Reading for a foundation:

Why Science Foundation Programme students struggle and how scaffolding can help.

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Declaration of work originality

I, Tamlin Kirkwood, declare that this dissertation is my own original work and has not been submitted previously for any degree at any university.

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Abstract

Reading lies at the centre of Science Foundation Programme (SFP) students' struggle for access to the very support that such programmes offer in preparation for undergraduate study. It is a skill that is generally not sufficiently improved over an initial year of university study because, apart from being underdeveloped in previous educational and life experiences, it is not explicitly developed at tertiary level where students are generally expected to process extended texts independently in a limited time period. This study not only probes the background literacy experiences of UKZN (PMB) SFP students, but also measures the reading ability, in terms of reading comprehension, rate, and receptive non-technical academic vocabulary, with which the majority begin their studies. To better understand why many SFP students struggle with their academic reading and find prescribed science texts inaccessible, student feedback on reading difficulties and reasons for not attempting homework reading is also considered.

In response to such data from the 2005 cohort of about 180 students, a means of supporting or "scaffolding" student reading was investigated. This involved preparing an experimental group of students for independent reading by initially "talking them through" an overview of the text in commonsense terms so that even the weakest readers could begin the reading process with some understanding of the extended text that had been assigned. The other half of the student cohort made up a control group who were merely instructed to read the text for homework. Overall comprehension of

experimental and control groups was tested, and questionnaires about reading difficulty administered. The effect, on reading rate, of using a paraphrased version of a text was also investigated by dividing students into an experimental group to read such a version and a control group to read the original. Reading rate was measured again at the end of the year, in comparison with a mainstream sample, for potential progress.

Findings suggest that SFP students are largely under-prepared academic readers who are more likely to read a prescribed text, and this with comprehension, when initially talked through a commonsense paraphrase. It is hoped that provision of such scaffolding over the course of the foundation year will develop students' confidence to attempt reading the texts assigned to them so as to become more practiced academic readers, and thus better prepared for mainstream study.

Chapter 1

Introduction

"Reading is the skill upon which success in every academic area is based."
- Nel et al (2004:95)

The Science foundation Programme (SFP) was initiated on the Pietermaritzburg campus of what is now the University of KwaZulu-Natal (UKZN) in response to the need to increase the throughput of African students in the sciences who, in 1990, made up only six percent of B.Sc. graduates. Poorly resourced and overcrowded schools, under-qualified teachers and limited exposure to academic reading and writing in English as an additional language have contributed to the disproportionate number of African matriculants who are underprepared for university study. The SFP thus provides a foundation year programme aiming to facilitate the transition of academically talented yet educationally disadvantaged African students from an underprepared school background to successful tertiary study in the sciences or applied sciences (Grayson 1996, 1997). The current SFP page on the UKZN website reaffirms such aims, offering the provision of alternative access into the Science Faculty for "students from disadvantaged schools who are interested in a science degree but do not meet the entry requirements for it". Previous educational disadvantage and adequate performance on selection tests is a requirement for students accepted on the programme.

Most South African universities provide some form of access to students whose inadequate secondary education has prevented them from achieving the matriculation points necessary for enrolment in tertiary studies, particularly in the field of science, according to usual criteria. Such access may be provided by way of supportive courses, be they discipline-specific modules or more generic academic literacy courses, or by the provision of a faculty-specific access or foundation year programme, such as the SFP. Students accepted on the SFP at UKZN are required to

study four foundation-level science courses (Mathematics, Chemistry, Physics and Biology) as well as a communication course aimed at developing academic literacy skills specific to the field of science. Counselling classes facilitate the development of the study and life skills crucial for successful study. Mid-year performance on examinations across these disciplines determines which students are unable to cope with further study in the Science Faculty and must be excluded from the programme. Those who score sufficient marks in class work and end of year examinations are able to begin mainstream study the following year, embarking on their first year of a B.Sc. degree.

On the Pietermaritzburg campus, approximately 200 students initially enrolled in the SFP in 2005, though by the end of the year, closer to 160 students remained in the programme.

Access into scientific study in a tertiary institution, for educationally disadvantaged Foundation Programme students, requires access to new ideas and new skills. Students who struggle to read the texts prescribed to enable them to develop the skills and understanding necessary to cope with tertiary study are denied access to the very support that they need to overcome previous disadvantage and to succeed in their studies. Any attempt to address student needs and to explore methods to facilitate their preparation for mainstream study can thus be of little use if students' academic reading abilities and difficulties are not considered. Hence the starting point of this project: an exploration of these academic reading abilities and difficulties that the 2005 cohort of SFP students bring to their foundation year.

Some sense of the linguistic background and literate experiences of students is built up from a questionnaire administered to the approximately 200 students embarking on a foundation year of science study. To probe why SFP students struggle with their academic reading, some indication of the reading abilities with which they begin tertiary study is also needed. Exploration of the myriad skills and abilities associated with reading being beyond the scope of this research, an initial measure of academic reading ability includes only a paragraph summary to test overall comprehension of an extended text. This is supplemented with results from a language placement test, widely used for tertiary ESL students, that is largely based on text comprehension.

Experience teaching SFP students has suggested that the time most of them require to read even the briefest of texts in class is a crucial factor in their reluctance and limited ability to read prescribed texts. There are often complaints that a text prescribed for homework reading is "too long", and students frequently ask about the meaning of individual words, complaining that a text is "too hard" because they could not understand many of the words.

The following extract from a student's dialogue journal (the "space" provided in the first few weeks of the communication course for students to write freely about any issue of concern) provides some sense of the frustration experienced when much academic English vocabulary is unfamiliar to an SFP student:

> *"I am still struggling to pass my SFP courses, but there are some problems which are opposing me.*
>
> *My problem is that there are some English words that I don't understand, that affect me when writting tests. It happens that I can't answer the question because of some words that I don't understand, even if the question is not difficult."*

Two specific aspects of academic reading ability selected for measurement in this study are thus reading rate and receptive academic vocabulary. To investigate the former, times taken to read short prescribed texts, with some comprehension, are averaged at the beginning of the year and again at the end of the year-long programme. Progress from initial to final performance on reading rate tests is considered, and also compared with performance of a small mainstream sample.

While conceptual understanding of scientific terms is, necessarily, a focus of research into ESL students' understanding of science texts, limited lexical knowledge of general, academic English has proven to be a source of difficulty for science students, including those in the South African context. The focus of this study is on second language English students' academic reading. Though the context of scientific study is central to any understanding of their reading, understanding of science texts, in this case, considers general reading and language issues to the exclusion of understanding

of scientific concepts. Understanding of non-technical, general academic vocabulary having been identified as a significant area of difficulty experienced by science students in their academic reading (Gardner 1972, Cassels and Johnstone 1980, Carré 1981, Sanders and Nhlapho 1993, Sanders and Mogodi 1998, 2000), a vocabulary test consisting of such lexical items is also administered at the start of the 2005 foundation year programme.

Of primary concern are the factors that prevent students not only from reading effectively, but from even attempting to read the texts that are assigned. Questionnaires are therefore administered along with reading tests so that students can share whether or not they read the texts prescribed for homework and explain why, if not, as well as discuss the difficulties that they experienced with their reading.

It is hoped that investigating these aspects of SFP students' academic reading ability will help to establish a clearer understanding of the "reading problems" that hinder them in their studies, and thus help to identify an appropriate starting point for developing the academic reading skills necessary for academic success.

"Scaffolding" reading is a possible strategy to aid students in their academic reading development as it enables all students to approach a particular text with some understanding. As a result, students are able to read, with the tutor's support, what would possibly be too difficult for them to read independently.

Strongly influenced by the methods advocated by Rose et al (2003, 1997), the "scaffolding" provided to prepare SFP students for independent reading is reduced to an initial discussion of the topic to provide them with necessary background information, and an overall summary of the text in simple, every day language. All students should thus have some idea of the main points to be discussed in the text, making it more accessible to them for independent reading. Though a detailed reading of the entire text is not carried out in class, it is hypothesised that individual students, with an understanding of the "big picture" as a resource to draw on, should be better equipped, and more confident, to work through unfamiliar wordings and difficult structures and concepts so as to achieve an adequate level of independent text comprehension.

The second part of this study explores the effectiveness of such a form of scaffolding as a possible strategy to facilitate SFP students' development as academic readers. If an experimental group of student subjects finds a prescribed text more accessible than does a control group not provided with an initial spoken paraphrase, then the method could offer content course lecturers, as well as academic literacy specialists, a viable strategy for dealing with the underdeveloped reading skills that deny many students adequate access to content knowledge.

If students do find prescribed texts to be more accessible as a result of this initial oral scaffolding, it is hoped that they will not only benefit more from the reading assigned across courses, but actually attempt more reading and thus become more practiced readers who, by the end of their foundation year, are able to read more quickly and, familiar with more general academic words and the written discourse of academic English as a result, are able to read with greater comprehension. As Eskey and Grabe (1988:228) argue, "classroom work can point the way but cannot substitute for the act itself: people learn to read by reading".

A more rigorous study of the effects of scaffolded reading support on academic development would only really be possible if the method was to be extensively implemented across the curriculum for the course of the SFP year. As SFP lecturers have the responsibility of training students in the skills and subject knowledge associated with their particular field, while attempting to help them overcome previous educational disadvantage, very limited time is available for in-class reading. A possible reading intervention strategy must therefore appear feasible in terms of its time requirements, and first be proven successful, if it is to be considered for implementation on a larger scale. For this reason, exploration of the effectiveness of a reduced form of reading scaffolding is tested experimentally within one section of the Communication in Science syllabus and is acknowledged to be a mere starting point in developing a potential means of meeting students' needs for academic reading development.

That SFP students are generally reluctant, under-practiced, and slow readers who struggle to comprehend academic texts, is evident from the initial findings of the study. Talking them through the central ideas of a prescribed text before expecting

them to read it independently does appear to be an effective strategy to include in attempts to address this problem and facilitate students' development of the academic reading skills fundamental to academic success.

Chapter 2

Literature review

This chapter will begin with an exploration of some of the theories and previous studies of the actual process of reading, before the reading practices of educationally disadvantaged SFP students are considered within their socio-cultural context in South Africa. Academic reading, specifically, will then be discussed, with the focus on general academic vocabulary comprehension and reading rate studies. After reviewing research into reading in the field of science, in particular, strategies to "scaffold" students' reading will be explored.

2.1 The Reading Process

> *"The ability to read refers to more than just being able to recognise letters and decode words; it includes the ability to construct meaning from the written word and familiarity with the various forms and functions of written texts" (Pretorius and Machet 2004).*

Reading is not an easy construct to define. In this study it will be considered as an element of academic literacy. Rather than the operation of a technical skill, reading is thus seen as a socially-situated practice, an aspect of the multiple *literacies* to which Street (1995) and other supporters of the New Literacy Studies refer when rejecting the notion of literacy as merely the ability to process written text.

To investigate the difficulties experienced by students in the area of academic reading so as to usefully inform pedagogical practice, it is, however, necessary to consider the processing that does take place when an individual reads. Historically, attempts to understand and describe the reading process have seen both a "bottom-up" approach and "top-down" models replaced by the interactive approach that is now generally

accepted as an adequate description of how we read (Carrell 1988a, Mc Carthy 1991, Celce-Murcia and Olshtain 2000).

Attempts to model the reading process are discussed by Urquhart and Weir (1998) who refer to Gough's (1972) "bottom-up" model which describes reading as a text-based process, relying on the reader's ability to decode written symbols. On the other hand, we read of theorists such as Goodman, first in the 1960s, and then Smith (1971, 1973) proposing a psycholinguistic model of reading (in Grabe 1991). This "top-down" approach highlights the role of the existing knowledge (schemata) and expectations of the *reader* in the process of reading.

Today reading is widely acknowledged to be an interactive process. Pioneered by Rumelhart (1977) and Stanovich (1980), interactive models describe the integration of decoding and comprehension of written text as bottom-up and top-down reading processes interact (in Urquhart and Weir 1998). To view reading as an interactive process therefore means acknowledging that reading ability requires that a reader, influenced by his or her purpose for reading, decodes the text itself while drawing on prior knowledge of the world, of reading, and of writing conventions, for comprehension and interpretation. Reading ability, in other words, consists of two major components - the ability to recognise words and to draw on existing schemata to understand what has been written. To further unpack the latter, we can consider the division of existing knowledge structures into content schemata, or knowledge about a text's subject matter, and formal knowledge about a text's rhetorical structure, as well as linguistic schemata or the understanding of language that a reader draws on (Carrell and Eisterhold 1988, Carrell 1988a).

Reading ability is a difficult construct to measure. Successful reading, from an interactive point of view, implies that an individual has processed written text and drawn on prior knowledge to arrive at an understanding of the author's meaning. Determining a reader's ability to do this would thus require some measure of reading comprehension. This construct Urquhart and Weir (1998:85) recognise as "a somewhat elusive entity" (possibly because of the different ways to read a text so as to arrive at different levels of understanding), but argue that it is necessary to make

some judgement of an individual's reading proficiency in the context of academic study.

The interactive model describes the processes involved whenever written text is read, but the broad notion of "reading" includes a number of different reading strategies used to accomplish different goals. "Reading" can thus range from skimming for global meaning, to very close, careful reading of a text. Detailed understanding of every aspect of a text, on the one hand, and the ability to extract important information and comprehend the gist of a text, on the other, could thus both constitute the notion of "comprehension", depending on the reader's purpose. Urquhart and Weir's (1998) response to this difficulty involves reasoning that a student is not likely to be able to work out the central ideas of a text without "some baseline competence in the microlinguistic skills" (133). That is, a student could only demonstrate a good understanding of the gist of the text as a whole if generally capable of some level of comprehension at sentence and word level.

2.2 Social Context

Although a cognitive-linguistic activity, reading is influenced by a number of social and cultural factors, so the technical process of reading must be considered in context. To explore SFP students' reading abilities would thus require that some consideration be given to the practice of reading in the South African context. Commenting on the reading situation in South Africa, Pretorius (2002a) describes a "national educational crisis" (170). There are no standardised reading tests to formally test the reading abilities of South African school students which, along with the disconcerting findings obtained when tertiary students' reading has been probed, impresses the urgency of the need to investigate the reading experiences and competencies of SFP students.

Many of those SFP students who are able to communicate proficiently in conversational English still struggle with their academic reading. Cummins' distinction between Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP) is useful in explaining this situation (Baker and Hornberger 2001, Clarence-Fincham 2000, Rosenthall 1996). In spoken

communication and written texts more typical of spoken language, it is generally possible to recover meaning from the context. Such communication would thus, according to Cummins, rely on BICS. Written texts, especially those that are "academic" in nature, do not offer such contextual clues to meaning, requiring a high level of cognitive ability – CALP – which takes longer to develop than BICS.

The underlying knowledge of text structure and content that an individual draws on when reading a text, regardless of the surface features expressing meaning in a particular language, are, according to Cummins' (1981) Linguistic Interdependence hypothesis (in Rosenthall 1996, Clarence-Fincham 2000), transferable to additional languages acquired. If CALP has not been developed in the mother-tongue, a student has nothing to transfer into the language of teaching, so must develop the academic skills and subject area concepts associated with academic success while simultaneously developing proficiency in the additional language through which such learning must take place (Cummins, in Cummins and Swain 1986).

The majority of SFP students are second language English speakers who, when it comes to academic language proficiency, are likely to have been disadvantaged by a situation of subtractive bilingualism (Luckett 1995) whereby initial mother-tongue instruction usually switches to English medium instruction in the fourth year of primary schooling in South Africa (Peacock 1996). English is generally seen as a more prestigious and more empowering language. Often introduced before CALP has been properly developed in the mother tongue, English is learned at the expense of the home language which is undervalued and underdeveloped at school. While struggling to master English, students miss out on the opportunity to develop a sound conceptual understanding of subject content, as well as reading skills, in their own language (Clarence-Fincham 2000, Luckett 1995, Macdonald 1990). Thus, for many SFP students, an early changeover from school instruction in their mother tongue to English means that they have not been able to develop CALP in their own language or English as the medium of instruction, a language in which the teacher may not even have been proficient.

It is only through reading that students develop CALP, Pretorius (2002a) argues.

However, the low English proficiency of many students makes reading in English a slow and difficult process, which in turn impacts negatively on motivation (Nuttall 1996, in Anderson 1999a). This is significant in light of Grabe's (1991) conclusion that students' academic reading ability can be profoundly affected by their L1 reading practices and access to texts for "students learn to read by reading" (396).

