommended programme moves from a premise that if a learner does not understand even a small number of words in a text, his overall learning efficiency can be adversely affected where intensive reading is concerned. Since Science texts are known for employing precise discourse style in addition to technical terms, the need for improving his language facility in general and technical, scientific vocabulary in particular becomes even more necessary.

The recommended programme will address this challenge by encouraging learners to look up immediately in a good dictionary any words they do not understand. This programme will also stress the use of words in context and then using such words correctly in their speech and writing. Noting that many scientific words are derived from Latin and Greek, this programme will emphasise the teaching of the roots of such words as this will assist learners to understand the meanings of those words.

6.4.9 The Recommended Content of the Science-Based English Programme (SBEP) Module

6.4.9.1 Introduction

Chapter 5 above shows that learner-needs are as varied as there are Science subjects. It is also evident that often learners over-rate their proficiencies while their educators rate them lower down the performance scale. By and large, however, both the learners and the educators are aware of the need for an ESP course for Senior Phase Science learners.

To do justice to an SBEP content, it seems the best structure would be a Unit-structure whereby learners go through the programme unit-by-unit and endeavour to master each unit before they proceed to the next unit. The purpose of structuring the SBEP curriculum in this way is to ensure that at the end of the programme the learner has a comprehensive competence of English enough to enable him to function effectively in Science lessons on his own.

Hereunder, follows a schematic representation of a recommended content of the SBEP module comprising the five learning domains:

Table 6.1 Recommended Content of the Science-Based English Programme

Learning Domain	Learning Outcome	Content	Assessment Standard	Skill Development	Values
Listening Domain	The competence to cope with lessons delivered through the medium of English.	(a)Listening strategies.	(a)Determine the purpose of listening (e.g. to obtain information, to solve problems, for enjoyment). (b)Give or follow three or four-step oral directions. (c) Retell, paraphrase, and explain what has been said by a speaker.	(a) Listening for overall comprehension	Respect for other people's point of view
Speaking Domain	Ability to communicate orally.	(a) Organization and delivery of oral communication. (b) Analysis of Oral Communications.	(a)Ask questions for clarification and understanding. (b) Ask thoughtful questions and respond to relevant questions with appropriate elaboration in oral settings. (c) Respond to questions with appropriate elaboration.	(a)Speaking Strategies. (b)Speaking applications (genres and their characteristics)	Appreciation of different points of view in language use
Reading Domain	Capacity to read text with sufficient understanding to internalize and retrieve information meaningfully.	(a)Concepts about print (b)Phonemic awareness (c)Decoding and word recognition	(a) Match oral words to printed words. (b) Read aloud with fluency in a manner that sounds like natural speech. © Read aloud fluently and accurately and with appropriate intonation and expression.	(a)Word analysis, (b)Reading comprehension and (c) Fluency.	Appreciation of lifelong learning.
Writing Domain	Ability to take down notes, to write up descriptions for visual cues and to interpret and write up description of processes and phenomena.	(a) Organization and focus. (b) Research and Technology. (c) Evaluation and revision.	(a)Use descriptive words when writing. (b)Understand the purpose of various reference materials (e.g. dictionary). (c) Revise and edit drafts to improve sequence and provide more descriptive detail.	(a) Writing strategies and writing applications e.g. genres and their characteristics. (b) Written and oral English language conventions	Respect for different types of genre and language abilities.
Grammar/Vocabulary Domain	The ability to use the language acceptably.	(a)Concept development.	(a) Use sentence and word context to find the meaning of unknown words. (b)Distinguish and interpret words with multiple meanings.	Systematic vocabulary development.	Appreciation of language structures and uses in different subjects.

6.4.9.2 The Implementation Strategy

The implementation strategy is captured in the following table.

Table 6.2 The Recommended Functional Structure of the SBEP Intersectoral Body

ESP Body	Sector	Head	Functions (Implementation)
	Province	**Director: ESP Studies**	**Provision** : Science Content and Assessment standards **Training** : School-based educators **Curriculum:** Development of academic content **Funding** : Learning materials in school
	District	**District Manager for ESP**	**Provision** : Teacher Training: English language and Science Content. Methodology **Training** : Organisation of ESP workshops in the district
	Circuit	**ESP Circuit Manager**	**Provision** : Monitoring of ESP Programme in the circuit **Training** : Organisation of ESP workshops in the circuit
	School	**ESP Educators**	**Provision** : Teaching the Programme Producing the material Learner Assistance
		Principals	**Provision** : Evaluation of Programme success Management of Programme

6.4. 9.3 Explanation of the Implementation Strategy

The SBEP Intersectoral Body will be coordinated by Provincial Directors. The chairmanship will rotate according to the hosting provincial department of education. Since districts are many the chairperson of the Intersectoral Body could be elected annually at the Annual General Meeting.

Membership will comprise the Provincial SBEP Directors of the Provincial Departments of Education, SBEP District Managers, SBEP Circuit Managers, Principals of schools and representatives of SBEP Grade 8 educators.

The role of the Intersectoral Body will be to implement and deliver services as planned by the SBEP Intersectoral Body. The Director of SBEP Studies from the Province will ensure that all the districts are furnished with the necessary human and material capital to carry out the ESP curriculum. On the other hand, the District SBEP manager will ensure that the Circuits falling under his jurisdiction are well capacitated to deliver quality SBEP curriculum to the schools. Further, the SBEP circuit managers will ensure that schools in their area of jurisdiction are well provided with the necessary support to accomplish the SBEP outcomes. The facilitation of learning of SBEP curriculum will be directly orchestrated at school level by SBEP educators under the adequate support and professional tutelage of the principals.

This kind of arrangement will promote efficient and productive SBEP tuition and will inevitably help alleviate the shortcomings observed in the research schools (see Chapter 3)

6.5 Limitations of the Study

A major drawback with regard to the present investigation is the fact that it primarily used the qualitative approach. This approach has been widely criticized as failing to adhere to the principles of validity and reliability. It has been described as being “undisciplined”, “subjective”, and “sloppy” because every researcher brings with him a certain amount of personal values, opinion, choices and power relations to the research situation (Adler, 1996:115). The researcher would concede that every research situation is unlikely to be exactly the same as the previous (see Chapter 4).

The interview with Grade 8 learners was by and large conducted in the African language (Sepedi) because of the level of the learners’ English proficiency. The meaning of some Science concepts may have been slightly altered. A major advantage, however, is that the researcher speaks the same language (Sepedi) and there were no problems of translations.