Added to the impact of linguistic difficulties on academic reading is the fact that few students have the opportunity to develop reading skills by reading for pleasure before having to master academic reading for their university courses. Many South African ESL students come from primarily oral cultures and their home languages are generally those in which few appropriate reading materials have been available (Pretorius 2002a, Niven 2005). This, along with the fact that more social or communal, rather than individual recreational pursuits are common, could be part of the reason that students' reading histories, in Niven's ethnographic study of access year university students, revealed that "books and reading were associated with schoolwork rather than recreation" (2005:781). Books may not even have been available for individual reading in poorly resourced secondary schools. If Niven's student-subjects' experiences are similar to those of many SFP students, then school reading may often have involved listening to one person reading a text, rather than actually working with individual copies of the text to access the meanings expressed. Research by Taylor and Vinjevold (1999) and Pile and Smythe (in Taylor and Vinjevold 1999) reveals that when text books are available in some South African schools, they may not actually be distributed to students for their use in the classroom. As a result of disadvantaged schooling, which, as Hardman and Ng'ami suggest, "may not have effectively mediated their entry into textuality" (2003:140), learners such as SFP students may begin university with limited experience of interacting with texts.

Much debate on the issue of reading in a language other than one's mother tongue has centred on the question of whether reading difficulties can be attributed to language or reading problems (Alderson in Alderson and Urquhart 1984, Carrell 1991). While it is not the purpose of this study to investigate either claim, the debate is significant in that it alerts us to the plight of the majority of SFP students for whom English is a second or other language because many struggle with the English language and, given

the dearth of suitable, accessible reading material, are also unlikely to be experienced readers in their first language. Alderson (in Alderson and Urquhart 1984) concludes that teaching should focus on language instruction if language is the cause of English reading difficulties, and on reading instruction if this is the cause of problems. In the case of the majority of SFP students, both aspects need to be addressed.

2.3 Academic Reading

Though it is in writing that the linguistic difficulties of ESL students are most obviously revealed, their receptive academic skills such as reading may be the more fundamental, but less visible, problem (Blacquiere 1989, Block 1992, Kilfoil 1998, Pretorius 2002a, Nel et al 2004, Hirvela, in Flowerdew and Peacock 2001). Winberg's (1999) argument that reading comprehension in higher education has been under-represented is hardly surprising, given the findings of the study by Pretorius (2002b) into the amount of locally published research on reading. Carson (2001) also suggests that reading is an area of English for Academic Purposes that has received limited attention, despite the importance of reading competence for academic study. Successful tertiary study relies heavily on the ability to comprehend ideas that must generally be accessed through written academic texts. Thus reading is one of the most important skills for second language learners in academic contexts (Grabe 1991; Nation 1990). "To experience success in the academic mainstream", agrees Kasper (1995:223), students "must attain an adequate level of English language reading proficiency". Limited research and the absence of standardised second language reading proficiency tests (Pretorius and Machet 2004) make it difficult to establish just what constitutes "adequate" English reading ability, though.

Sadly, many South African students are not prepared to cope with the reading demands of tertiary study (Zulu 2005; Nel et al 2004). Pretorius (2002a) provides an example in describing the average comprehension level of a group of Unisa's first year Psychology and Sociology students as well below frustration level at 53%. When reading rates of a small sample of these students were measured, it was found that they read at only 96 words per minute, well below the 200 words per minute speed generally agreed to be the minimum rate necessary to read with understanding.

Reading and writing skills are, however, closely linked (Eisterhold 1990). As Kilfoil argues, "If students read better, they write better because they understand what they read and do not need to copy large sections verbatim because they cannot differentiate between important and non-essential information" (1998:53). Extensive reading also leads indirectly to improved writing ability because of the exposure this gives students to written forms of language which, in Stanovich's words, prompts them to develop "a range of literacy-related skills and abilities" (in Grabe 2001:26).

The assertion that students learn better with improved reading skills introduces the important issue of the relationship between reading ability and academic performance. A study of undergraduate students revealed that a lack of ability in reading, "the very process by which learning occurs" (Pretorius 2002a:169), bars students from performing effectively in their studies. When the reading comprehension scores of Medical University of South Africa students, for example, were compared with their performance in final examinations, a strong relationship emerged between reading ability and academic performance (Pretorius 2002a). The students who passed their mathematics exams were those with the higher reading scores. The researchers were thus able to calculate a reading score (in this case, below 60%) that could predict the likelihood of failure in mathematics. Such findings give rise to Pretorius's (2002a) prediction that science education in South Africa is unlikely to improve if little is done to develop the reading skills that science and mathematics students lack. Also convinced of the link between reading ability and academic success, Nel et al (2004) conclude, from their findings in profiling the reading ability of a group of first year Potchefstroom University students, that poor reading ability is a major reason for the fact that few students successfully graduate from South African universities.

Academic reading ability is, of course, built up from a myriad of component skills and associated knowledge and abilities. As it is beyond the scope of this study to focus on all aspects of SFP students' academic reading ability, the investigation will only measure, apart from reading comprehension, receptive non-technical academic vocabulary and reading rate.

2.3.1 Comprehension of academic vocabulary

Vocabulary development is generally acknowledged to be a critical aspect of reading comprehension. "Students need a knowledge of academic vocabulary to gain access to texts", argues Zimmerman (1997:138) while acknowledging that it is largely through reading that learners develop their lexical knowledge. As Nagy (1994:1) puts it, "one cannot understand text without knowing what most of the words mean". If too many words are unfamiliar to a reader – more than five in one hundred words is Fry's "frustration level" (1963, in Eskey and Grabe 1988) – then Eskey and Grabe (1988) argue that no strategy can really be drawn on to make the text accessible to a reader. Knowledge of vocabulary is thus one of the reading component skills listed by Grabe (1991) who argues that not only is "a large recognition vocabulary" one of the requirements for fluent readers, but that vocabulary knowledge is a predictor of overall reading ability. Thus, "academic vocabulary causes a great deal of difficulty for learners" (Coxhead 2000:217).

Adequate vocabulary knowledge is not only necessary for effective reading comprehension, but also for successful academic performance. When the importance of vocabulary knowledge for scientific study is considered, Kilfoil concludes, from a study of the linguistic competence of tertiary science students, that "neither syntactic competence nor social fluency are good predictors of academic success: precision in language use within an academic framework, particularly precise command of vocabulary, is of greater significance" (1999:51). In Leki and Carson's study (1994, in Zimmerman 1997), L2 university students themselves identified vocabulary as their main stumbling block in academic work. Similarly, Mokhtari and Sheorey's (1994) study of tertiary ESL students' perceptions of their reading difficulties revealed that students with lower English proficiency believed inadequate vocabulary to be the main limitation in their reading ability. In South Africa, Cooper (1999, in Cooper 2000) found a positive correlation between academic vocabulary and academic performance, with 45% of students to fail a vocabulary test, failing the year and leading to the conclusion that L2 students' academic vocabularies are insufficient "to meet the lexical demands of the prescribed reading material on which their studies are based" (19).

"Vocabulary" knowledge is a broad construct. The aspect under investigation as part of "reading ability" to be probed in this study is non-technical, general academic vocabulary. Bohlman and Pretorius (2002:200) refer to the group of words commonly occurring in academic discourse as "academic words", distinguishable from both those high-frequency words common in everyday conversation, and the technical words encountered in specific subjects. Termed "low-frequency" words as they do not often occur in everyday conversational English, they include such examples as *assumption* (Bohlman and Pretorius 2002), *simultaneous* and *abundant* (Sanders and Mogodi 1998), *contrast* (Cooper 1984), and *random* (Gardner 1972).

As academic texts contain more of the less frequent English words than general English texts would contain, and as an academic reader would need to understand the numerous different meanings associated with any one word, Grabe (1991) suggests that it is likely that ESL readers, to comprehend academic texts effectively, would require similar receptive vocabularies to L1 readers in an academic context. Celce-Murcia and Olshtain (2000:76), in pointing out the great discrepancy between the English vocabulary needed for everyday conversation and academic reading, argue that a far larger receptive vocabulary is required for processing "all but the most rudimentary written English texts" than the productive vocabulary necessary for taking part in informal conversation. This situation highlights the difficulties faced by SFP students in their tertiary studies, especially when we consider the assertion Bohlman and Pretorius make that "Students who do little reading in English have poor exposure to low frequency words" (2002:200).

While conceptual understanding of scientific terms is, necessarily, a focus of research into ESL students' understanding of science texts, limited lexical knowledge of general, academic English has also proven to be a source of difficulty for science students, including those in the South African context. This study focuses on the latter as it is precisely these vocabulary items, unlike the discipline-specific technical terms, that are rarely taught explicitly (Hubbard 1996, in Cooper 2000) for they may be assumed to be understood by students or possibly not recognised as a potential barrier to conceptual understanding of the text. However Gardner argues that "There are many words, frequently encountered in scientific contexts, which are not technical terms … Yet an understanding of their meaning is certainly important for science

students" (1972:6-7). In support of this view, Cohen et al (in Carrell et al 1988) explain that it is often these non-technical words which are "carrying much of the meaning of the text, particularly with regard to scientific writing" (164).

As academic vocabulary, by definition, consists of those words rarely encountered in conversation, the lexical knowledge of ESL students unused to reading in general, and to extensive academic reading in particular, is a cause for concern. Not surprisingly, understanding of non-technical, general academic vocabulary has been identified as a significant area of difficulty experienced by students (Cooper, in Alderson and Urquhart 1984), and science students in particular (Gardner 1972; Cassels and Johnstone 1980; Coady, in Devine et al 1987; Selinker and Trimble 1974, in Carrell et al 1988; Carré 1981; Sanders and Nhlapho 1993; Sanders and Mogodi 1998, 2000; Kilfoil 1999), in their academic reading.

Comprehension difficulties related to general academic vocabulary are described by Cohen et al (1988, in Cobb and Horst 2001) whose Israeli subjects were able to translate 85% of the technical terms encountered in a text, but only 32% of the general academic or "sub-technical" lexical items.

Clark's (1997) research into the accessibility of science texts for South African secondary school learners is just one example of a local study revealing that it was often the non-technical words that caused the greatest difficulty for the grade nine readers participating in the study.

Sanders and Nhlapho (1993) argue that students' difficulties in understanding the non-technical vocabulary used in science teaching impacts negatively on effective learning, and must be addressed. The study that led them to this conclusion involved a test of a selection of those non-technical vocabulary items identified as problematic by Cassels and Johnstone (1990). Like Gardner's 1972 study of Australian science students, which tested understanding of non-technical vocabulary by multiple choice test, Cassels and Johnstone's research tested students' understanding of vocabulary items from science texts. Studying British secondary and tertiary students (both ESL and L1 English speakers), they concluded that it was largely the non-scientific terms that caused difficulties for students. A group of South African secondary school

students studying biology was the target of Sanders and Nhlapho's (1993) study which tested not only ESL and L1 English speakers' understanding of selected words, but also their confidence that the meaning they chose in each case was correct. Results revealed very limited understanding of the given words: a similar looking or similar sounding word was erroneously selected at times, and in some cases the opposite meaning was chosen. The fact that few teachers realise the difficulties that learners, particularly ESL learners, experience with such words is compounded by the fact that many learners are themselves unaware that they do not understand particular words correctly (Sanders and Mogodi 1998). Sanders and Mogodi express concern about how students can be expected to understand the scientific concepts that they are being taught if "they cannot understand the meanings of words being used to explain the science to them" (1998).

2.3.2 Reading rate

"The definition of reading ability comes from considering both speed and comprehension", argues Perfetti (1985 in Carver 1992:347). The issue of reading rate, for fluent academic reading, is, like receptive vocabulary, a key aspect of reading ability to be investigated. According to Grabe (2001:18), accurate reading of a short text, without time constraints, is a more likely indicator of problem-solving ability than the fluent comprehension ability central to successful academic study. The rate at which a reader reads has been described as "an inextricable dimension of what happens during comprehension" (Carver 1990:4). Many reading researchers would agree, primarily because reading too slowly impacts negatively on comprehension, as meaningful units of information are broken up in processing text word by word, which in turn puts too much strain on the reader's short term memory to allow an understanding of the whole text to be built up (Rasinski 2000, Anderson 1999a, Grabe 1991, Carver 1990, Celce-Murcia and Olshtain 2000, Eskey and Grabe 1988).

Reading rate is not a simple construct to measure as there are many different ways to read, depending on an individual's purpose. It is unlikely that anyone would take the same time to study a text to commit to memory the ideas it contains, as he or she would take to skim through a text for a rough idea of the general gist.

Carver's "Rauding Theory" (1990) is helpful in this respect for it labels and details, more precisely, the type of reading referred to when an individual's general "reading rate" is assessed. This theory is essentially an explanation of that reading process most commonly operating when an individual reads with comprehension to understand complete thoughts in the consecutive sentences of a text, as they are being read. Carver suggests that this is the most typical reading process (estimated to account for 90% of reading an individual does per week) as readers usually aim to understand the complete thoughts that a writer expresses sentence by sentence. It is therefore possible to assume a relatively constant reading rate for individuals as long as this purpose for reading is the same for subsequent measures of reading speed.

Drawing on the analogy of changing gears when driving a car, Carver (1990, 1992) describes the selection of appropriate reading processes to fulfill the reader's changing purpose. The first reading type, used for the difficult task of memorising information, is compared with the most powerful first gear. Reading to learn, to gain understanding, is likened to the somewhat faster and less powerful second gear. When a reader shifts into "ordinary" reading mode he or she is "rauding". Speeding up from this third reading "gear", a person would be skimming: quickly processing paragraphs for central ideas without building up a sentence by sentence understanding of the writer's message. Like fifth gear, scanning is the option for the fastest and least intensive reading. This involves reading specific key words rather than reading to comprehend complete ideas. As the way in which an individual reads any given text would change with any change in purpose, Carver argues that an individual's rauding rate is more or less constant unless situational factors, such as a change in difficulty level, induce a "shift in gear" to another type of reading process, such as slower reading to learn or faster skimming for an overview.

The speed at which an individual can read is closely linked to word recognition ability. Technically, the "rauding" process of reading involves visually and semantically recognising a word, integrating it with what is similarly read in the rest of the sentence, storing the complete thought in short term memory, and then continuing with the next sentence, unless regressions to words already read disrupt the process (Carver 1990). To comprehend the complete thought expressed in a sentence, the reader thus needs to recognise or "lexically access" words (Carver 1990:249). If a

reader takes a long time to recognise words, the rauding rate slows down. If unfamiliar with a word, he or she will be forced to focus attention on it, which may mean losing from short term memory what has previously been processed and having to reread the sentence, which in turn impacts negatively on reading rate. Once able to decode accurately, a reader can become more practiced at word recognition until the process becomes automatised, requiring little attention and thus little time. No longer moving through a passage one word at a time, the reader can devote more cognitive skills to understanding ideas in the text (Anderson 1999a). Grabe (1991) thus attributes rapid reading to the ability to identify most words automatically, which implies that extensive reading practice would lead to increased reading rate. As Nagy and Herman (1987) put it, "incidental contact with language through extensive reading is a prime source for automacity development" (in Grabe 1991: 391). For second language readers, then, being a practiced reader as well as having a well developed vocabulary in the target language must be vital for efficient reading.

The crucial question is at what speed a text should be read to facilitate effective comprehension. Although a number of reading theorists have investigated the optimal rate for reading efficiently, with understanding, there is no consensus in reading theory literature about the minimum rate at which reading must take place to facilitate comprehension. This is probably because of the impossibility of standardising studies of reading rate, given the sensitivity of such a measure to changes in text difficulty and instructions for inducing a particular type of reading. In the available literature on first and second language reading rates, though, a rate of no less than 200 words per minute is a popular figure for minimum reading rate necessary (Eskey and Grabe 1988, Dubin and Bycina (1991, in Anderson 1999a), Anderson (1999a), Celce-Murcia and Olshtain 2000), while other researchers, such as Carver (1990), Jensen (1986) and Nuttal (1982) (in Anderson 1999b) suggest that 300 words is optimal for students at tertiary level.

There is further discrepancy about the difference between the minimum rate necessary for first and second language readers to read successfully. Pretorius has South African ESL students in mind when she refers to a 160 to 180 words per minute minimum for speakers of English as an additional language (2002a:176). Like Anderson (1999a), who refers to ESL readers' 30% slower rate than those reading in their first language,

Pretorius suggests that roughly 70% of the rate at which first language English speakers read is adequate for students reading in a second language (pers. con. 2005).

The significance of limited reading rate for academic progress is linked to the cyclical relationship between reading rate, comprehension, motivation, practice, and resulting reading fluency. Much practice is required for students to become fluent readers in a language (Grabe 2001). Referring to what Stanovich (1985) calls the "Matthew effect", Rasinski (2000) explains that as reading too slowly is associated with reduced comprehension, motivation to read decreases. As reading progress is largely determined by the amount of reading one does, this means that a student's reading ability in general, and reading rate specifically, will not improve significantly. Thus reading below an efficient rate (whatever that may mean in words per minute for individuals in a particular context) is especially problematic because it prevents students from practicing, and hence, improving, their reading. Being associated with reading comprehension, reading rate must be linked to academic performance, as content knowledge is largely built up from information accessed through written text. Reading too slowly must therefore hinder students' academic progress.

Slow reading rates are particularly problematic for science students, suggests Carré (1981:9), for "the average sentence length in science texts is generally far too long for slow readers to cope with". Science texts are thus especially challenging for students more familiar with spoken than written English as they are generally highly nominalized and lexically dense (Halliday and Martin 1993, Unsworth 1997a, Lemke 1990). The grammatical process of nominalization in English, whereby much information can be condensed into one noun phrase, is common in academic writing and results in structural complexity and content density. Such writing, particularly common in science, affects a reader's processing of the written text (Celce-Murcia and Olshtain 2000). Not only would the length of a noun phrase with numerous modifiers slow down the rate at which a reader could process the phrase, but ESL readers, especially, might struggle to identify a head noun and would thus analyse the phrase more slowly (Celce-Murcia and Olshtain 2000). These "heavy" noun phrases (Berman, in Alderson and Urquhart 1984), which contain much embedding and modification, require a reader to remember a great deal of information. As a result of having to focus so closely on one part of a sentence, the reader may struggle to

remember the information with which the phrase is connected, reducing reading efficiency.

2.4 Reading Science

Written language, in the words of Halliday (1989:41), "never was, and never has been, conversation written down". Though written academic texts generally display the features typical of "written language", it is in scientific writing that highly nominalized, lexically dense language is particularly noticeable (Lemke 1990, Halliday and Martin 1993, Unsworth 2001). While Cummins' BICS/CALP distinction can help in accounting for the academic reading difficulties experienced by ESL students generally, an analysis of typical scientific writing can give further clues as to why science texts are particularly inaccessible to many students. (Though analysis of the genres of scientific writing allows us to generalise about certain features common to such texts, it is important to recognise, as Bazerman (1998:16) does that "scientific discourse is evolving and multiple").

"No domain represents academic … language better than science", maintains Gee (2005 in Yore and Treagust 2006:295). This is largely because scientific language is a very different language "from that of human experience" (Lemke 1990:134) which, in many ways, is quite the opposite of the explicit yet abstract scientific style that avoids narrative explanation or figurative description. The language of science may be unfamiliar to most students, regardless of mother tongue, but could be particularly alienating for SFP students as the majority share a heritage rich in oral tradition and have had limited experience with extended written discourse.

It is the lexicogrammar, rather than difficult vocabulary, according to Halliday and Martin (1993:4), that gives scientific texts their distinctive quality. Of the various lexicogrammatical features identified by the authors, grammatical metaphor – the substitution of one grammatical structure by another – and lexical density – the high proportion of lexical or content words packed into each clause – are of particular interest in this study.

Nominalization, "the favorite grammatical pattern in modern scientific English", in terms of the semantic load that can be carried (Halliday, in Martin and Veel 1998), is a kind of grammatical metaphor as it is one way of replacing a grammatical form with a less congruent, or less typical one to carry its meaning. In this case, events, qualities and relationships are reworded metaphorically as nouns – 'things' – rather than verbs, adverbs, or conjunctions (Veel 1997). Nouns thus "replace what in the observable world is a whole series of events" (Veel 1992:35). For example, instead of reading "*When people **plant** a lot of crops year after year, many nutrients **go out** of the soil*", we would read that "**Overcropping** often ***causes*** a **breakdown** in the soil." (Droga and Humphrey: 2003:102)

This process of nominalization has historically been used to create more abstract texts (Bazerman 1998). In his typically functional approach to language, Halliday (1994:353) argues that the popularity of 'nominalizing metaphor' in scientific writing came about in response to the need to construct hierarchies of technical terms, as well as to enable writers to explain phenomena step by step, by transforming complex information into nominal groups to act as the Theme of subsequent sentences. For example, the phenomenon of water vapour condensing or returning to a liquid state when it cools could be realised by the noun "condensation". Further sentences referring to this scientific phenomenon could then begin with "condensation" or a pronoun (such as "it" or "this") in Theme position. That is, we could read on that "**Condensation** can also occur when a vapour is compressed into a liquid. **This compression** leads to the formation of water droplets known as condensate." "**Condensate**" could in turn be the Theme of the next sentence in the explanation sequence. By summarising, in one nominal group, what has gone before to move to the next step, a complex chain of reasoning can be built up (Unsworth 2001). Once "things", processes and qualities also become measurable (Veel 1997). Nominal groups can also be expanded lexically as a head noun can be modified by the inclusion of a Deictic, Numerative, Epithet and Classifier, as well as a Qualifier (Halliday, in Martin and Veel 1998). While nominalization does enable writers to facilitate classification and categorisation (Halliday, in Martin and Veel 1998) and "to compress as much information as possible into a short space" (Martin, in Halliday and Martin 1993), it encodes ideas in a form that is less familiar to students. "Syntactic ambiguity" (Halliday, in Halliday and Martin, 1993:78) also results as some

meaningful information (such as the agency) is hidden in the process of transforming whole clauses expressing processes, relationships and so on, into nouns (Halliday 1994). As more and more nominal abstractions are introduced, "concrete referential information" is lost (Bazerman 1998), thus increasing the difficulty level of the text for readers whose cognitive load is increased as they need to fill in more gaps. Possibly the most significant implication of the use of grammatical metaphors such as nominalization, for SFP students' reading, is the resulting "shift from commonsense to uncommonsense" (Derewianka, cited by Halliday in Martin and Veel, 1998:225).

Heavily modified nouns resulting from the process of nominalization contribute to the high lexical density of many science texts. To determine a text's lexical density, the number of lexical items must be divided by the number of clauses. While spoken language becomes more complex from a build up of clauses, the complexity of written texts is brought about by packing many lexical items into each clause (Halliday 1994). Written clauses thus generally carry a much heavier semantic load, and the more abstract the text, the higher the lexical density (Veel 1997). Typical spoken texts have a lexical density of 2.0 while most written texts, particularly scientific ones, are much more lexically dense (Halliday 1994, Veel 1997).

2.5 Scaffolding reading

The majority of SFP students' linguistic experience, because of limited reading, would not include what Wells calls "a strong orientation" to the written grammatical forms of nominalization and high lexical density (1994, in Unsworth 2000:259). Thus their ability to read scientific texts "depends on a long apprenticeship into science", and "at each stage of this apprenticeship, knowledge of the field and ability to read and write the grammar become more and more specialised" (Rose 1997:42).

Learning how to interpret the lexically dense, metaphorical grammar forms of explanatory texts is an important part of understanding the content of such science texts (Unsworth 1997a). To access the ideas necessary for developing their understanding of a particular scientific topic, students must read texts written in the abstract, technical style typical of written language in general and of science in

particular. Thus the linguistic gap between 'commonsense' and 'technicality' (Halliday 1993:55) must be bridged if comprehension is to be possible. This can be facilitated by the teacher providing some scaffolding: helping students to unpack the central meaning of a text before they have developed the level of familiarity with written language necessary for effective independent reading and hence, for successful study.

Behind the concept of 'scaffolding' lies the Vygotskian notion of providing the support necessary for learners to successfully complete a task they would not initially be able to carry out independently. As theorised by Bruner (1983) in the context of child development, where caregivers adjust the amount of support given to a child in mastering language and other practices, scaffolding is seen as "a social, communicative process" (Mercer 1995:73), a means of apprenticeship involving the use of speech or "collaborative dialogue" (Swain 2000:97) to mediate the learning process. Temporary and dynamic, the scaffolding offered is reduced as the learner's skill increases (Donato 1994). Applied in the context of academic reading support, scaffolding involves supporting students' reading, to a lesser degree as they develop their reading skills, so that they are able, with a teacher's guidance, to access meaning in authentic academic texts before their academic reading proficiency is adequate for independent reading for understanding.

To provide such scaffolding, Unsworth proposes "teaching/learning activities which deconstruct written explanations, collaboratively talking out the text and shunting back and forth between the grammar of spoken and written language" (1997a:34). Facilitating a student's apprenticeship into reading and writing science texts in this way, for Unsworth, involves drawing on the Teaching/Learning Literacy Development Cycle (LDC) of "modelled", "guided" and "independent" comprehension and composition practice (2001:222), which is much like the genre-based "Teaching/ Learning Cycle" of "modelling", "joint negotiation" and "independent construction of text" described by Macken et al (1989, in Unsworth 1997a:39).

As this study is specifically concerned with scaffolding SFP students' *reading* of science texts to help them to access the ideas that they are required to understand,

consideration of Unsworth's suggested classroom practice will be limited to only those stages related to comprehension. The initial stage of orienting students to the text is much like the process that Rothery (in Hasan and Williams, 1996:103) calls "negotiating the field" where together teacher and students build up shared knowledge of the field or topic of the text to be read. In this modelling stage, students' commonsense knowledge is drawn on and extended by the teacher orally explaining ideas to be encountered, and starting to "informally" weave "the grammar of the written medium" into the oral language (Unsworth 1997a:39). Previous work in the field of reading pedagogy acknowledges the vital relationship between background knowledge and comprehension (Carrell 1988b, Grabe 1991). As Grabe argues, "If students do not have sufficient prior knowledge, they should be given at least minimal background knowledge from which to interpret the text" (1991:390).

Next, in Unsworth's (1997a, 1997b) cycle, teacher and students read the text together and ideas, stages and grammatical features are explained in deconstructing the text. As teacher and students talk about the text, the teacher can reword unfamiliar aspects in more familiar, commonsense terms, as well as provide the more appropriate, "written" realisations of ideas discussed in a familiar, informal way. In "talking out the text", as Unsworth (1997a:40) calls it, students actually learn to discuss a text in their own words as their teachers implore, but seldom equip them to do.

Scaffolding academic reading is also a pedagogic approach proposed by Rose et al (2003) to enable inexperienced readers, who rarely read their prescribed texts, to comprehend texts to facilitate their learning in various content areas. The difficulties faced by such readers are identified as being twofold, incorporating both unfamiliar subject matter and language patterns uncharacteristic of the everyday spoken or written language with which they are familiar (2003). Added to this is learners' limited reading experience and thus, limited reading ability.

Bernstein's notion of "invisible pedagogy" is the theory Rose (2004) draws on to uncover the roots of the need for supported reading practice for educationally disadvantaged students in Australian society. It seems quite possible that educational disadvantage in South Africa may, to some extent, be similarly affected by a hidden curriculum that is more accessible to learners from highly literate backgrounds. Rose

argues that, by reading with their children at a young age, parents with a high level of literacy generally scaffold their children into "written ways of meaning" before the start of school (2004:93). Through interactive reading with a caregiver, young children gain experience with books and reading that enables them to see themselves as "readers", reading as a pleasurable activity, and printed text as something with which it is possible to interact, before they learn to recognise letters and read independently.

As Heath found in her ethnographic study of different literacy practices in U.S. communities, non-mainstream children, who have not experienced a "scaffolding" dialogue of questions and feedback about bedtime stories that a caregiver reads "with" them, are at a disadvantage when they begin formal schooling as teachers assume that the apprenticeship into ways of interacting with written text has already taken place at home (1994). As Gee phrases it, "schools ... tend to be good places to practice mainstream literacy once you have its foundations, but they are not good places to acquire those foundations" (1994:188).

In South Africa, Ntuli and Pretorius (2005) found that promoting storybook reading in the mother-tongue (isiZulu) of poverty-stricken, rural pre-school children, as part of a Family Literacy project in the area, had a very positive effect on their language and literacy development. As a result, they significantly out-performed their older primary school peers in tests of linguistic, literacy and discourse proficiency. Supporting the idea that academic success is heavily reliant on the emergent literacy skills promoted by storybook reading before schooling begins, such a study highlights the difficulty faced by disadvantaged students, such as those on the Science Foundation Programme, as a result of their limited exposure to storybook reading before they learn to read and write.

Students from oral, rather than literate cultural backgrounds, begin school with a limited or no experience of shared reading of books, and an experience of stories that are patterned differently from most written ones (Rose 2004). Confronted with the same syllabus and teaching methods when starting school, those learners that are unfamiliar with reading are at a distinct disadvantage as they are already a few steps behind their peers for whom the curriculum was designed. Pressured to cover

curriculum content and not trained to teach reading skills beyond the first few years of schooling, teachers are not able to help students to catch up. As they progress through school, students are required to learn more and more through independent reading, and writing tasks merely assess what has been learned from texts read. By tertiary level, knowledge is virtually inaccessible to those who struggle to read independently with comprehension.

To overcome such barriers to reading, and hence to learning, a similar scaffolding process to that suggested by Unsworth (1997a, 1997b, 2001) is outlined by Rose: "orient learners to the field of the text before reading" and "interpret the information expressed in the wording of each sentence" (Rose et al 2003:43). This scaffolding interaction cycle (Martin and Rose 2005) begins with an initial "preparing for reading" stage where students are given sufficient background information to understand the topic of a text, and are presented with a commonsense outline summarising, in accessible terms with abstract nominalizations expressed more concretely, ideas as they unfold in the text (Rose et al 2003:43). An interactive process of "detailed reading" then enables the teacher to ensure that all students, regardless of reading ability, can identify central meanings within each sentence. Interpreting, in sentence and whole text context, meaningful "wordings" (43) that are deconstructed in commonsense terms is believed to provide "intensive supported practice in recognising and interpreting academic language" (44). Once identified (from the teacher's questions or "cues"), wordings are further explained and discussed in the "elaborating meanings" stage (44). Particular structural and linguistic resources used in the text are considered in terms of how they realise meaning. The process then moves towards preparation for writing – an area not to be considered in detail here. In this stage, wordings identified and highlighted by students are collaboratively transcribed as notes on the board, to be used in joint and then independent rewriting of a text.

As the subjects of Rose et al's (2003) study – tertiary level students from disadvantaged backgrounds – are in some ways comparable to SFP students, the reported improvements on students' ability to write summaries on their readings as well as their implementation of the reading strategies across subjects, as they are actively involved in learning to recognise wordings, is encouraging. Of crucial

importance also, is the conclusion that the method gives students the ability to approach academic reading more confidently (Rose et al 2003).

To scaffold student learning through dialogic classroom talk, Sharpe (2006) suggests a number of discourse strategies which similarly help students to identify key ideas, move from the known to the unknown, and from everyday to more technical language. These include:

> repeating, recasting and appropriating language to develop technical vocabulary and recontextualise the content; increasing … questions to extend or reformulate students' reasoning; cued elicitation to encourage joint construction and "track" students' understanding; use of analogy to draw on students' existing background knowledge; and "metacomments" to summarise key concepts (211).

A central aspect of scaffolding academic reading for students is that of "modelling". To better demonstrate the process of extrapolating key meanings from a text, so as to prepare learners for independent reading, it would be useful to consider what distinguishes efficient readers from those who are less skilled, so as to explicitly reinforce effective reading strategies during the scaffolding process. As findings from a study by Carrell et al (1989) suggest, teaching subjects to use more effective reading strategies does enhance ESL reading ability. Cooper's study of practised and unpractised non-native readers revealed that paying too much attention at word level was characteristic of weaker readers (1984) while think-aloud techniques used in Hosenfeld's (1977) study of secondary school learners suggested that successful readers keep overall text meaning in mind, focussing on meaningful chunks of text rather than individual words (in Alderson and Urquhart 1984). Similar findings emerged from a study by Block (1992) whose investigation of readers' comprehension monitoring revealed that more proficient readers (both L1 and L2) favoured general, global comprehension strategies to work out text meaning, in comparison with the less proficient readers who drew on localised strategies in an attempt to understand a text at word or sentence level. Unlike the less proficient readers, successful readers were able to dismiss unknown words if they were able to work out the main idea of the sentence.

Such findings justify a somewhat reduced form of reading scaffolding where the text as a whole, rather than individual words, forms the primary focus of the commonsense summary presented orally to students. This macro-level scaffolding will still, of course, require that difficult words, as well as complex syntactical structures, be rephrased in commonsense terms, given the difficulties that academic vocabulary and the grammar of scientific writing is shown to present for students. Because of the length of SFP students' prescribed texts, though, initial preparation for independent reading will seek to encourage sustained reading, of authentic texts to be encountered in undergraduate studies, for "the big picture" rather than close reading of small portions in an attempt to discourage anxious attempts to unpack every unfamiliar word which slows down the reading process and further erodes motivation.

Pre-reading activities, such as previewing a text before reading it, Pretorius explains, increase readers' comprehension because "they provide readers with a schema of what is coming up, they help to activate prior knowledge, and they can also help to generate a more positive attitude to the text" (Pretorius 2005:802). Such previewing enabled the subjects of Pretorius' study to "get the big picture", which in turn "seemed to generate a more positive attitude to their reading tasks and to result in claims of better text understanding" (804). For students who are not yet able to preview an extended text independently, so as to generate a good idea of what to expect when they read, scaffolding students' reading by talking them through an initial, paraphrased summary, could similarly motivate them to read an extended text to the end, as they would begin the reading task with a general understanding of the text – a resource to draw on in working out difficult expressions of meaning as students encounter them in the text.