The small size of the sample, typical of qualitative research, is the most obvious limitation of this study. This cannot support a general theory of English LoLT in Science education, because different schools and different communities could disclose different findings. On the other hand, this research was not concerned with generalizations or predictions. Moreover, it does allow important conclusions to be drawn about the situation in which the seven secondary schools are found, about the educators and the learners involved in the interviews and the context in which English in Science education should take place.

The inability to interview circuit and district officials could have had a limiting effect on the stated recommendations. The researcher would concede that such an inability as cited above could have clouded a bigger picture that would otherwise come to the fore.

Further, the researcher is aware that where a lone researcher is involved in a study, there is a danger that the data might not be distinguishable from the researcher's interpretation. It is intended that building the techniques of triangulation, prolonged engagement, persistent engagement, provision of thick description, member checks and peer debriefing into the methodology helped to ensure that the work was trustworthy.

The researcher is also aware that this investigation was conducted on too small an area and therefore no major generalizations can be drawn from it. However, the study has provided valuable information about the research schools that could be used by the provincial education department. Secondly, this investigation could act as a catalyst for more research in Limpopo and other provinces that resemble the research area closely.

6.6 Recommendations for Further Research

This study has managed to unearth questions which constitute further research possibilities in the area of language in Science education in South Africa generally and in rural Limpopo in particular. Some of these were only referred to in passing because they make discrete research directions. According to the researcher, the following questions warrant further research:

It is clear from the findings of this study and more so from current language practices in the country that the implementation of English for Science is not immediately in sight. Given this scenario, the question that begs attention is: How can the poor English language proficiency of educators and learners in African schools be compensated for, especially its cumulative impact on learning and teaching Science, without necessarily paying attention to what the government has or has not done? Further research in this regard is a necessity.

The difficulties encountered with vocabulary by the learners in this study suggest that there is a need to investigate more effective methods of dealing with this issue. Research could also be directed into the development of a Science glossary with appropriate language levels for ESL learners. This could include technical scientific terms with examples of how terms can be used.

Further research is also needed to investigate if there are any pedagogic reasons why government has not adopted more aggressive measures for implementing ESP in schools. It has to be found out if the government is perhaps contemplating more robust corpus planning measures prior to more widely spread efforts at implementation of ESP.

The investigation through the interviews with educators has also highlighted the need for further research, especially concerning strategies that can be used to tag economic value to the use of English in Science in ESL situations, thus making knowledge of and in it a rewarding priority.

Based on what respondents said in this study about their incapacity to use English as a language of learning and teaching Science, further research on what corpus and planning needs to be done for English in Science to help in ESL situations is urgent necessity.

Finally, further research is necessary on how the English language can be made user friendly in Science education in view of the inevitable era of globalization we find ourselves in. This is because in the light of the findings of this study, it is prudent to have additional research conducted in the area of the mastery of Science concepts at secondary school level. Not enough research has been conducted in this field.

6.7 Conclusion

The question in this study was to establish the extent to which the use of English as a medium of education could influence the learning and teaching of Science. It was concluded that the English medium of learning Science disadvantage learners because they have to grapple with the language (English) itself and the technical terms they encounter in their Science texts. The stated recommendations in this regard could improve the learners' performance in Science. The researcher is of the opinion that there is definitely a strong case for the issue of the medium of learning to be probed in the learning of Science to eventually ensure that the learners' educational future is secured.

Literature review has shown that both educators and learners are struggling with using English as a language of learning and teaching as neither of them is proficient in it. The result has been that learners are left with partial subject knowledge and little or no real knowledge in the second language either. Hence, Brock–Utne (2000:154) holds that "one of the most important factors militating against the dissemination of knowledge and skills, and therefore of rapid social and economic well–being of the majority of people in developing countries, is the imposed medium of communication". How can we expect children and adults to acquire knowledge and skills when they are taught through a language they do not understand? It is impossible to empower individuals and to build upon their linguistic heritage in a system that perpetuates the use of a second language of instruction for its learners.

Likewise, interviews with educators and learners have demonstrated that learners are unable to benefit from educational opportunities if these are provided through a second medium of learning that they do not understand. These learning opportunities are then not designed to meet the basic learning needs of the learners if the language of learning and teaching becomes a barrier to knowledge. Similarly, education cannot possibly be equitable and non–discriminatory when the language of learning and teaching is foreign to educators and learners and when the majority of the population is required to receive their education through a language of the dominant minority.

It is noteworthy that research into language-in-education policies in Africa over the past few years has shown comprehensively that despite all efforts to make the European languages available to the African masses and thus increase literacy, (these efforts have been resounding failures), the majority of the masses remain on the fringe; language-based division has increased (Alexander, 1999: 88). This has resulted in the high illiteracy levels both in the European language as well as the mother tongue.

Referring to the above-mentioned failures, a report by the former Minister of Education, Kader Asmal indicates that 12 million South Africans are illiterate and that 20 million others, mostly school children, are not fluent readers in any language including their mother tongue (a direct consequence of a foreign medium of instruction) (Sunday Times, 16 April 2000).

What the above tells us is that in educational terms, the research area of the present study, as part of South Africa which is a developing country, is subject to all the difficulties that characterise communities in other developing countries. This necessitates that priorities be urgently established and that human resources, financial resources and material be critically assessed and prioritised with a view to increasing them as those that are available are neither adequate nor sufficient to meet the challenges of the present nor of the future especially in the learning and teaching of Science through English. The researcher is of the opinion that if the above are not prioritized, the situation as observed by Howie (2001) as pointed out in chapter 1 (see Chapter 1) will persist unabated.

The recommendations described in Chapter 6 above are thought to be the most effective in promoting Science learning and, simultaneously, second language development among learners. They have been selected because they respect generally accepted principles of effective learning and teaching. Also, they reflect various aspects of the nature of Science and language. Some of these recommendations overlap and others are intricately linked just as Science and language overlap and are linked in the expression “talking Science”.

Experienced educators of ESL Science learners are most likely implementing many of these teaching strategies in their Science classrooms. Nonetheless, trying to implement all of these strategies simultaneously could seem to be an overwhelming task. Indeed, it would be. Their implementation is better conceptualized as a long term developmental project. Each of these strategies could be seen as an essential component of the theoretical framework needed to help educators to reflect and improve Science teaching in classrooms where ESL Science learners are learning. Educators could reflect on their own classroom practice and choose one or two strategies that seem particularly well suited to their situation and implement them. As they gain experience with these new strategies and develop a richer practical knowledge of all their implications, they could implement other strategies through the same process.