Informed by research in the field of academic reading, particularly in science, and in the specific areas of academic vocabulary comprehension and reading rate, the methods employed to investigate such academic reading abilities of SFP students, and the potential of facilitating their development by scaffolding students' reading, will be discussed.

Chapter 3

Methodology

Investigating SFP students' academic reading - operationally defined as the reading of any materials associated with their studies - consisted of two parts in an attempt to answer two broad questions. An initial probe into the linguistic background and previous literacy experiences of students, as well as independent reading comprehension, academic vocabulary and reading rate, aimed to reveal, in as quantifiable a way as possible, some aspects of the reading ability and background that SFP students bring to their initial year of tertiary study. With a picture established of the academic reading resources that most students have to draw on at the outset of their studies, the project aimed to test, experimentally, the effectiveness of a method of scaffolding students' academic reading in response to the degree of need ascertained.

Although this project measured the existing academic reading capability of students in a largely positivist fashion, by testing comprehension and reading rate, such data was enriched with an emic perspective from students whose views were elicited by a number of questionnaires over the course of the year.

The decision to focus on the collection of quantitative data was made largely to allow for the testing of the entire 2005 SFP cohort so as to establish the range of academic reading abilities and needs across individual students whose scores on various measures provide the averages for the cohort. As the purpose of the study includes the transformative aim of encouraging relevant curricular changes in response to the findings, it seemed more strategic, particularly in the Faculty of Science, where quantifiable evidence is highly valued, to collect such data to motivate for a greater emphasis on the development of reading skills to be instituted across disciplines. As this study does not merely propose to determine where students are at, but also to probe the reasons for their difficulties and the effectiveness of pedagogical

interventions to facilitate improvement, similarly quantifiable evidence, gathered from the whole cohort, was to be collected in response to these issues.

This study can be described as a form of action research if we are to define such research as that which studies social situations with the aim of improving action to solve problems (MacNiff 1988) or as that research which is carried out by practitioners rather than outside researchers (Nunan 1992). The project also meets Nunan's requirement of action research being situational as it is concerned with identifying and attempting to solve problems within a specific educational context.

Data was collected from activities done in class as part of the content of students' compulsory Communication in Science course. This was done to avoid resentment about "additional" work, though it meant repeating data gathering exercises in smaller groups. To keep the sample as representative of SFP students as possible, data was obtained from the entire 2005 cohort of about 180 students, although only a fifth of the students were actually taught by the researcher. The researcher merely took over another tutor's class session when an activity generating data for the study was planned, and as this was done a number of times over the course of the year, all students became somewhat familiar with the researcher. Such data obtained from the 2005 SFP cohort was also compared with language test results for mainstream students entering the Science Faculty on the Pietermaritzburg campus in 2005, and with the reading rate test results of second year students in a Biology class in 2006.

The data that was collected as part of the study is summarised in the following table:

Initial probe
Background questionnaire Comprehension of independent reading (summary) Questionnaire based on this independent reading Reading rate (two tests, including True/ False tests of comprehension) General academic vocabulary (multiple choice test) Language / academic literacy (placement test - "Ecotourism")
Comparison with final measures
Reading rate (two tests, including True / False tests of comprehension) Language / academic literacy (placement test - "Fire")
Comparison with mainstream students
Reading rate (two tests, including comprehension test) of mainstream sample Language / academic literacy (placement test - "Ecotourism") of mainstream students entering first year Science
Experiment
Comprehension test (summary) of text read without initial scaffolding Questionnaire based on reading of this text Comprehension test (summary) of text read with initial scaffolding Questionnaire based on reading of this text Reading rate (including True / False comprehension test) of original text Reading rate (including comprehension test) of paraphrased version

3.1 Initial probe: Why do SFP students struggle to read their prescribed texts?

Investigation of the academic reading needs of SFP students involved probing their previous linguistic and literate experiences and attitudes towards reading, and ascertaining the reading abilities that they initially bring to their tertiary studies. The latter was limited, in this case, to measurement of reading rate, text comprehension and understanding of general academic vocabulary, as well as the academic literacy and language proficiency assessed by a language placement test based on text comprehension. Questionnaires made it possible to determine whether or not students read an assigned text and elicited feedback about reasons, if the reading was not done, and about difficulties experienced with the reading.

3.1.1 Background linguistic and literacy experiences

Attempts to answer the question of why SFP students struggle to read their prescribed texts began with an initial probe into the reading background of the 2005 cohort of SFP students. A questionnaire was used to locate subsequent measures of "reading ability" in the socio-cultural context of individual students' experience of language learning and reading. As Mann (2000:297) argues, "Reading in the academic context has to be understood within both the personal and biographical context of the individual reader, and within the socio-cultural and political context of the reading activity".

The questionnaire (Appendix 3.1) was administered in the first session of the science-specific academic literacy module that all SFP students are required to take. Piloted the previous year and modified for the study, the questionnaire aimed to quantify what is often only known anecdotally about media of instruction at different levels of schooling, first experiences of reading, access to resources, attitudes to reading for pleasure and views about the difficulties of academic reading.

The decision to collect this data by means of a questionnaire was largely motivated by the potential that such a method offers for collecting quantifiable data from a large

sample (McDonough and McDonough 1997). As responses are to a large extent controlled by the questions, questionnaires allowed for the collection of focused and specific data from the entire 2005 SFP cohort. While this can be a limiting factor in that the questions do not allow any exploration of other relevant issues to emerge in particular responses, it did mean that data could be collected at different times and still be comparable. This made the use of questionnaires particularly convenient as the SFP cohort consists of smaller groups of around 20 students with contact sessions at different times and in different venues.

Although limited by the fact that research gathered by means of questionnaires is completely reliant on "the honesty and accuracy of participants' responses" (Marshall and Rossman 1995: 96), the use of student numbers rather than names on the questionnaires possibly does provide more of a sense of anonymity than an interview would to encourage greater honesty. The fact that questionnaires do not allow the researcher an opportunity to check respondents' understanding of a question or to seek clarity on a response given is particularly problematic in the case of respondents reading and writing in a second or additional language (McDonough and McDonough 1997), as the vast majority of the SFP cohort would be doing. However, it was felt that conducting interviews, apart from resulting in a far smaller and possibly less representative sample group, would be experienced as more intimidating by the majority of SFP students.

To reduce the interference of linguistic difficulties in answering a questionnaire in a language other than one's mother-tongue, and to prevent the loss of motivation likely when too much writing is expected of respondents (McDonough and McDonough 1997), questionnaire items were largely kept to closed or structured questions. These were phrased as simply as possible and required the selection of the most appropriate answer from a list of alternatives (Goddard and Melville 2001). Apart from the factual question asking students to fill in their home language, only one open-ended question was posed at the end to generate more detailed information about the reasons why students may experience difficulty with their academic reading in English. This question was asked of students as a preferable alternative to putting particular options to them because it was felt that these may all be recognised as part of a student's own experience, to some extent, and would limit responses to possibilities that have

occurred to the researcher and are unlikely to cover the unique difficulties students may experience with reading.

This aspect of the project, though a crucial basis for interpreting further, more specific findings about students' reading ability, is not intended to be an in-depth exploration of the social and linguistic factors shaping their literacy experiences. Rather than add to existing local research in this field, the aim of this part of the study was, to a large extent, to confirm the extent to which students in the study represent the needs of educationally disadvantaged and underprepared student readers. Thus the questionnaire was the most appropriate instrument to use for the purposes of this aspect of the study, despite its obvious limitations.

3.1.2 Independent reading ability and feedback

Deciding how to assess reading comprehension was especially difficult as the influence of writing ability is not easily distinguished from reading ability in written tests, while oral interviews have limitations of their own, influenced by affective factors such as anxiety, for ESL students in particular, as well as the difficulty of maintaining consistency from one interview to the next. The practical constraint of limited resources to carry out successive interviews with a representative sample of students was also a factor in ruling out the possibility of assessing reading comprehension orally. In the end, two different instruments were selected to measure comprehension: multiple choice questions and short written summaries.

To measure students' comprehension of a prescribed text read independently, a text to be worked with on the course was assigned as homework reading and in the following session, students were given 15 minutes to summarise the central ideas of the reading. The time limit was imposed to prevent them from re-reading the entire text, their *homework* reading being the focus of the comprehension test. The selected text (Appendix 1.1.1), an extended one about four pages long, taken from a popular science journal, dealt with the first topic to be covered in the academic literacy course: bilharzia.

Students had not been warned about the specific task to be done, and were free to refer to the reading so as to avoid reducing the test to a measure of memory recall rather than the investigation of a homework reading task as intended. A topic was given to guide them in summarising the key issue discussed in the reading (Appendix 2.2.1), and a questionnaire (Appendix 3.2) was administered after the paragraph had been written. This was primarily to ascertain which students had actually read the text so that results would not be skewed to reflect mere unfamiliarity with the text as opposed to poor comprehension. A summary was required of all students, not only those who had read, for fear that some who had read would avoid a bit of work by claiming not to have, thus reducing the sample group and limiting findings.

Such a measure of comprehension is unavoidably subjective. In an attempt to limit this problem by standardising the marking as far as possible, the same researcher scored each paragraph. This was done on the basis of relevant and sufficient content and not expression, although it must be acknowledged that very weak expression could obscure relevant meaning and thus still influence the score. Students were instructed to explain in their own words and direct chunks lifted from the original text were not taken as an indication of understanding of a particular issue. Assessment of the summaries involved scoring them along the three continua of insufficient to sufficient content, irrelevant and incorrect to relevant and correct information, and plagiarised chunks to expression in the students' own words. Marks of between zero and three were awarded accordingly and the total of these scores was divided by three for a final score between zero and three to represent the categories of no, weak, adequate or good comprehension respectively.

Even more useful than the comprehension test itself, in contributing to our understanding of students' struggles to read prescribed texts, is possibly feedback from the questionnaire administered after the task to determine whether or not students did read the text. Such feedback made it possible to identify and discount those summaries written by students who had not done the reading. Also probed by the questionnaire was the reason, if the reading was not done, as well as students' perceptions of the facility of the text. Students had the opportunity to express, in response to an open-ended probe, why they experienced difficulty if they did find the reading hard.

To collate the data, the number of particular responses to each closed question was recorded and average percentages were calculated. All responses to open questions were initially read and a set of categories established to encompass all ideas generated by students. Once coded, the number of responses was counted up and averages calculated.

3.1.3 Vocabulary test

A test of understanding of general or non-technical academic vocabulary (Appendix 2.1), one aspect of the reading-related ability of arriving SFP students, was based on 32 words selected from the prescribed readings for the academic literacy course. These lexical items were drawn from the Biology, Physics and Chemistry texts to be read over the course of the year, but were general words common to academic texts, rather than subject-specific, technical terms.

A multiple choice format was selected as the aim of the test was to derive some measure of students' receptive, rather than productive, vocabulary as far as general academic words are concerned. This allowed for the elimination of the writing ability variable and made objective marking possible for a large sample of students. Students were required to select one correct synonym or explanation of an underlined word, presented in the context of a sentence, from three options provided, rather than provide a synonym or explanation of their own. This would also reveal whether any distractors are chosen particularly frequently to provide some insight into common misperceptions surrounding specific words. Having been piloted with the previous year's SFP cohort, the test was adapted and a measure of certainty about the meanings given was also included so as to distinguish mere guesses (correct or incorrect) from the actual understanding that students have of different words. Each item thus included a confidence scale, as is reported in research by Sanders and Mogodi (2000), where students were required to indicate how certain they were that a particular choice was correct by selecting the option "I'm sure", "I think so" or "I don't know".

One of the limitations of a multiple choice test format is the fact that linguistic difficulties may hinder subjects from understanding the question or the distractors

provided, and not necessarily the construct being tested. For this reason, lexical items selected for testing were presented in the context of an authentic sentence, rather than in isolation, and distractors were written as simply as possible, with the use of potentially unfamiliar terms avoided.

3.1.4 Reading rate

The reading rate of all SFP students was measured within the first two weeks of the first semester. Carver (1990, 1992) maintains that the efficiency of reading comprehension depends on both accuracy and rate of comprehension. The former he operationalises as a score of 75% or above on a test of general understanding of a given text at a difficulty level not beyond the ability of the majority of subjects. Rate is calculated as the number of "standard" (six lettered) words read per minute by the "rauding" process.

SFP reading rates were calculated by providing students in each group with a copy of the same text related to the primarily biological topic of bilharzia that they were about to focus on in their academic literacy course at that time (Appendix 1.2.1a). As this first text used to measure reading rate was related to the topic of the independent reading task assigned, in that it dealt with the lifecycle of bilharzia while the homework reading discussed methods of eradication, the first measure of reading rate was carried out before the topic of bilharzia was discussed in class, and before the independent homework reading was assigned. This was to ensure that no group of students had begun to discuss or read about it in advance, so as to eliminate the additional variable of familiarity with the content of a reading for its possible effect on reading speed. The selected text, with a lexical density of 4.1, was relatively simple in syntactic structure so as to be an appropriate test of students' usual reading speed, but "scientific" enough to measure the rate at which students can read authentic texts at foundation level.

The same researcher administered the reading rate test to students in each group, explaining that it was not for marks, but part of research, so they needed to respond honestly, without the influence of "test" anxiety. Students were told that they should

read at a comfortable speed so as to understand, but not memorise, what they were reading. They were also informed that four True/False questions (Appendix 2.3.1) were to be answered on completion of the reading, merely to check that they had actually read and understood the text. Such a test of comprehension was selected to avoid unintentionally measuring expression rather than understanding. Multiple choice questions, though likely to serve this same purpose, could, to a greater degree, test understanding of the language of the question and statements as well as of the text, and, as Carver (1990:159) points out, induce the process of learning or memorising, rather than rauding.

To measure individual reading rates, students were requested to draw a line after the particular word they were reading when instructed to stop. All students were set to begin simultaneously and told to stop and draw their line after exactly one minute of reading time (as is described by Carver 1992:350). They were then free to continue reading the page-long text until they had completed it, at which stage their student number had to be filled in and the sheet handed in. Each student was given a question sheet on handing in the text, and required to select the correct options as well as fill in his or her student number so it could be matched with the text handed in.

The number of standard, six-letter words per line was calculated and individual reading rates determined accordingly. More than one of the four questions wrong meant that a student scored less than 75% and was thus considered not to have read with comprehension.

To arrive at an initial measure of students' reading rates, a second text (Appendix 1.2.1b.) was administered within two weeks of the first. Reading rate was measured in the same way, with a True / False test to measure comprehension (Appendix 2.3.2), and the average of the two rates calculated taken to be a measure of the speed at which each student could read at the beginning of the programme. The second text dealt with the evolution of the domestic dog and, again, was a relatively simple one with a lexical density of 4.5.

3.1.5 Language test

All SFP students, like all entering first year Bachelor of Science students, were required to sit a standardised language placement test at the start of lectures in 2005. Part of longer term research into the suitability of the test for selecting and placing students, where necessary, in appropriate courses to support their development of English for academic purposes, results of this Standardised Assessment Test for Admission and Placement (SATAP) are not currently used as a criterion for entry into the institution. As versions of the test are used for assessment within the institution, copies cannot be included in the appendix.

The "language test" is largely based on multiple choice questions, but a gap-filling exercise and a written response to given texts is also included. In terms of weighting, the MCQ section carries nearly two-thirds of the marks allocated. The remaining third of the marks are spread between the cloze and written sections, with the latter carrying roughly double the marks allocated to the cloze passage.

Based on the theme of ecotourism, the texts used in the test provide the knowledge required for answering the comprehension questions and the extended writing section requires interpretation of this given information, while the cloze passage relies more heavily on linguistic ability.

Though not a reading test per se, the language placement test measures academic language proficiency by testing students' comprehension of texts read within time constraints. Results thus offer a valuable means of triangulating data gathered on SFP students' reading experience and ability.

3.2 Comparison of initial findings with final measures of reading rate and academic literacy, and with mainstream data

Initial data collected in investigating why SFP students struggle with their academic reading was compared with results gathered at the end of the foundation year to determine the extent to which students had developed their academic reading skills in preparation for mainstream study and thus to inform future teaching practice by probing the nature and extent of academic reading development still necessary for students. To this end, reading rate and academic literacy, as demonstrated by text comprehension in the language test, were retested. For comparison with mainstream students, the reading rates of a sample group studying Biology at second year level were also collected in order that, like the initial language placement test scores of students entering mainstream study, some sense of the academic reading proficiency that SFP students should develop so as not to be at too much of a disadvantage when studying in the mainstream, could be obtained.