In some cases, the implementation of these strategies will require educators to acquire new pedagogical knowledge and, possibly, content knowledge in Science or language. In other cases, educators might experience difficulties in implementing some of these strategies because the theoretical underpinnings might be contrary to their own beliefs. Adopting some of these strategies will involve re-evaluating and changing one's own beliefs. In some instances, these beliefs might be very difficult to modify because they relate to issues of power in the classroom (Spurlin, 2005; Treagust, et al., 2006) or because they appear to be consistent with "the dominant pedagogical orientation of previously disadvantaged communities" (Snow, 2000:163). This is why thinking and talking about teaching strategies in light of educators' beliefs is an essential component of thoughtful teaching and an integral part of the process of educator change. It is also essential that throughout this process, educators be encouraged and supported by colleagues, the school administration, parents and the larger community (Barba, 2003:43).

Further, from all the above recommendations it is clear that the sample group's needs of English cannot be met by a programme based on the traditional format of ESP teaching - an argument that has been reiterated and upheld throughout this study - and that is why the researcher has recommended several adjustments in orientation methods and materials to meet those needs.

Because of these adjustments the SBEP educator is advised, indeed urged to experiment with various and flexible scheduling arrangements suitable to his situation so that learners are not divided all of the time on the basis of homogeneity of specific interest (e.g. Science) but also on the basis of the level of English proficiency. This kind of learning-centred arrangement will allow not only efficiency of SBEP instruction but also allow the kinds of activities that may not be possible in groups with a wide dispersion of interests.

Hence, the SBEP Intersectoral structure referred to above will go a long way in helping alleviate the anomalies inherent in the present system that does not promote harmony between language and Science learning. Up to date the struggle has always been to put implementation structures in place and it is sad to report that little success has been achieved. Research at this stage is very important because it is through rigorous investigations that government will be appropriately advised about the delivery of plausible language programmes in the learning and teaching of Science in secondary schools.

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APPENDIXES

APPENDIX 1: A letter to request permission to conduct research

Ref: Setati MC
Tel: 0152942528
Cell: 0826526241

P O BOX 777
POLOKWANE
0700
25 March 2009

The Circuit Manager
Vlakfontein Circuit
Private Bag X02
JUNO
0748

Dear Sir/Madam

REQUEST FOR PERMISSION TO CARRY OUT PHD RESEARCH

The above matter bears reference.

I am studying for a PHD with the University of South Africa. My research topic is: ***English as a Language of Learning and Teaching Science in rural secondary schools: A study of the Vlakfontein Circuit in Limpopo.*** The study requires me to observe lessons and interview Grade 8 Natural Science educators and Grade 8 learners.

The purpose of writing you is therefore to ask for your permission for me to conduct the research in all the secondary schools in Vlakfontein Circuit during the month of April.

If permission is granted, I humbly request that the information be cascaded to the schools so that they are apprised of my intended visit.

Hoping in anticipation of your positive response that my request will be considered favourably.

Yours faithfully

____
Setati MC

CC: Dr Lenyai EM (University of South Africa)

APPENDIX 2

DEPARTMENT OF EDUCATION
LANGUAGE IN EDUCATION POLICY

14 JULY 1997

The language in education policy documents which follow have been the subject of discussions and debate with a wide range of education stakeholders and role-players. They have also been the subject of formal public comment following their publication on 9 May 1997 (Government Notice No. 383, Vol. 17997).

Two policies are announced herewith, namely, the LANGUAGE IN EDUCATION POLICY IN TERMS OF SECTION 3(4)(m) OF THE NATIONAL EDUCATION POLICY ACT, 1996 (ACT 27 OF 1996), and the NORMS AND STANDARDS REGARDING LANGUAGE POLICY PUBLISHED IN TERMS OF SECTION 6(1) OF THE SOUTH AFRICAN SCHOOLS ACT,1996. While these two policies have different objectives, they complement each other and should at all times be read together rather than separately.

Section 4.4 of the Language in Education Policy relates to the current situation. The new curriculum, which will be implemented from 1998, onwards, will necessitate new measures which will be announced in due course.

LANGUAGE IN EDUCATION POLICY IN TERMS OF SECTION 3(4)(m) OF THE NATIONAL EDUCATION POLICY ACT, 1996 (ACT 27 OF 1996)

PREAMBLE

This Language-in-Education Policy Document should be seen as part of a continuous process by which policy for language in education is being developed as part of a national language plan encompassing all sectors of society, including the deaf community. As such, it operates within the following paradigm:

1. In terms of the new Constitution of the Republic of South Africa, the government, and thus the Department of Education, recognises that our cultural diversity is a valuable national asset and hence is tasked, amongst other things, to promote multilingualism, the development of the official languages, and respect for all languages used in the country, including South African Sign Language and the languages referred to in the South African Constitution.

2. The inherited language-in-education policy in South Africa has been fraught with tensions, contradictions and sensitivities, and underpinned by racial and linguistic discrimination. A number of these discriminatory policies have affected either the access of the learners to the education system or their success within it.

3. The new language in education policy is conceived of as an integral and necessary aspect of the new government's strategy of building a non-racial nation in South Africa. It is meant to facilitate communication across the barriers of colour, language and region, while at the same time creating an environment in which respect for languages other than one's own would be encouraged.

4. This approach is in line with the fact that both societal and individual multilingualism are the global norm today, especially on the African continent. As such, it assumes that the learning of more than one language should be general practice and principle in our society. That is to say, being multilingual should be a defining characteristic of being South African. It is constructed also to counter any particularistic ethnic chauvinism or separatism through mutual understanding.

5. A wide spectrum of opinions exists as to the locally viable approaches towards multilingual education, ranging from arguments in favour of the cognitive benefits and cost-effectiveness of teaching through one medium (home language) and learning additional language(s) as subjects, to those drawing on comparative international experience demonstrating that, under appropriate conditions, most learners benefit cognitively and emotionally from the type of structured bilingual education found in dual-medium (also known as two-way immersion) programmes. Whichever route is followed, the underlying principle is to maintain home language(s) while providing access to and the effective acquisition of additional language(s). Hence, the Department's position that an additive approach to bilingualism is to be seen as the normal orientation of our language-in-education policy. With regard to the delivery system, policy will progressively be guided by the results of comparative research, both locally and internationally.