3.2.1 Reading rate

A final measure of reading rate was taken at the end of the year. This was done to determine whether exposure to academic texts over the SFP year did give students sufficient practice for improving their reading efficiency to cope with the reading load in studying for a science degree.

The text presented to students for the measure of reading rate was, again, one prescribed as part of the material for the final topic covered in the course, namely the use of fossil fuels for energy. Taken from a popular science journal, the text was substantially adapted so that it would not be too difficult for ordinary reading or "rauding", yet would be representative of the type of material that a pre-degree student might be expected to read with understanding. The revised text was divided into two sections (Appendix 1.2.3a. and 1.2.3b.) so that an average reading rate for individuals could be calculated from two timed reading tests. Again, short True / False comprehension tests were administered (Appendix 2.3.4a and 2.3.4b) after texts

had been read. To offer some indication of the comparability of the two parts of this text with those used in the initial measure of reading rate, lexical density was calculated. The first part had a lexical density of 4.6 and the second part, 4.9.

Reading rate, though clearly an important aspect of SFP students' academic reading ability, is not in itself a useful determinant of the academic reading needs that such students bring as there appears to be a dearth of second language data, particularly in the local context, to indicate an acceptable standard for effective reading at this level. As we have seen, with 70% of the rate of first language readers considered acceptable, yet differing opinions on what is optimal or minimal for first language readers at different levels, it is difficult to estimate the approximate rate at which SFP students should be aiming to read. This is further compounded by the fact that the number of words (literal or standard, depending on the researcher in each case) to be read with comprehension in a minute could be greatly influenced by the difficulty, both conceptual and linguistic, of texts and questions used in the measurement. Such factors would of course also influence whether a reader is deemed to have read with "comprehension". The measure of SFP student reading rates in this study therefore considers possible improvement over the year rather than comparison with data from other research.

To consider this aspect of reading ability as an indicator of preparedness for first year study would require comparison with a sample of "successful" mainstream students' reading rates. Such a sample was collected in the second semester, from a Biology practical group of 34 second year students who were requested to complete the reading rate tests at the beginning of a Biology practical.

This mainstream sample group was selected for a number of reasons. Having reached the second semester of their second year of study in Biology, the group could be considered "successful" undergraduate students and, as Biology is one of the science subjects that does include significant amounts of reading, one would expect adequate reading ability to characterise the majority of students in this particular class. The group contained both first and second language English speakers, though there were not quite as many of the latter (44 %). 12% of the mainstream sample (27% of those for whom English is a second or additional language) were in fact ex-SFP students

who had not only passed their SFP year to enter mainstream study, but had also passed their first year of such study and had experienced a semester of second year study.

For comparison, the rate at which the mainstream students read was measured as the final SFP rate had been. Apart from taking the tests anonymously, the students received the same explanation and instructions, from the same researcher, as those in the SFP cohort. They also sat the tests as part of an allocated class session, rather than in their own time. Again, the two versions of the fossil fuels text were used. Although more advanced in their studies, mainstream students should not be at a particular advantage over SFP students in terms of content knowledge as the more "general knowledge" type of scientific texts, rather than the more Biology-specific bilharzia texts were used to prevent familiarity with biological concepts, rather than reading ability, from interfering with the measure of reading rate. This made it possible to gauge the difference between the time required by SFP students to read their academic texts, and that likely to be expected of them in mainstream study, given the rate at which the mainstream sample students in this study were able to read with comprehension.

A far larger and more representative sample of "mainstream" reading rate, for both first and second language speakers, was logistically inaccessible at this stage but further research into the performance of academically able students, across disciplines, would be useful in establishing some sort of minimal level necessary for students to cope adequately with the reading load expected of them, both in independent homework reading and when required to read within time constraints under test conditions.

3.2.2 Language test

As for a final measure of the 2005 SFP cohort's academic language competence (largely based on reading), an early version of the language placement test, this time themed around "fire", was administered to students at the end of the course. As this

version of the SATAP test is also in use for student assessment, a copy could not be included in the appendix.

Both fire and ecotourism tests followed the same format and made use of texts and questions of a similar level of difficulty, although the comparable facility of the topics is questionable, given that fire would be a far more familiar and hence less alienating concept for a number of SFP students than the notion of ecotourism. As both versions of the test had previously been used at a number of institutions, sufficient data was available to determine that results from the two tests are statistically comparable and thus useful for showing whether or not students had made progress over the year and, specifically, over the course of the communication module.

As the SATAP test administered to SFP students at the beginning of the 2005 academic year was also administered to students entering first year study in the Science Faculty, the performance of these mainstream students on the Pietermaritzburg campus was compared with the SFP average. However, only the multiple choice section was scored for the mainstream cohort of roughly 270 students as a high correlation between MCQ scores and those obtained on cloze and written sections had been established from previous test data collected across disciplines and institutions. Overall SFP test scores were thus divided into separate averages for MCQ, cloze and written sections for comparison.

3.3 Experiment: Can a means of scaffolding students' academic reading have a positive impact on SFP students' limited reading ability?

A potential strategy to help students overcome the academic reading difficulties that prevent them from accessing meaning in texts prescribed is to provide reading support or "scaffolding" to enable them to read, with assistance, what would, for many students, be beyond their independent reading ability. A viable method, given time and resource constraints, would need to result not only in improved comprehension, but also increased motivation to engage with an assigned text. The effectiveness of such a means of scaffolding students' reading was thus tested experimentally and comprehension test results and questionnaire feedback compared with that generated by control groups who were not initially exposed to a commonsense oral paraphrase of the text. To investigate whether a commonsense paraphrase, when presented in writing, would affect reading rate, control and experimental groups were also respectively required to read and respond to comprehension questions based on an original and paraphrased version of another prescribed text.

3.3.1 Comprehension of scaffolded versus independent reading

To investigate whether academic reading could be made more accessible to students by scaffolding their reading with an initial, spoken summary of a text, the 2005 cohort of SFP students was split into experimental and control groups at the beginning of the second semester.

Academic exclusions after the mid-year examinations meant that the cohort consisted of fewer students than the beginning of the year when initial data was collected. During the collection of experimental data, both control and experimental groups consisted of about 70 students each, divided, in both cases, into four groups for their academic literacy module. Data was collected during the contact sessions timetabled for the academic literacy course. Two prescribed readings on the topic of ethics in science, to be referred to as Text 1 and Text 2 (Appendices 1.1.2a and 1.1.2b

respectively), dealt with the debate against and for the use of animals in research respectively. Both had been adapted from the same edition of a journal that covers issues in popular science. The articles were roughly the same length (about two and a half pages) and adapted to move away from a more journalistic style so as to better model the more formal, "academic" style that students are required to use in their own essay writing.

Text 1, arguing, on scientific, rather than ethical grounds, against the use of animals in research, was allocated to the student-subjects in each of the four sub-groups making up the experimental group. The researcher spent an hour with each class, introducing the text.

Initially, students were spoken through "the big picture" - an overall summary, in commonsense or every day terms, of the authors' main arguments against animal experimentation. Key words were put up on the white board as this spoken overview unfolded and students were free to ask questions to elicit further explanation along the way. The spoken paraphrase or initial "scaffolding" included a simple summary of salient examples given in the text to develop each of the four or so main points developed.

Students were then instructed to look at their individual copies of the full text and referred again, this time paragraph by paragraph, to the key ideas and examples already discussed in everyday language. Some key words and phrases in the actual text, corresponding to ideas previously spoken through, were read out with students following. Paragraphs were not, however, read and explained with the class sentence by sentence, as advocates of what has come to be known as the method of "scaffolding reading", generally suggest.

This decision was made as the length and quantity of prescribed readings would make it impossible to carry out such detailed reading support on a regular basis. Only two double periods (of 90 minutes each) were timetabled for the academic literacy course each week, and the need for extensive writing practice and language development work as well as reading practice, meant that an extended form of reading scaffolding in class time would result in students working through very few authentic texts. For

fear that boredom with a limited variety of texts used, and a misleading impression of the amount of prescribed reading to be covered in a module, would result, it was decided to investigate the effectiveness of the reduced form of reading scaffolding described above.

If such a strategy proved helpful, then other subject teachers, who frequently voice frustration that students "just do not *read*", could be encouraged to include similar methods in their classes. The demands of content to be covered in such courses would prevent consideration of the more extended approach to scaffolding reading as a possible strategy for encouraging students to read. Introducing independent reading tasks with an initial commonsense summary, however, should this prove helpful, could be incorporated into content subject tutorials. Helping students to develop their reading ability could thus be integrated into courses across the curriculum, taking reading development beyond the domain of "academic literacy" and into the broader educational experience of SFP students.

Having been introduced to the text against vivisection, experimental group students were then instructed to read the entire text for homework, for the next communication class. Although they were not told that they would be required to write a summary of the reading to hand in, they were reminded that the reading needed to be done for an activity in the next class. For different groups "the next session" was the following day, or later that week.

Each of the four classes making up the control group of 70 students were merely given the first text and instructed, as the experimental group had been, to read the text for homework, in preparation for the next session.

In the following session, all classes (both control and experimental groups) were tested for comprehension of the text that should have been read for homework. Students were given a topic as a prompt (Appendix 2.2.2) and a maximum of 15 minutes to jot down a summary of the main reasons that the text authors gave against vivisection. To allay fears that the task was "for marks", students were told that it would not count towards their class record mark, so they had no need to panic about

remembering details of what had been read. Comprehension of the gist of the text was all that was to be measured.

On completion of this task, students were given questionnaires (Appendix 3.3.1) to elicit whether or not they had actually read the whole text and the reason, if not. Students were also asked to indicate how difficult they had found reading the text ("easy", "OK" or "difficult") and were prompted to discuss why they experienced difficulty, if this had been the case. This was phrased as an open question so as not to "put ideas into their heads" or limit them to preconceived categories. A further question asked students to rate the text according to how interesting they found it. Students were encouraged to answer as honestly as possible and assured that putting student numbers on the summary and questionnaire was merely to match up responses and not remove anonymity so as to use any information against them. Responses were coded and counted and summaries scored as described for the initial questionnaire and summary tasks given to students on completion of the first (Bilharzia) text that they were to have read independently.

So as not to unfairly disadvantage the control group by depriving students of the initial reading support hypothesised to help with academic reading, and also to replicate the experiment so as to improve the reliability of the study, Text 2 was used in the same way the following week. This time, the experimental group became the control group and subjects were merely given the second text as a homework reading task. The original control group, likewise, became the experimental group. In the same way as before, the second reading, developing scientific reasons to support the use of animals in research, was prepared and introduced to the classes making up the experimental group. Again, both control and experimental group subjects were given a topic (Appendix 2.2.3) prompting them to summarise the key ideas of the text in 15 minutes. Questionnaires (Appendix 3.3.2) to elicit feedback about their experience of reading the text were the same as before except that students, rather than commenting on how interesting they found the second text, were asked to compare both texts that they had read in terms of difficulty, and were given the opportunity to give reasons for their choice.

As with the initial summary test of reading comprehension, summaries were marked by the same researcher for general understanding of two or three relevant ideas. Linguistic competence was, as far as possible, not taken into account in awarding an assessment of no, weak, adequate or good comprehension.

3.3.2 Reading rate

As slow reading is something that hinders many students in their academic progress, the investigation into the possibility of a spoken, commonsense summary making texts more accessible, was extended to include a measure of reading rate. Again, the student cohort was divided into an experimental group and a control group. The latter were assigned one of the communication course's prescribed texts on the chemistry-related topic of landfills (Appendix 1.2.2a). Taken from a scientific journal, it dealt with factors affecting the rate of methane production in landfills and had a lexical density of 6.0.

For the experimental group, this text was used to supply the content for a paraphrased version (Appendix 1.2.2b) that explained the same issues in more commonsense terms, using a style of English closer to that of spoken language than written. The highly nominalized writing of the original, typical of scientific explanation, was replaced with a simpler version with clauses foregrounding the actual processes and participants responsible for carrying them out. For example, "the production of methane gas … resulting from the biodegradation of organic material in association with bacteria …" was expressed rather as "Bacteria help organic material to break down … and then methane gas is produced". Where the original read "With the rapid increase in urbanisation in South Africa and the encroachment of housing near landfill sites, the production of leachate and landfill gas is of great concern", the paraphrase read "We should be very worried about the leachate and landfill gas that rubbish dumps produce. This is because more and more people are now moving into towns so houses are being built closer and closer to the rubbish dumps". The lexical density was thus reduced, resulting in a paraphrased version, of similar length to the original, with a lexical density of 3.5.

Reading rate was tested in the same way as was initially done to get a sense of students' reading ability when they began their SFP year. That is, both experimental and control groups were given instructions and then presented with the relevant text to read for a minute, indicate where they got up to, and then continue reading. As before, four True / False questions (Appendix 2.3.3) were administered when the text was handed in, to measure whether or not the text had been read with comprehension. These question sheets were the same for both groups as the two versions of the text presented the same content.

Chapter 4

Research findings

The picture to emerge of SFP students as academic readers suggests that reading, even of short prescribed texts assigned for homework, is not extensively practiced. Many students are slow readers who struggle with the unfamiliar vocabulary of academic texts and demonstrate inadequate understanding of what has been read. Specific tests of such aspects of students' reading are confirmed by performance on a test of academic literacy and language proficiency. Academic reading ability does improve over the course of the year, but for many students in the cohort, further development in this area is needed if they are to begin first year science study with the reading ability expected of mainstream students. Scaffolding SFP students' academic reading with the provision of an initial commonsense oral paraphrase appears to be an effective method of encouraging students to engage with texts prescribed for homework reading. Better comprehension is also demonstrated by experimental group subjects exposed to such scaffolding. This approach thus appears to be a potential means of encouraging the reading practice necessary for SFP students to develop their academic reading skills over their foundation year of study.

4.1 Initial findings: Why SFP students struggle to read their prescribed texts

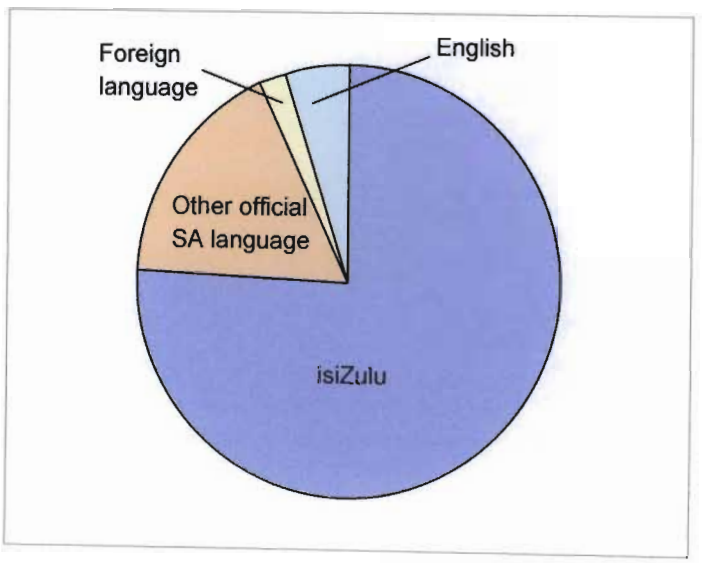
Responses elicited by questionnaires on language and literacy background suggest that SFP students have had limited access to written texts and thus have limited experience as readers. Findings from initial investigation into independent reading comprehension and feedback about difficulties experienced, as well as receptive academic vocabulary, reading rate and proficiency in English for academic purposes, are also considered for insight into the academic reading abilities and needs of SFP

students. Such data is also compared with that generated by similar tests of academic reading proficiency at the end of the SFP year, and with academic literacy and reading rate test results obtained from sample groups of mainstream students. These findings show that academic reading progress is made, on the whole, but imply that many students require further development of their academic reading skills to overcome previous educational disadvantage in preparation for mainstream study.

4.1.1 Background linguistic and literacy experience

Student feedback in response to the questionnaire probing linguistic background and previous literacy practices showed that most students (75%) were mother-tongue speakers of isiZulu. A number spoke other official South African languages (17%) and a few (2%) had a foreign language as their mother-tongue, but no more than 5% had English, the medium through which they must study at university, as a home language.

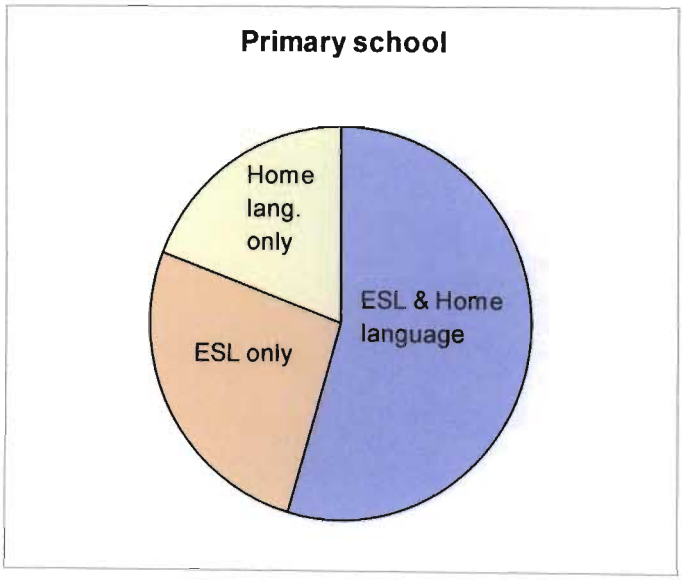
Fig. 1.1.i Home Language

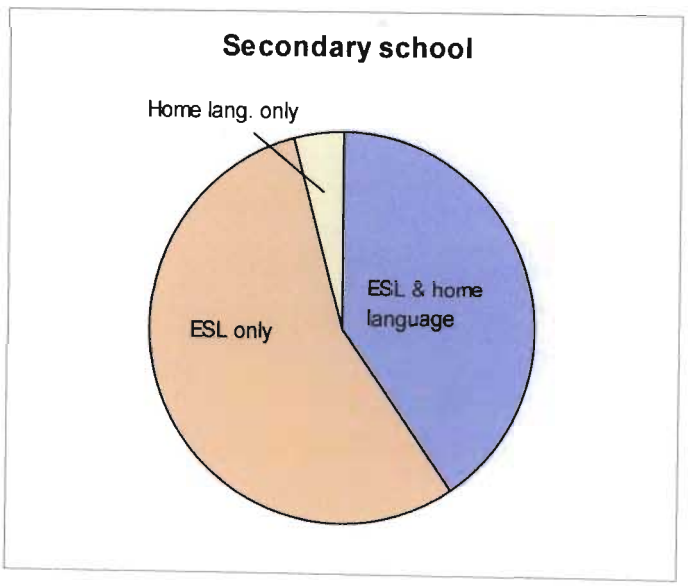


On the issue of medium of instruction, a combination of English and mother-tongue was used to teach the majority of students (54%) at primary school, while a significant proportion (26%) indicated that they had learned only in English at this level. 19% had experienced primary school learning in their mother-tongue. (What

must be pointed out is that the small number of English first language speakers would have faced the ambiguous question of whether they were taught in "English" or "home language" at school. To rectify this problem in the design of the questionnaire, responses from those students were monitored and changed to the "home language" option if "English", rather than "home language" had been selected as the medium of instruction at primary or secondary school.)

Fig. 1.1.ii Medium of instruction



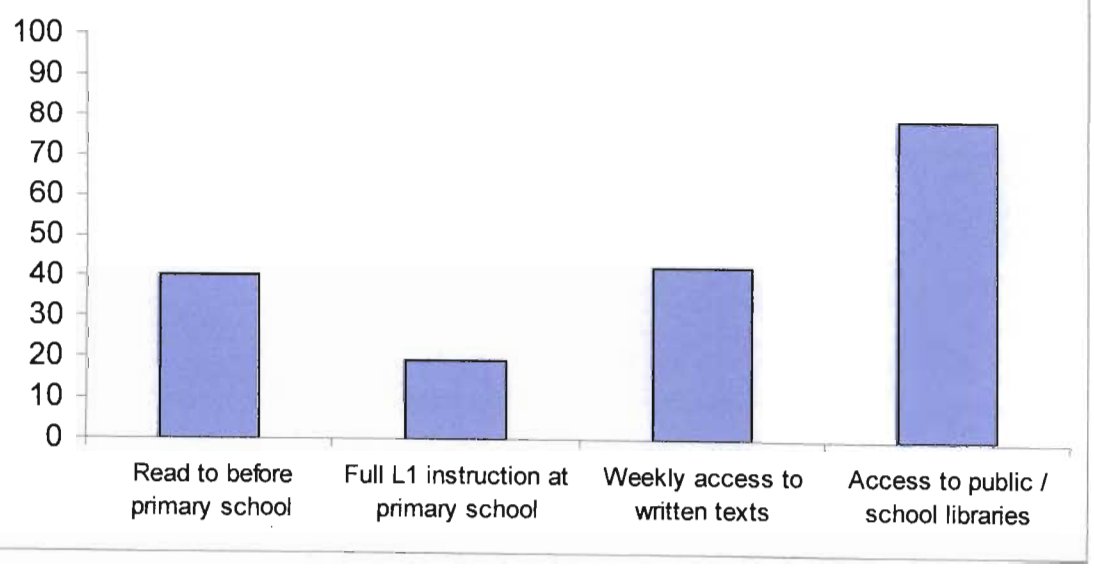


As for early literacy experiences, only 21% of the SFP students had books read to them at home to facilitate the start of their apprenticeship as "readers" before having to master the technical skill of reading once at school. 19% were read to for the first time at pre-school, while over half (52%) only had a book read to them for the first time at primary school. Some students (7%) responded that they had never had anyone read to them before learning to read themselves.

When asked how frequently they had access to individual copies of academic reading material at school, the largest proportion (44%) indicated that they could only access written material a few times a term, but for almost as many students (42%), this was possible on a weekly basis. For 11%, this was only possible a few times a year while 3% indicated that they never had such opportunities.

What actually constituted a school library, and how well resourced public and school libraries were, was not investigated. Responses do show, however, that only 23% of SFP students attended a school with a library. Just over a fifth of the students responded that they used neither a school nor public library, while 35% did use a public library and a fifth used both a school and public library.

Fig. 1.1.iii. Background: Literacy experiences

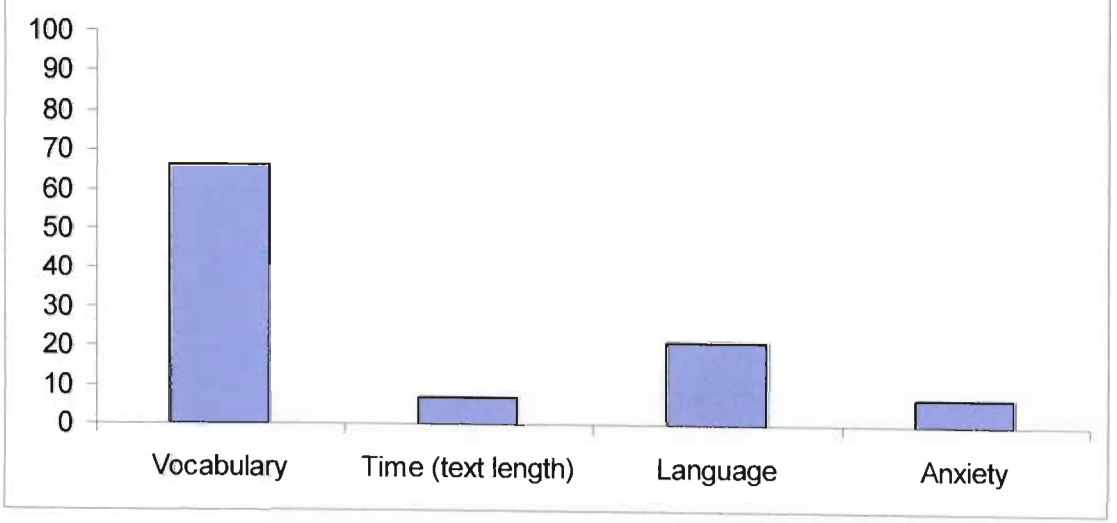


An encouraging number of students (84%) reported that they now read for pleasure. The types of texts read for fun was not ascertained, however. Only 12% never read for pleasure while at school. For the majority (61%), this was something they did "sometimes" while a fair number (27%) responded that they read as often as possible when still at school.

As for reading difficulties experienced, a surprising 81% indicated that they did not find reading difficult, although comprehension of specific texts suggests that reading is problematic for more than 31% of the cohort.

15% of respondents gave reasons for reading difficulties experienced. 66% of these students cited problems with vocabulary as the reason, and 21% referred more generally to language difficulty. For 7% it was the length of time they needed to get through the reading and for a further 7%, anxiety associated with reading was given as the main cause of difficulty.

Fig. 1.1.iv. Perceived reasons for reading difficulties



Examples of such reasons include the following explanation where a student links limited resources to the difficulties she experiences with reading in English:

"Because at my school there is no libraries to read and teachers teach with isiZulu most of the time."

Emphasising vocabulary difficulties, as the majority do, the following student response demonstrates a keen understanding of the negative impact that a limited receptive vocabulary can have on the comprehension process:

"Sometimes there are those words where you can't understand and they made you loose the concentration of reading that article."

Voicing similar frustration, another student writes:

"I do not understand the meaning of many words, and therefore I waste a lot of time tryieng to figure out its meaning."

Another student who recognises that reading rate is a real hindrance to effective reading expresses the following reason for experiencing reading as difficult:

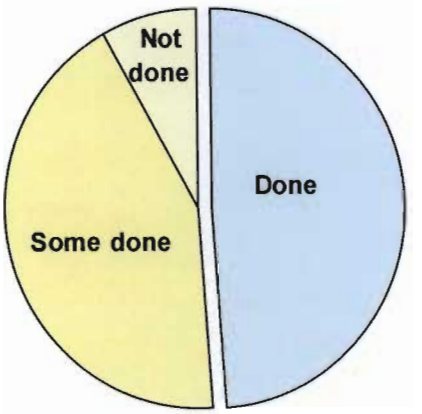
"Well, it's not that English reading is difficult, it because I am reading too slowly."

4.1.2 Independent reading comprehension and student feedback

Framed by this picture of students' experiences of books and reading, their independent comprehension of an extended text, and feedback about difficulties experienced, can be considered.

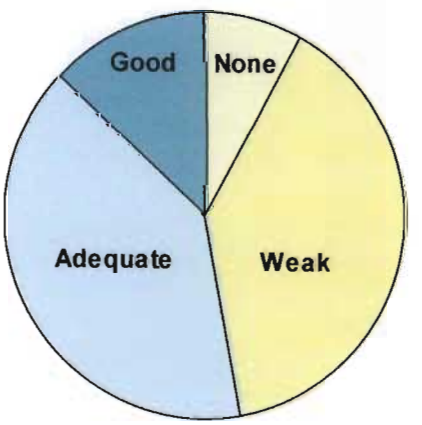
Responding to a questionnaire about the assigned reading, just under half the group (49%) said that they had read the text assigned for homework. 43% had read some of it, while 8% had not read the text at all.

Fig. 1.2.i. Completion of homework reading



Of the 172 students to have attempted the homework reading task, just over half (53%) produced paragraph summaries indicating that they had read with comprehension, whether adequate (40%) or good (13%). For the rest, no comprehension (8%) or weak comprehension (39%) was demonstrated.

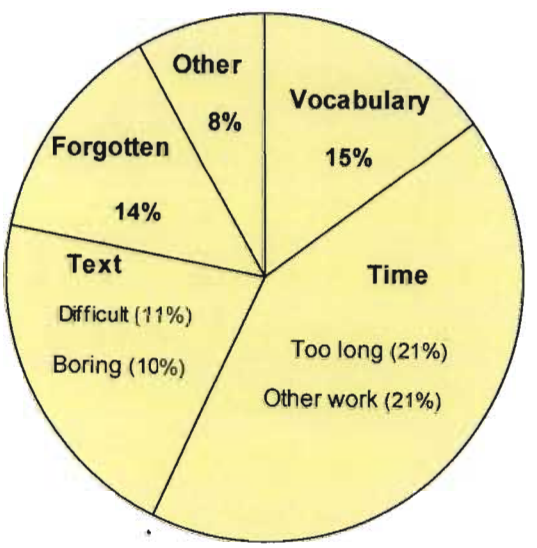
Fig. 1.2.ii. Independent reading: Comprehension



As would logically be expected, comprehension was generally better when the prescribed reading was done in full. When this was the case, however, still less than two-thirds (63%) read with comprehension. 47% and 16% read with adequate and good comprehension respectively. Of the 48% to have read some of the text, 37% demonstrated adequate and 11% demonstrated good comprehension.

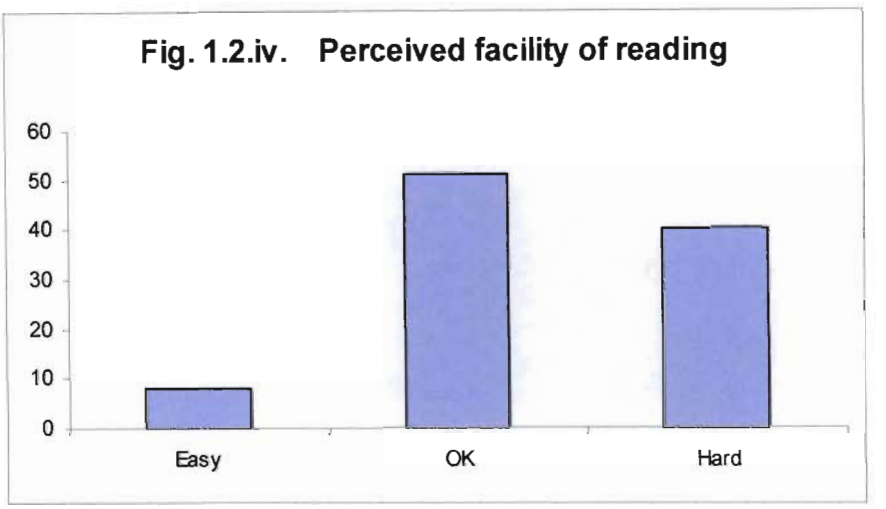
Reasons for not reading the whole text were given by most (92%) of those who had not read the text in full. Thus 47% of the whole cohort gave reasons. Of these, the time required for reading the text was the most common problem, identified by 42% who were equally divided between those who complained of the length of the text itself, and those who mentioned the amount of other work, as reasons for insufficient time for the prescribed reading. A smaller proportion of those giving reasons for not reading (15%), blamed difficulties with vocabulary. Forgetting to do the reading and finding it too difficult or too boring, were other reasons given by 14%, 11% and 10% of respondents respectively. "Other" categorised reasons involving some practical constraint, and affected 8% of the students who gave reasons for not completing the reading.

Fig.1.2.iii. Reasons for not reading



Commenting on the difficulty of the prescribed text, about half of the students (51%) responded that the text was "OK" to read but for 40%, it was a difficult text. Only 8% reported that they found it an easy text to read. This is interesting in view of the fact that, when initially asked about reading difficulty generally, only 19% said they experienced difficulty with reading in English.

Fig. 1.2.iv. Perceived facility of reading



The list of reasons given by 62% of the cohort for difficulties experienced in reading the Bilharzia text is informative (see Fig. 1.2.v.). The majority (66%) attributed problems with reading the text to difficult vocabulary. Exemplifying this is the following comment:

> *"Difficult because there is no dictionary to use and most words are terrible words eg. alleviate."*

Next was the length of the text, with 14% explaining that it was difficult to understand the text because it took so long to read. One student writes:

> *"It is too long, when I read the second page I forget what was happening on the first."*

9% complained of both these reasons, such as the following student who explains that:

"The words that are used in the text are hard and it is long. You have to read it more than once to understand it."

4% specified difficult language, while smaller proportions of students (3% in both cases) mentioned unfamiliar content and boredom with the text as reasons why they found the text difficult to read.

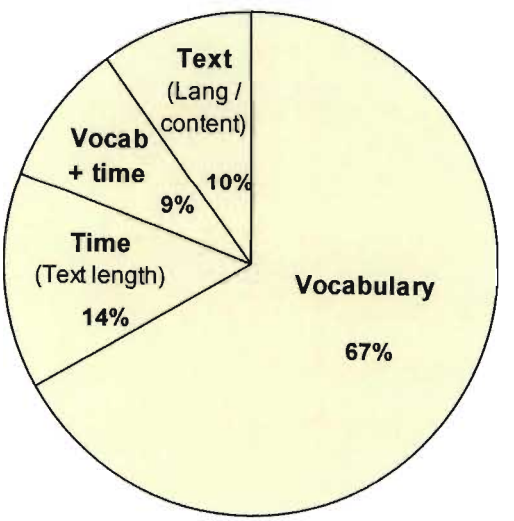
The following reasons given for the "Bilharzia" text being experienced as difficult to read show that the students themselves realise the difficulty of approaching a text without the background knowledge needed for comprehension:

"Since I don't know anything about bilharzia, I found it un-understandable."

And:

"I don't know the disease mentioned in the text, it is for the first time I hear of that Schistosomiasis."

Fig.1.2.v. Reasons, if reading experienced as difficult



In response to how interesting they found the reading, about a fifth reported not finding it interesting while 37% and 42% found it interesting and quite interesting respectively.

4.1.3 Vocabulary test

In view of the fact that vocabulary difficulties were commonly perceived by students to be a hindrance to their reading, results from a test to measure receptive academic vocabulary, as one aspect of reading ability, are particularly relevant.