6. The right to choose the language of learning and teaching is vested in the individual. This right has, however, to be exercised within the overall framework of the obligation on the education system to promote multilingualism.

This paradigm also presupposes a more fluid relationship between languages and culture than is generally understood in the Eurocentric model which we have inherited in South Africa. It accepts *apriori* that there is no contradiction in a multicultural society between a core of common cultural traits, beliefs, practices, etc., and particular sectional or communal cultures. Indeed, the relationship between the two can and should be mutually reinforcing and, if properly managed, should give rise to and sustain genuine respect for the variability of the communities that constitute our emerging nation.

AIMS

The main aims of the Ministry of Education's policy for language in education are:

1. to promote full participation in society and the economy through equitable and meaningful access to education;
2. 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;
3. to promote and develop all the official languages;
4. 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;
5. to counter disadvantages resulting from different kinds of mismatches between home languages and languages of learning and teaching;
6. to develop programmes for the redress of previously disadvantaged languages.

POLICY: LANGUAGES AS SUBJECTS

All learners shall offer at least one approved language as a subject in Grade 1 and Grade 2.

From Grade 3 (Std 1) onwards, all learners shall offer their language of learning and teaching and at least one additional approved language as subjects.

All language subjects shall receive equitable time and resource allocation.

The following promotion requirements apply to language subjects:

1. 1. In Grade 1 to Grade 4 (Std 2) promotion is based on performance in one language and Mathematics.
2. From Grade 5 (Std 3) onwards, one language must be passed.
3. From Grade 10 to Grade 12 two languages must be passed, one on first language level, and the other on at least second language level. At least one of these languages must be an official language.
4. Subject to national norms and standards as determined by the Minister of Education, the level of achievement required for promotion shall be determined by the provincial education departments.

POLICY: LANGUAGE OF LEARNING AND TEACHING

The language(s) of learning and teaching in a public school must be (an) official language(s).

NORMS AND STANDARDS REGARDING LANGUAGE POLICY PUBLISHED IN TERMS OF SECTION 6(1) OF THE SOUTH AFRICAN SCHOOLS ACT, 1996

INTRODUCTION

AIM OF THESE NORMS AND STANDARDS

Recognizing that diversity is a valuable asset, which the state is required to respect, the aim of these norms and standards is the promotion, fulfillment and development of the state's overarching language goals in school education in compliance with the Constitution, namely:

1. the protection, promotion, fulfillment and extension of the individual's language rights and means of communication in education; and

2. the facilitation of national and international communication through promotion of bi-or multilingualism through cost-efficient and effective mechanisms,

3. to redress the neglect of the historically disadvantaged languages in school education.

DEFINITIONS

In these norms and standards, unless the context otherwise indicates, words and expressions contained in the definitions in the Act shall have corresponding meanings; and the following words and phrases shall have the following meanings:

1. "the Act" means the South African Schools Act, Act 84 of 1996
2. "the Constitution" means the Constitution of the Republic of South Africa, Act 108 of 1996
3. "school district" means a geographical unit as determined by the relevant provincial legislation, or prevailing provincial practice
4. "language" means all official languages recognized in the Constitution, and also South African Sign Language, as well as Alternative and Augmentative Communication.

THE PROTECTION OF INDIVIDUAL RIGHTS

The parent exercises the minor learner's language rights on behalf of the minor learner. Learners, who come of age, are hereafter referred to as the learner, which concept will include also the parent in the case of minor learners.

The learner must choose the language of teaching upon application for admission to a particular school.

Where a school uses the language of learning and teaching chosen by the learner, and where there is a place available in the relevant grade, the school must admit the learner.

Where no school in a school district offers the desired language as a medium of learning and teaching, the learner may request the provincial education department to make provision for instruction in the chosen language, and section 5.3.2 must apply. The provincial education department must make copies of the request available to all schools in the relevant school district.

THE RIGHTS AND DUTIES OF THE SCHOOL

Subject to any law dealing with language in education and the Constitutional rights of learners, in determining the language policy of the school, the governing body must stipulate how the school will promote multilingualism through using more than one language of learning and teaching, and/or by offering additional languages as fully-fledged subjects, and/or applying special immersion or language maintenance programmes, or through other means approved by the head of the provincial education department. (This does not apply to learners who are seriously challenged with regard to language development, intellectual development, as determined by the provincial department of education.)

Where there are less than 40 requests in Grades 1 to 6, or less than 35 requests in Grades 7 to 12 for instruction in a language in a given grade not already offered by a school in a particular school district, the head of the provincial department of education will determine how the needs of those learners will be met, taking into account:

1. the duty of the state and the right of the learners in terms of the Constitution, including
2. the need to achieve equity,
3. the need to redress the results of past racially discriminatory laws and practices,
4. practicability, and
5. the advice of the governing bodies and principals of the public schools concerned.

THE RIGHTS AND DUTIES OF THE PROVINCIAL EDUCATION DEPARTMENTS

The provincial education department must keep a register of requests by learners for teaching in a language medium which cannot be accommodated by schools.

In the case of a new school, the governing body of the school in consultation with the relevant provincial authority determines the language policy of the new school in accordance with the regulations promulgated in terms of section 6(1) of the South African Schools Act, 1996.

It is reasonably practicable to provide education in a particular language of learning and teaching if at least 40 in Grades 1 to 6 or 35 in Grades 7 to 12 learners in a particular grade request it in a particular school.
The provincial department must explore ways and means of sharing scarce human resources. It must also explore ways and means of providing alternative language maintenance programmes in schools and or school districts which cannot be provided with and or offer additional languages of teaching in the home language(s) of learners.

FURTHER STEPS

Any interested learner, or governing body that is dissatisfied with any decision by the head of the provincial department of education, may appeal to the MEC within a period of 60 days.

Any interested learner, or governing body that is dissatisfied with any decision by the MEC, may approach the Pan South African Language Board to give advice on the constitutionality and/or legality of the decision taken, or may dispute the MEC's decision by referring the matter to the Arbitration Foundation of South Africa.

A dispute referred to the Arbitration Foundation of South Africa must be finally resolved in accordance with the Rules of the Arbitration Foundation of Southern Africa by an arbitrator or arbitrators appointed by the Foundation.