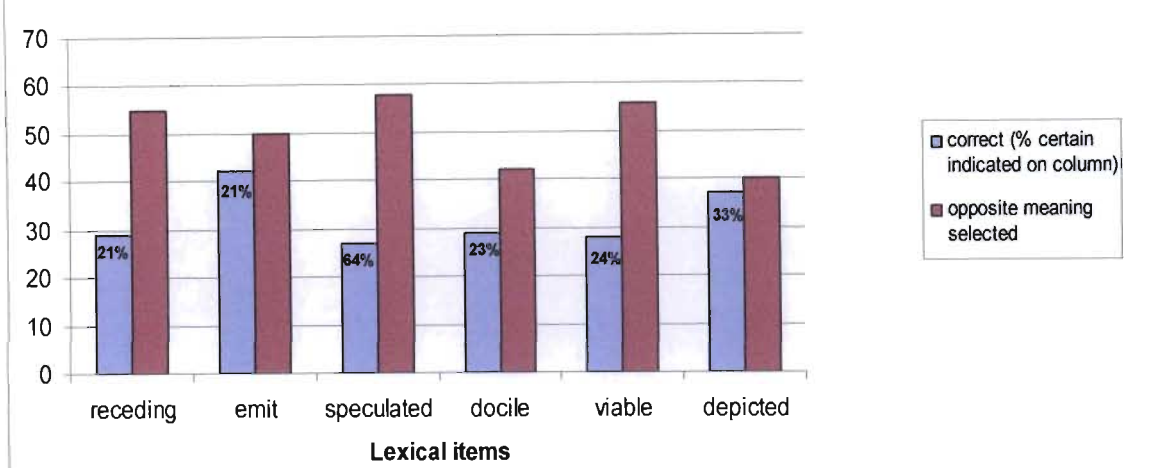
The average score for the vocabulary test was 58% and the pass rate, 79%. On average, 62% of answers (in response to all test items) were correct and 38% incorrect. As for respondents' certainty that their responses were correct, students selected "sure" for correct responses 39% of the time and for incorrect responses, 30% of the time. Students were thus only slightly more sure of correct meanings than incorrect ones, guessing correct meanings about 60% of the time.

The majority of students gave incorrect answers for 31% of the items tested – 19% of these having a particular distractor selected more commonly than the correct answer, and 13% having a combination of the two distractors selected more often than the correct meaning.

More informative, though, are the commonly held misconceptions of specific words that are typical of the general academic vocabulary items that students struggle with in their prescribed texts. Examples (see Fig. 1.3.i) include most students (58%) thinking that *receding* means *approaching*, while only 29% chose the correct meaning. Of those who selected the correct meaning, only 21% were sure that this meaning was correct. Half the subjects thought that *emit* means *absorb*, and of the 42% who did give the correct answer, again only 21% were sure. Similarly, we have *speculated*, with 58% thinking that it means *discovered* and only 27% supplying the correct meaning (with 64% certain of this). As for *docile*, 42% believed it to mean *aggressive*, compared to the 29% who

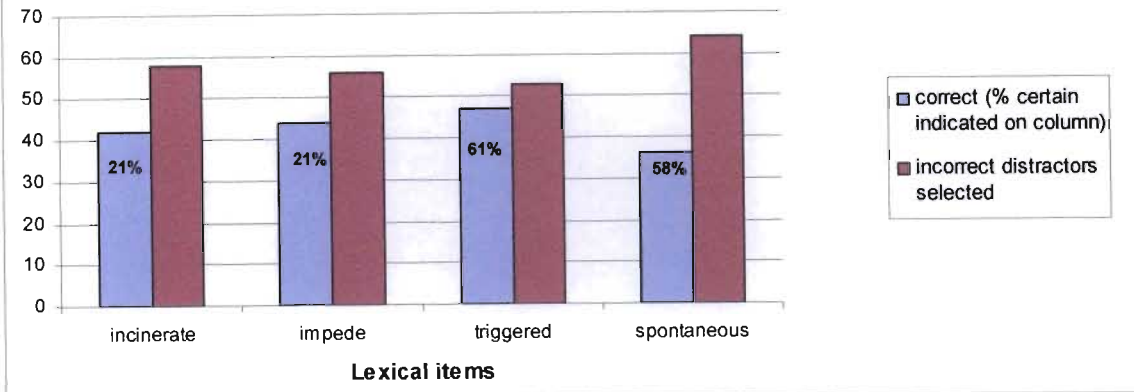
understood it correctly (of whom only 23% indicated certainty about this). More subjects (56%) thought that *viable* means *affordable*. Of the 28% who did select the correct meaning, only 24% selected this option with certainty. That *depicted* means *destroyed* was a belief held by the largest proportion of students (40%). While 37% were aware of the correct meaning, only about a third of them were sure that this was so.

Fig. 1.3.i. Misconceptions of some general academic vocabulary items tested



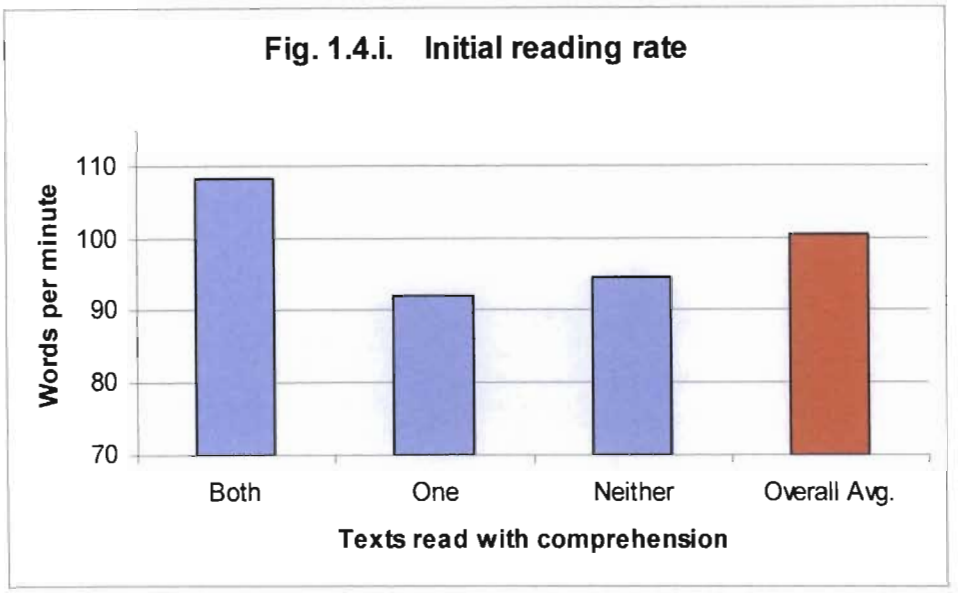
Incinerate was misunderstood by 58% overall, and the correct meaning was only selected with certainty by 21% of the 42% who chose it. 56% of all answers given for *impede* were incorrect. Again only 21% of the 44% minority to answer correctly were certain of this answer. More students misunderstood than comprehended the word *triggered*. Of the 47% minority to respond correctly in this case, most (61%) were actually sure of this meaning. 64% of all students did not understand the word *spontaneous*, but half of these students were sure that the incorrect meaning selected was, in fact, correct. A slightly higher percentage (58%) of the 36% minority correct in choice of meaning for this item, were certain that this was so.

Fig. 1.3.ii. Vocabulary items more commonly misunderstood than understood



4.1.4 Reading rate

As an average reading rate was obtained for each student from two tests administered on different days, not all SFP students were present for both tests. Students for whom two sets of results were available for calculation of an average reading rate totalled 179. Only once individual students' average reading rates were calculated, was the overall group rate averaged from these. Theorists such as Carver (1990, 1992) define reading rate as that calculated when subjects read with comprehension. The average rate of those students to read both texts with comprehension, in this case, worked out to be 108.3 standard words per minute (Wpm). As linguistic difficulties and other factors could have influenced students' comprehension scores, the average reading rate of students who did not achieve above 75% is also worth considering. This average, for students whose comprehension scores imply that they read without understanding on one of the two tests, was 94.5 Wpm, while those who scored below 75% for both was 92.2 Wpm. 100.4 Wpm, the overall average reading rate (with or without comprehension), is possibly the most representative one for the group as a whole, as less than half of the student cohort did, in fact, read both texts with comprehension. Variation across these alternative rates is, in any case, rather minimal.



Individual reading rates range from the lowest average of 23 Wpm to the highest of 217 Wpm, with well over half (57%) of the cohort reading at a rate below the 100.4 Wpm average. A similar distribution pattern of individual reading rates is evident for the group of students to read both texts with comprehension and for the whole cohort, whether or not reading was done with comprehension.

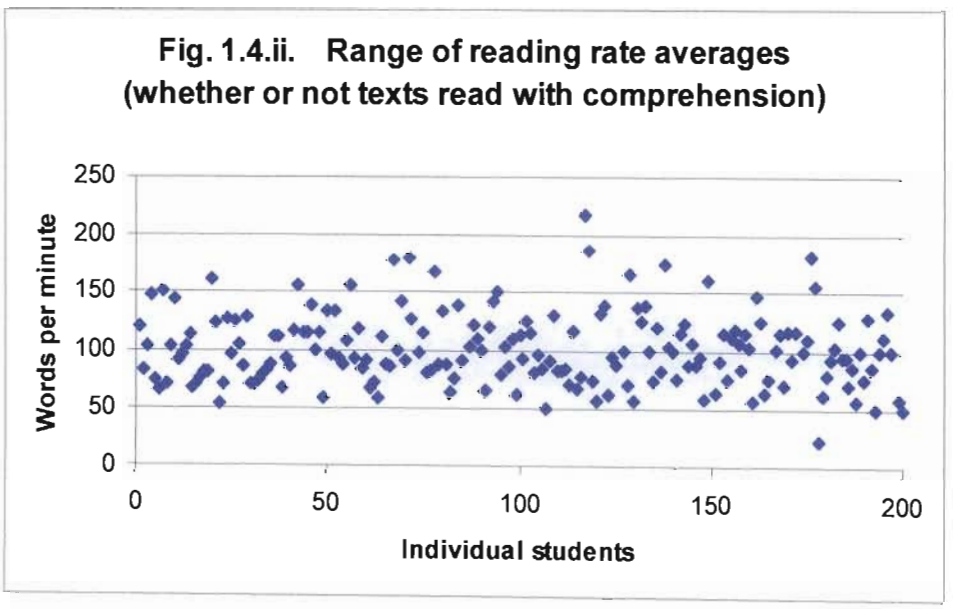
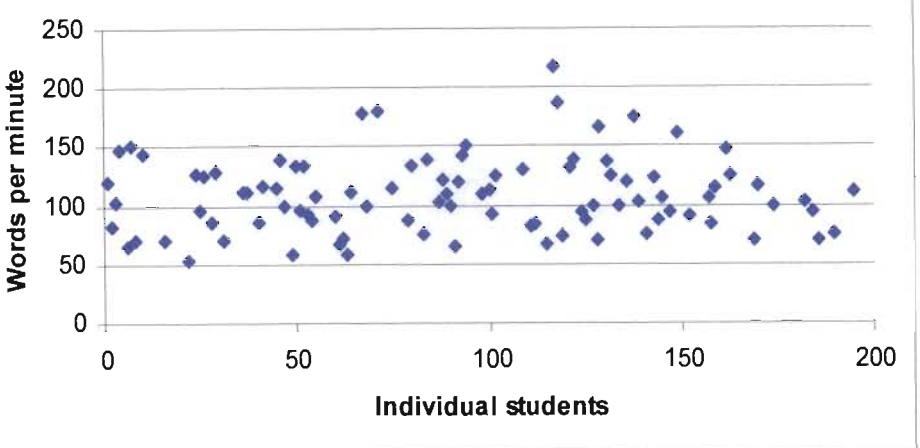


Fig. 1.4.iii. Range of reading rate averages (when both texts read with comprehension)

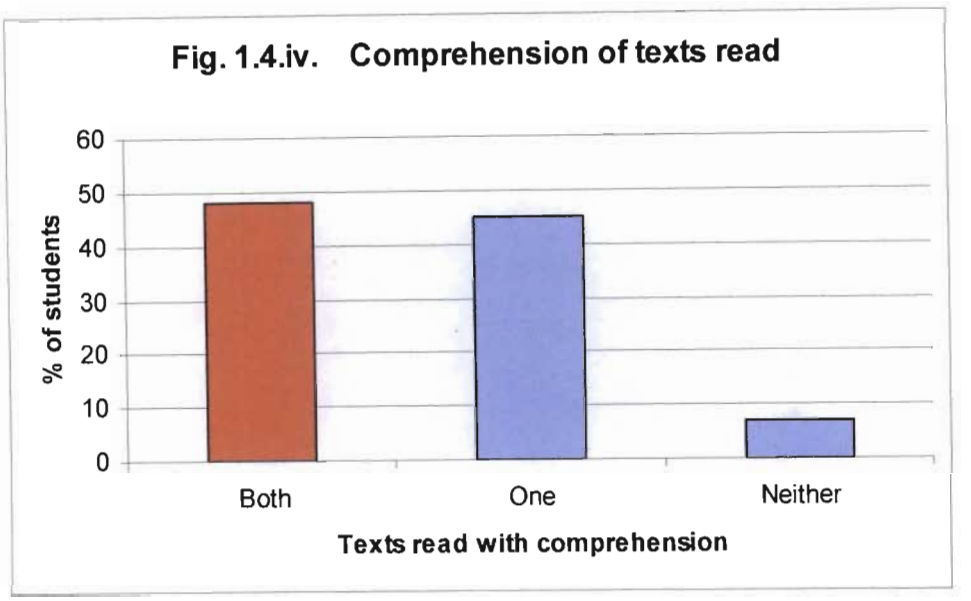


As the reading rates of individual students and the average for the cohort, rather than the relationship between rate and comprehension, was the focus of this investigation, a causal link cannot be established between comprehension and reading rate. Subjects were merely divided into the three categories of adequate comprehension, as demonstrated by a score of 75% or above (three or four correct answers out of the four) on both, one or neither of the two texts read. What is evident, in terms of rate and comprehension, is that the fastest individual reading rate of 217 Wpm was achieved by a student in the group demonstrating comprehension of both texts, while the fastest rate amongst those who only understood one text was a lower 181 Wpm, and 161Wpm was the quickest rate recorded in the group to have read without comprehension of either text.

Slightly more students (48%) did read both texts with understanding than the 45% who read only one of the texts with comprehension. The latter, together with the 7% who did not demonstrate comprehension of either text, do, however, make up the majority.

Rates at which the two texts were read were considered separately to check whether either text was read, on average, significantly more quickly or with more comprehension. More students (76%) read the first text (Bilharzia) with understanding than the second, which 65% read with comprehension, but this did not seem to affect reading rate as the

two texts were read, on overall average (that is, regardless of whether or not they had been read with comprehension), at virtually the same rate: 102.0 and 102.1 Wpm for "Bilharzia" and "The African Dog" texts respectively.



4.1.5 Language test

The average score for the standardised academic language placement test was 52%, and 56% of the SFP students passed. Individual scores ranged from the lowest, at 18% to the highest score of 89%.

Students accepted, on the basis of matric points, to begin mainstream study in the Science Faculty were also required to take the language test at the beginning of the year. High consistency between performance in the multiple choice questions and other, written, sections of this test by mainstream students across faculties and campuses in the past meant that only the multiple choice questions were marked for mainstream science students. SFP students' performance on the whole test can therefore not be accurately compared with the Pietermaritzburg campus mainstream average of 78%, and 96% pass rate on the MCQ section.

To allow for such a comparison between SFP and mainstream academic language ability, the SFP cohort's multiple choice section initial average of 60%, and 78% pass rate, has been extracted. It must be acknowledged, however, that this could also be misleading as the majority of SFP students, unlike their mainstream counterparts, scored significantly lower on the written and cloze sections than multiple choice questions. When the three sections are considered separately, the average score is 60% for the most heavily weighted multiple choice section, but a failing mark of 41% for the gap-fill task and 38% for the writing task.

4.2 Comparison of initial findings with final measure of academic language and reading rate

Findings that provide some indication of the academic reading abilities brought by SFP students to tertiary science study are compared with those obtained by the end of the foundation year for a sense of the extent to which students have improved as readers, and of the needs that still need to be meet in terms of academic reading development. These final measures of academic reading ability include performance on the comprehension-based language test and reading rate tests.