APPENDIX 3

LESSON OBSERVATION SHEET

3.1. General

3.1.1. School :

3.1.2. Grade :

3.1.3. Learning Area :

3.1.4. Date :

3.1.5. Duration of the Lesson :

3.2. Classroom Environment

3.2.1. Number of Learners :

3.2.2. School Buildings :

3.2.3. Seating Arrangement :

3.2.4. Availability of Stationery :

3.2.5. Availability of Textbooks :

3.2.6. Wall Displays :

3.2.7. Language of Learning and Teaching :

3.3. Laboratory Facilities :

3.4. Libraries :

3.5. Classroom Interaction (s) :

3.5.1. Educator/Learner Interaction :

3.5.2. Educator Pace :

3.5.3. Educator Lesson Plans :

3.5.4. Learners' Prior Knowledge :

3.5.5. Guiding Questions

The following questions guided the researcher gather and analyze data through the classroom observation method:

3.5.5.1. What language of teaching was used by educators while teaching?

3.5.5.2. To what extent did the learners participate in the teaching and learning process?

3.5.5.3. Which language was used by the educators to interact with learners in the teaching and learning process?

3.5.5.4. Did learners have the ability to perform lesson evaluation tasks?

3.5.5.5. Which language was used by educators and learners to answer written tasks?

APPENDIX 4

Educators' Interview Items

1. How does English as a language of teaching influence interaction in your Science classroom?
2. What proportion of Sepedi v/s English do you use in teaching Science in your lessons?
   Under what circumstances do you use (a) Sepedi, (b) English and (c) mixed code in your teaching?
3. How do you help your learners to learn scientific/technical terms in English? What methods do you use?
4. What methods do you think the learners usally employ in learning and thinking about Science?
5. What do you recommend to facilitate your teaching Science through English?

APPENDIX 5

Learners' Interview Items

1. Do you experience challenges/problems while using English to learn in your Science class? What are those challenges?
2. Are you able to interact confidently in English with the educator during the Science lesson?
3. Does English as a language of learning and teaching affect your understanding of Science concepts?
4. How does the educator use English to make sure that you understand Science? Mark with X in appropriate box below

Explanation of difficult English words	Explanation of contextual meanings of words	Explanation of difficult Greek and Latin words

5. What do you recommend could be done to help you learn Science successfully using English as a language of learning? Mark with X in the appropriate box below:

Assistance from Department of Education	Provision of Learning Resources

APPENDIX 6

Educators' Questionnaire

The importance of language skills has been widely acclaimed in the Science education literature. Language does not only facilitate internal and external communication but it also provides the soil "within which reason and logic can take hold" (Claxton, 1991:94). Lemke (1990) maintains that language is not only vocabulary and grammar. It is also a system of resources for making meaning.

It is within this context that in 1997 the Department of Education promulgated the new Language in Education Policy. Among other things, the main purpose of the policy was to give direction about the issue of Language of Learning and Teaching (LoLT). This study seeks, with your help, to identify as to whether English as a Language of Learning and Teaching influences the teaching of Science in Grade 8.

Please respond to the questionnaire items honestly and frankly. The information obtained will be used strictly for purposes of this research project. You do not have to mention your name on the questionnaire.

Please use the space provided on the questionnaire, you may use extra paper if your responses do not fit on this questionnaire.

SECTION A: PERSONAL PARTICULARS

Please indicate your gender …………………………………………………………...

Institution attached to …………………………………………………………………....

Designation ………………………………………………………………………………..

What is your mother tongue? **…………………………………………………………………**

SECTION B

Educators' Questionnaire Items

1. In a scale of 1 to 6, where 1 represents *very poor* and 5 represents *excellent* how do you rate the English standard of your learners? Fill in the following table by putting an X in the appropriate column.

LEVEL OF ENGLISH PROFICIENCY	**NO. EDUCATORS**	**PERCENTAGE**
Very Poor		
Poor		
Fair		
Good		
Very Good		
Excellent		
TOTAL		

2. Does English LoLT influence the performance of learners in Science?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

3. Do you experience problems with your learners when you use English as a language of teaching Science?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

4. Which Language Approach do you use in your Science Class? Select from the following: Strictly English (SE); Codeswitching (CS) or Predominantly AfricanLanguage (PAL)?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

5. Do your learners struggle with the formation of Science concepts?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………

6. Would you then assert that English LoLT is a barrier to Science learning? Agree; Strongly Agree; Disagree; Strongly Disagree.

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

APPENDIX 7

Learners' Questionnaire

Dear Learner

Thank you for taking time to complete this questionnaire. Your views and opinions are highly valued and will help me improve your English language difficulties (if any) by enabling me to design a Science based English programme which will be both interesting and functional in nature. You are not expected to write down your name and as such you will not be identifiable by your responses.

Please assist me in this effort by completing and returning the attached questionnaire now as honestly and candidly/frankly as possible. The success of this research depends on your cordial cooperation and assistance.

I thank you in advance for your cooperation and assistance.

Kind Regards,

Setati MC

Learners' Questionnaire Items

1. How often do you use English in the following language skills in your Science class? Mark with X in the appropriate box below.

	English Language Skills	Always	Frequently	Sometimes	Infrequently	Never
Reading sub-skills	**1) Reading textbooks**					
	2) Reading study notes					
	3) Reading instructions for assignments/projects					
	4) Reading handouts					
Aggregate for reading skill						
Writing sub-skill	**5) Writing Assignments**					
	6) Writing notes in lessons					
	7) Writing test/exam answers					
Aggregate for writing skill						
Listening sub-skills	**8) Following lessons**					
	9) Following question/answer sessions in class					
	10) Listening to instructions for assignment					
Aggregate for listening skill						
Speaking sub-skills	**11) Participating in discussions**					
	12) Asking questions in class					

2. How would you rate your overall ability in English? (Mark with X)

Very Poor		i.e. unable to follow lessons in English
Poor		i.e. barely able to follow lessons in English
Fair		i.e. able to cope somewhat in English
Good		i.e. able to follow lessons adequately in English
Very Good		i.e. no problem at all in following lessons in English

3: Where do you have the most difficulty in English? (Mark with X)

English Language Functions	**YES**		**NO**	
Defining				
Describing				
Classifying				
Discussing				
Explaining				
Comparing and contrasting				
Interpreting textual and diagrammatic illustrations				

4. Do you have difficulty in understanding the language of prescribed texts? (Mark with X)

Difficulty	**YES**	**NO**
TOTAL		

5. What do you think your teachers should do to help you learn better through the medium of English?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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APPENDIX 8

An Example of an Educator's Lesson Plan

Learning Programme: Natural Science **School: _______________**

Phase: Senior **Term: ___________** **Grade: 8**

Lesson Plan No: __________ **Context:** Traditional Medicine CO 1, 2,3,4,5 **Time:** 2 Hours

Focus LA		**Integration**		**Activities**					**Assessment**						
ILO	AC	LO	AC	Teacher	Learner	Methodology Teaching strategy	Resources	Remedial/ Expanded opportunities	**Purpose**	**Form**	**Who**	**W2so**	**Evidence**	**Tool**	**Record**
6	**2**	LLC: SO5	**1**	**Explains functions of plants, animals. Can also be used for medicinal purposes Natural phenomena & the beliefs surrounding it**	**Find plants and animal matter used for medicinal purposes**	**Examples of medicine**	**Encarta Zoology & Botany reference Elderly People**	**Learners can further their work in different MS Applications**	**Summative-**	**Project**	**Teacher**	**End Product as Presentation**	**Written Document**	**Checklist**	**Record for selection purposes**
1	1	LLC SO5	**1**	**Natural phenomena & the beliefs surrounding them.**	**Find beliefs regarding natural phenomena**	**Examples of natural phenomena**	**Encarta Different Natural Science textbooks**	**Learners can further their work in different MS Applications**	**Summative**	**Project**	**Peer**	**End Product as Presentation**	**Written Document**	**Rubric**	**Record for selection purposes**

APPENDIX 9

AN EXAMPLE OF ASSESSMENT GRID IN GRADE 8

1. Observation sheet for informal assessment
2. Learner Self-assessment
3. Self-assessment of group work
4. Peer assessment of group work
5. Teacher's group work checklist
6. Example of baseline, formative or summative record sheet - Listening
7. Example of baseline, formative or summative record sheet - Activity

1. Observation Sheet for Informal Assessment

Date:

Learner's name:

Relevant activity:

Learning outcome and assessment standard:

Strength or weakness noted:

Plan for supporting weakness or extending strength:

2. Learner Self-assessment

[Grade 8]

Name: _______________________ **Date:** ____________________

Colour the picture that describes your work today:

(three little pics of smiley, less happy, unhappy faces for kids to choose from and colour in.)

I did very well today I tried hard This is not my best work

[Grade 8]

Name: ______________________________ **Date:** ________________

Activity: ____

What I did ____

How I did it ____

What resources I used ____

How long did it take? ____

Did I enjoy the work? ____

Was it easy or difficult? ____

I think I did
[ ] excellent work [ ] good work [ ] average work [ ] poor work

3. Self-assessment of Group Work

Name: _________________________ **Date:** ________________

Activity:____

How did I do?	**Yes**	**No**
Did I follow instructions?		
Did I understand the group's task?		
Did I have a task to do?		
Did I do it?		
Did I listen to others?		
Did they listen to me?		
Did I help others?		
How did my group do?		
Did we understand the instructions?		
Could we do the task?		
Did we cooperate by talking, listening and sharing work		
Did we finish on time		

What did we do well? ____
____

What would we do better? ____________________________________
____

4. Peer Assessment of Group Work

Name: __________________________ **Date:** ________________

Activity:____

Group members					
Did he/she cooperate?					
Did he/she help others and explain or share ideas?					
How did he/she communicate?					
Did he/she work until the task was finished?					

5. Educator's Group Work Checklist

Names of Learners in the Group: ____
____

General comments: ____
____

	Yes or No	**Comment**
Did learners listen to the instructions?		
Did all the learners participate?		
Did learners listen to one another?		
Did learners work together?		
Did learners complete the task?		
Did the group have any problems?		
Did learners solve any problems they had in the group?		

6. Example of Baseline, Formative or Summative Record Sheet

LO 1: Listening (see Revised National Curriculum Statement for further details of assessment standard in column 4)

Class list	AS: listens attentively to instructions and announce-ments and responds appropriately	AS: Demon-strates appropriate listening behaviour by litening without interrupting, showing respect for the speaker, taking turns to speak and asking questions for clarification	AS: Listens with enjoyment to short stories, rhymes, poems and songs from a variety of cultures, and shows unders-tanding	AS: Listens, enjoys and responds appro-priately to jokes.	AS: Listens to messages and conveys them correctly

Name					
Name					

Assessment Codes
4 = Learner's performance has exceeded the requirements of the learning outcome for the grade.
3 = Learner's performance has satisfied the requirements of the learning outcome for the grade.
2 = Learner's performance has partially satisfied the requirements of the learning outcome for the grade.
1 = Learner's performance has not satisfied the requirements of the learning outcome for the grade.

7. Example of Baseline, Formative or Summative Record Sheet

Activity: ____________________ Date: ____________

Class list	Learning outcome: Assessment standard:	Learning outcome: Assessment standard:	Learning outcome: Assessment standard:	Learning outcome: Assessment standard:

Assessment codes
4 = Learner's performance has exceeded the requirements of the learning outcome for the grade.
3 = Learner's performance has satisfied the requirements of the learning outcome for the grade.
2 = Learner's performance has partially satisfied the requirements of the learning outcome for the grade.
1 = Learner's performance has not satisfied the requirements of the learning outcome for the grade

APPENDIX 10

AN EXAMPLE OF VERBATIM INTERVIEW RESPONSES

SCHOOL DETAILS

Number of Grade 8 Classes:	1
Total Number of Learners:	38
Average Age of Learners:	13
Highest Grade in School:	12

INTERVIEW WITH GRADE 8 EDUCATORS

Question: How does English as a Language of Learning and Teaching (LoLT) impact on learner interaction and participation in your Science classrooms?

Answer: I think English is the simplest language as far as I am concerned. I think the problem lies with the foundation. Learners are unable to express themselves in English and as such you find that when you ask them a question in English, they opt to keep quiet.

Extended Question: You say the problem lies with foundation. What do you mean? Further, do you find your learners participating lively in class or are they passive?

Answer: According to my view, ke nagana gore bana ba swanetse go rutwa go bala le go ngwala (I think that learners should be taught reading and writing). The thing is, when they fail, they fail not because they don't know but because they don't understand English. Learners become passive except only when we deal with calculations but when it comes to respond to the questions, they become very passive because they are unable to use English.

Question: What language modes do you employ to improve the interaction and participation of your learners in Science classrooms? What do you do to improve interaction with your learners?

Answer: We encourage our learners to use a dictionary.

Question: Do you find yourself being forced to switch to Sepedi for example in order to clarify concepts as a result of the learners' ability to communicate concepts in English?

Answer: Sometimes as educators we find ourselves being forced to switch from English to mother tongue, especially Sepedi in order to encourage maximum participation because learners participate actively in class activities when we use their home language.

Question: Would you say this form of code-switching is helpful?

Answer: Yes, it does help because learners become participate actively when their home language is used to clarify Science concepts.

Question: What impact does English as a language of learning and teaching have on Science performance of your learners, generally? Do you find your learners' performance going up or down as a result of English LoLT?

Answer: In most cases the learners' performance is going down. The instruction in the textbooks are given in English. So learners fail not because they don't understand concepts but because they don't understand instructions given in English. If we can encourage our learners gore ba bolele ka English , e ka ba thusa kudu (to speak in English, this will help).

Question: How does English LoLT affect your learners' understanding of Science concepts?

Answer: It affects the learners because most of the Science concepts are written in Latin words and as such our learners, they don't know Latin words and as such we need to have a Science dictionary.

Extended Question: Science dictionary, now, do they have an ordinary English dictionary?

Answer: They have English dictionary, even if our learners find don't know how to use a dictionary and as educators we should blame.

Extended Question: So you would say that you have inherited some of problems from your primary school counterparts, in other words you would say the problem lies much with the foundation?

Answer: Yes. The problem lies much with the foundation, which means the government must do something and make sure that learners come to secondary schools knowing how to read and write.

APPENDIX 11

AN EXAMPLE OF VERBATIM INTERVIEW RESPONSES

SCHOOL DETAILS

Number of Grade 8 Classes:	2
Total Number of Learners:	59
Average Age of Learners:	13
Highest Grade in School:	12

INTERVIEW WITH GRADE 8 LEARNERS

Question: What are the challenges that you face in class while using English as a language of learning and teaching Science?

Answer: Sometimes when we are in class we don’t understand some words in our textbooks.

Extended question: So the challenge is that when you use English in your Science class, you don’t understand some of the words in your textbooks?

Answer: Yes, and sometimes when you want to answer others laugh at you.

Question: How does that affect you in your learning of Science?

Answer: It affect, it affects me, when I people laugh at me, I become so very fear. I ask my teacher and sometimes I look for the meaning in the dictionary. Sometimes when I read they laugh.

Follow-up Question: Does you school provide you with dictionaries?
Answer: No.
Question: Whose dictionary do you use?
Answer: My mom's dictionary?

Question: Do you know a Science dictionary?
Answer: No.

Question: Have you ever heard about a Science dictionary?
Answer: No.

Question: Which other ways do you use to help yourself when you find difficult words?
Answer: I have a problem because when I speak a English, sometimes they, they, they, they wrong a spellings and people laugh.

Question: If you had a choice, which language would you prefer to be a language of learning Science?
Answer: English, because many people speak English. English is perfect for Science.

Extended Question: So you will stick with English so that you may be able to communicate with other people?
Answer: Yes.

Question: What do you mean when you say English is perfect for Science?
Answer: *Ke ra gore batho ba bantshi ba bolela English and Sepedi ga se na mantsu a mantshi a Science* (I mean many people speak English and Sepedi doesn't have enough Science vocabulary). *English ke yona e ka kgonang go re ruta in a Science way* (English is the only one that can teach us Science perfectly).

Question:	Which language does your teacher use most often in your Science class?
Answer:	English and Sepedi?
Extended Question:	So your teacher always switches from English to Sepedi in your Science class?
Answer:	Yes, sometimes he use Sepedi to make us understand.
Question:	Are you confident to use English in answering questions in your Science lessons?
Answer:	No, because other learners will laugh at you. This will make you shy.

APPENDIX 12

PROGRESSION SCHEDULE FOR GRADE 8

LIMPOPO PROVINCE

PROGRESSION SCHEDULE FOR GRADES

SCHOOL NAME	CIRCUIT	DISTRICT	GRADE
MAKOBATENG	VLAK FONTEIN	CAPRICORN	8

Number	Admission number	Learner in alphabetical order per grade Surname and first names	Male/Female	Date of Birth	Number of years in grade	Home language %	Home language C	1st Additional Language %	1st Additional Language C	Other Language %	Other Language C	Mathematics %	Mathematics C	Arts and Culture %	Arts and Culture C	Life Orientation %	Life Orientation C	Natural Science %	Natural Science C	Economic Management Sciences %	Economic Management Sciences C	Social Science %	Social Science C	Technology %	Technology C	Promotion P-promoted NP – Not promoted	REMARKS
1		CHOLO FANNY	M	22.07.91	1	12	1	60	5			43	3	40	2	62	5	10	1	15	1	32	2	48	3	N.P	
2		DIPELA PATRACIA	F	26.02.94	1	30	2	51	4			37	2	80	4	92	7	15	1	27	1	33	2	69	4	N.P	
3		KGANO JULLIET	F	22.10.94	1	46	3	51	4			36	2	84	4	88	7	25	1	35	2	46	2	75	6	N.P	
4		KHOZA KHEMSANI	F	17.01.93	1	10	1	72	6			74	6	84	4	53	4	20	1	39	2	18	1	78	6	N.P	
5		KOMAPE ELSIE	F	16.06.94	1	62	5	55	4			69	5	84	4	88	7	48	2	66	5	48	2	78	6	P	
6		MABOTJA PHILLIPINE	F	26.5.94	1	36	2	42	3			60	5	68	3	28	1	45	2	38	2	64	3	56	4	N.P	
7		MAIMELA SYLVESTOR	M	15.12.94	1	44	3	85	7			50	4	76	4	72	6	30	1	48	3	28	1	60	5	P	
8		MAHOLO KOKETSO	F	02.10.94	1	24	1	64	5			39	2	72	4	44	3	10	1	39	2	40	2	72	6	N.P	
9		MALETE EMMANUEL	M	22.01.94	1	44	3	82	7			68	5	80	4	72	6	48	2	52	4	80	4	79	6	P	
10		MALULEKA MAGGIE	F	30.03.94	1	68	5	30	2			50	4	84	4	91	7	48	2	71	6	64	3	80	7	P	
11		MANAKA CALPHARNIA	F	22.08.94	1	68	5	61	5			66	5	92	4	91	7	95	4	79	6	66	3	71	6	P	
12		MASALESA MICHACIOUS	M	02.12.94	1	44	3	79	6			50	4	84	4	55	4	50	3	48	3	56	3	62	5	P	
13		MASIPA CAROL	F	09.01.94	1	42	3	96	7			50	4	88	4	83	7	58	3	58	4	50	3	68	5	P	
14		MASOMA GOLDEN	M	05.05.94	1	48	3	69	5			52	4	68	4	66	5	20	1	33	2	22	1	65	5	NP	
15		MATHEBANE JUSTICE	M	04.04.94	1	26	1	78	6			39	2	18	1	38	2	10	1	49	3	44	2	42	3	N.P	

Number	Admission number	Learner in alphabetical order per grade Surname and first names	Male/Female	Date of Birth	Number of years in grade	Home language %	C	1st Additional Language %	C	Other Language %	C	Mathematics %	C	Arts and Culture %	C	Life Orientation %	C	Natural Science %	C	Economic Management Sciences %	C	Social Science %	C	Technology %	C	Promotion P- promoted NP – Not promoted	REMARKS
16		MATHEKGA PATRACIA	M	05.09.93	1	44	3	79	6			32	2	72	6	55	4	33	2	34	2	20	1	48	3	NP	
17		MATLALA JOSEPH	M	02.09.94	1	34	2	61	5			70	4	84	7	83	7	43	3	45	3	30	2	84	7	NP	
18		MATLOU LESLEY	M	28.06.93	1	48	3	59	4			44	2	72	6	88	7	8	1	23	1	38	2	72	6	NP	
19		MATSIMELA LIZZY	F	15.06.92	1	32	2	69	5			49	2	52	4	33	2	60	5	40	3	52	4	81	7	NP	
20		MAUTLA TSHEGO	F	05.05.94	1	36	2	74	6			52	3	88	7	55	4	40	3	50	4	64	5	72	6	N P	
21		MOJA JEFFREY	M	04.12.92	1	24	1	76	6			53	3	64	5	88	7	8	1	33	2	34	2	80	7	N.P	
22		MOJA JOHANNES	M	16.01.94	1	58	4	76	6			66	3	80	7	88	7	20	1	42	3	62	5	72	6	P	
23		MOJA MARVIN	F	26.10.94	1	86	7	88	7			44	2	92	7	94	7	78	6	66	5	72	6	69	5	P	
24		MOJA RAYMOND	M	16.02.93	1	46	3	81	7			19	1	64	5	88	7	30	2	32	2	48	3	73	6	N.P	
25		MOJELA EGNOLIA	F	30.12.91	1	23	1	42	3			59	3	36	2	33	2	25	1	12	1	30	2	66	5	N.P	
26		MOLOKOMME RONALD	M	26.07.93	1	46	3	51	4			62	3	84	7	50	4	23	1	36	2	46	3	41	3	P	
27		MOKGOBU TREVOR	M	02.06.93	1	08	1	67	5			59	3	76	6	94	7	15	1	46	3	16	1	72	6	NP	
28		MOKGOBU VALENCIA	F	04.02.94	1	56	3	85	7			84	4	92	7	83	7	70	6	76	6	84	7	72	6	P	
29		MONOA LEBOGANG	F	06.09.94	1	60	3	85	7			44	2	84	7	72	6	48	3	52	4	33	2	85	7	NP	

Number placed in next grade: ....

Certified correct: Teacher: [signature]..........................

Principal: S K Mawamela ....

APPROVED: CIRCUIT MANAGER: ....

Date: ....

Date: 20/03/2008

Date: 28/03/08

Date: ....

DEPARTMENT OF EDUCATION
MAKOBATENG SEN. SEC. SCHOOL
2008 -03- 20
P.O. BOX 439 JUNO 0748
CAPRICORN DISTRICT
LIMPOPO PROVINCE

Number	Admission number	Learner in alphabetical order per grade Surname and first names	Male/Female	Date of Birth	Number of years in grade	Home language %	Home language C	1st Additional Language %	1st Additional Language C	Other Language %	Other Language C	Mathematics %	Mathematics C	Arts and Culture %	Arts and Culture C	Life Orientation %	Life Orientation C	Natural Science %	Natural Science C	Economic Management Sciences %	Economic Management Sciences C	Social Science %	Social Science C	Technology %	Technology C	Promotion P- promoted NP – Not promoted	REMARKS
30		MOTLILENG ANNA	F	30.01.93	1	40	3	51	4			44	2	84	7	66	3	25	1	43	2	46	3	53	4	NP	
31		MOTLILENG JANE	F	30.01.93	1	38	2	43	3			48	2	60	5	50	3	0	1	28	1	42	3	51	4	NP	
32		NGOEPE MELVA	F	29.11.91	1	12	1	42	3			44	2	52	4	44	2	15	1	53	3	38	2	36	2	N.P	
33		NGOEPE PATRACIA	F	14.05.93	1	24	1	85	7			66	3	72	6	80	4	20	1	56	3	62	5	74	6	N.P	
34		NGOEPE WHITNEY	F	04.03.94	1	58	3	74	6			51	3	84	7	72	4	20	1	39	2	48	3	65	5	P	
35		PHAGO WENDY	F	07.12.94	1	42	3	78	6			50	3	88	7	72	4	65	5	59	3	52	4	76	6	P	
36		PHUKUBJE AUDREY	F	23.06.94	1	44	3	58	4			47	2	60	5	66	3	38	2	39	2	54	4	71	6	NP	
37		RAMOROKA CEDRICK	M	10.10.94	1	68	4	88	7			69	3	84	7	88	4	70	6	56	3	48	3	74	6	P	
38		RATHOKOLO GIFT	M	06.03.94	1	46	3	76	6			47	2	80	7	33	2	10	1	35	2	38	2	82	7	NP	
39		RATHOKOLO THANDI	F	20.09.94	1	40	3	77	6			27	1	84	7	83	4	40	3	41	2	70	6	66	5	N.P	
40		SEKHULA DAPHNEY	F	05.11.93	1	08	1	76	6			38	2	88	7	88	4	50	4	60	4	56	4	72	6	N.P	
41		SEOPA LYDIA	F	27.11.94	1	76	4	88	7			64	3	80	7	77	4	48	3	74	4	82	7	65	5	P	
42		SETLAU WILLIAM	M	22.10.94	1	30	2	74	6			60	3	52	4	83	4	20	1	23	1	38	2	78	6	P	

Number placed in next grade: ....

Date: ....

Certified correct: Teacher: [signature] ....

Date: 20/03/2008..........

Principal: SKMamamela ....

Date: 20/03/08..........

APPROVED: CIRCUIT MANAGER: ....

Date: ....

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