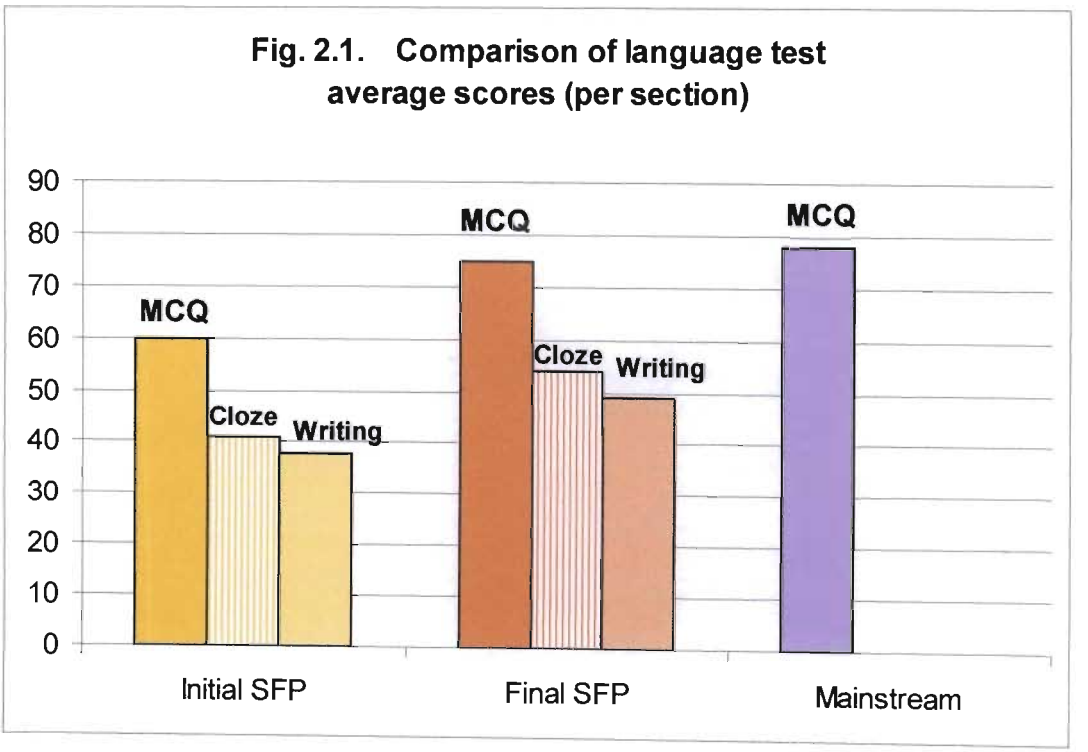
4.2.1 Language test

Total scores on the final language test administered averaged at 62%. This reflects an average improvement of 10% for the 2005 cohort of SFP students from the initial measure. Even more significant is the fact that the pass rate went up from an initial 56% to 92%.

Improvement in the MCQ section of the final "fire" test (the most heavily weighted section in both versions) is most pronounced, with an initial score of 60% on the "ecotourism" version increasing to 75% in the final test. When we compare these to the average MCQ score of 78% for mainstream students entering the science faculty, it appears that SFP students, after their foundation year studies, are almost as adequately prepared to use English for academic purposes.

Averages for the other sections of the test, however, must be taken into account for a more realistic picture of the progress made by the SFP cohort and the continuing linguistic and literacy support they require if they are not to be too disadvantaged in their study in mainstream science. Though demonstrating some improvement, scores in the other two sections of the test are still fairly low with 54% achieved in the cloze task while the average mark for the written section is still not a passing one at 49%.

Fig. 2.1. Comparison of language test average scores (per section)



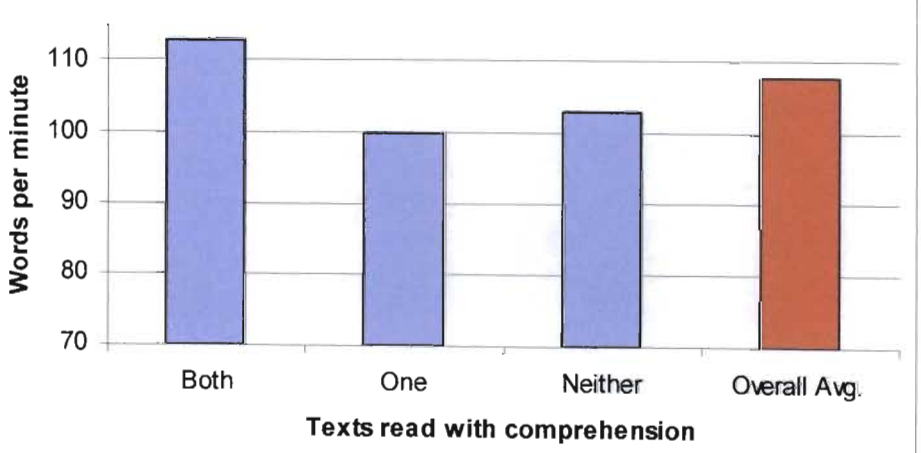
If we assume that mainstream averages are fairly consistent across the three sections, then it becomes clear that SFP students still lag behind their mainstream peers, by the end of

their foundation year, when it comes to written expression to demonstrate understanding of the texts they have read.

4.2.2 Reading rate

A year of exposure to academic reading across different SFP subjects, including those prescribed by the communication course, did not result in a significant improvement in reading rate. If comprehension of both texts read to measure average reading speed at the end of the year is considered, students demonstrated a 3% improvement, increasing from a rate of 108.3 to a mere 112.9 words per minute. The difference, still of little significance, is slightly greater if we consider rates measured when only one or neither of the two texts was read with understanding. In this case, reading rates improved from 94.5 to 100.0 and 92.2 to 102.9 respectively. Arguably the most representative measure of reading rate – the overall average when speeds, both with and without comprehension, are calculated – reveals an improvement of 7% from 100.4 to 107.8 Wpm.

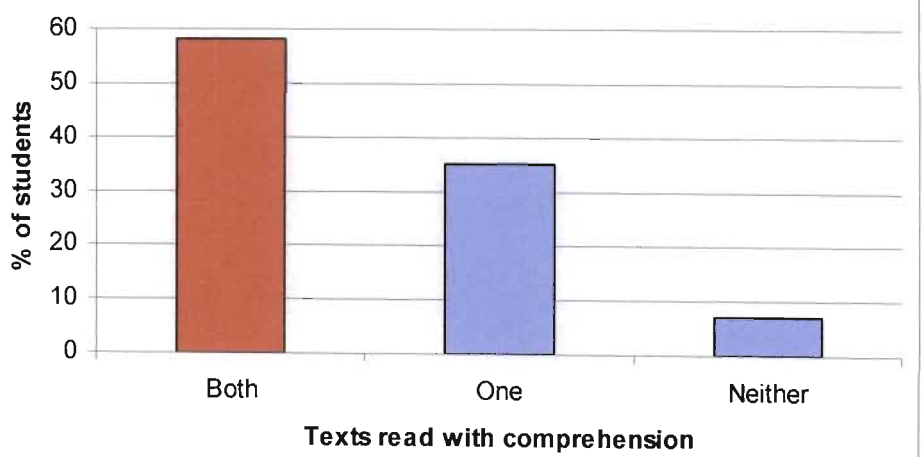
Fig. 2.2.i. Final reading rate



Comprehension of texts read did improve over the course of the year, if we consider that 58% of students read both with comprehension, compared with the 48% to do so when reading rate was initially measured.

An analysis of comprehension of specific texts used in the final measure of reading rate reveals that a significantly greater proportion (86%) of students read the first text (Part I of the "Fossil Fuels" text) with understanding compared with the 66% who comprehended the second. Reading rate did not appear to be affected by this, however, as the rate at which the two texts were read was virtually the same, at 107.3 and 108.7 Wpm respectively.

Fig. 2.2.ii. Comprehension of texts read

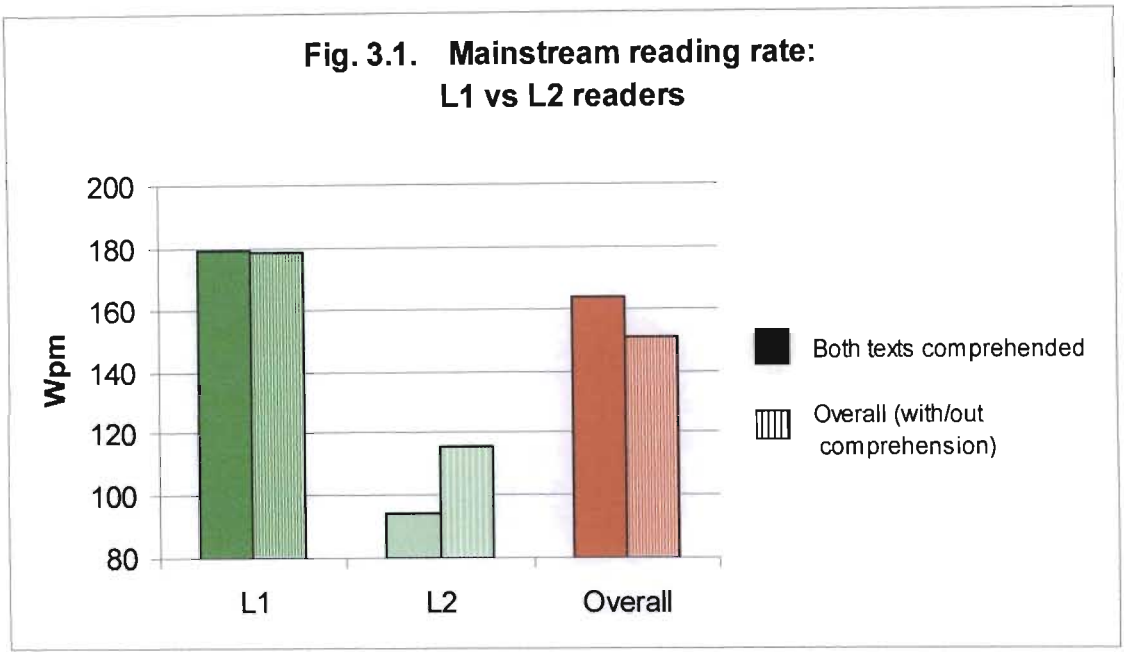


4.3 Comparison of average SFP reading rate with that of mainstream sample

A comparison of the final measure of the 2005 SFP cohort's reading rate with the performance of successful mainstream students reveals that, on average, they read at 73% the rate of the overall mainstream sample's rate of 151 Wpm.

The mainstream group of 34 second year Biology students consisted of both first and second language English-speaking science students. 19 of the former and 15 ESL students (of whom 4 were ex-SFP students) represented 56% and 44% of the group respectively. As literature in the field suggests that subjects reading in a second language should be doing so at about 70% of the rate of their L1 peers, separate averages for the two groups within the mainstream sample were extracted.

Fig. 3.1. Mainstream reading rate: L1 vs L2 readers

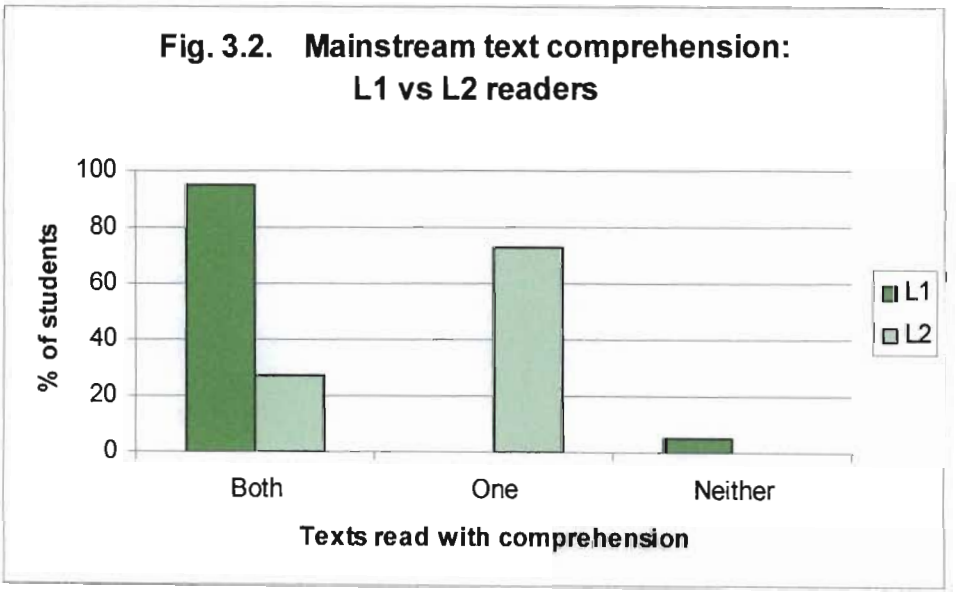


Overall (whether they had read with comprehension, as 95% had, or not) first language English students read at an average rate of 179 Wpm – significantly faster than the SFP students, who read at only 61% of this rate. Mainstream students who were reading in a second or additional language read at a rate closer to that of the 2005 SFP cohort, though, with an average of 116 Wpm, which is 65% of the rate at which their L1 peers read.

Higher than the SFP average of 58% is the 65% of mainstream students to demonstrate comprehension of both the texts used to measure average reading rate. There is a marked difference evident in the percentage of students to comprehend texts across language groups within this sample, though. While 95% of the L1 readers had comprehended both texts, only 27% of those reading them in a language other than their mother tongue

demonstrated understanding of both. 73% of this group did, however, read one of the two with comprehension. Interestingly, the four mainstream L2 students who did read both with understanding, did so at a slower pace than those who did not demonstrate comprehension of either text.

Fig. 3.2. Mainstream text comprehension: L1 vs L2 readers



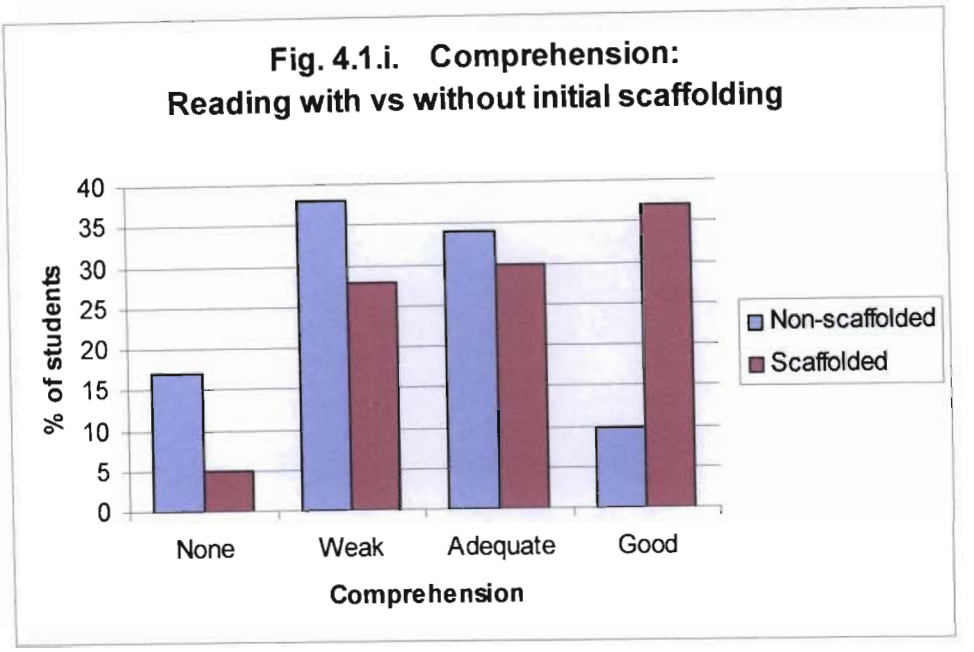
Although SFP students' better comprehension of the first text than Part II did not affect their average reading rate, mainstream subjects, across language groups, did read the first text more quickly than the second, at an average pace of 155 Wpm for the first and 147 Wpm for the second.

4.4 Experiment: Can a means of scaffolding students' academic reading have a positive impact on SFP students' limited reading ability?

To investigate the usefulness of providing initial reading scaffolding by way of a summary spoken in everyday language, as well as the effect of a written form of such a paraphrase on reading rate, findings from reading rate and comprehension tested under experimental and controlled conditions are presented. Better performance of experimental group subjects on comprehension tests suggests that initial scaffolding does aid comprehension. Comments elicited by questionnaires about the reading also show that students are more likely to read, in full, a text assigned when this is introduced by a commonsense paraphrase. A written version of a text, paraphrased in commonsense terms, is better understood than the original version read by students, but students do not appear to be able to read such a text at a more rapid rate. This suggests that reading efficiency, in terms of rate, is not affected by the difficulty of a prescribed text. Improvement in this area would require extensive reading practice which is likely to take place if students are more motivated to read and understand a text introduced with initial scaffolding.

4.4.1 Reading comprehension and feedback

Experimental group subjects, who were "talked through" a commonsense summary of a prescribed reading before reading it independently for homework, did perform better, on average, than those in the control group who were merely instructed to read the text. Brief summaries based on the main ideas covered in the text revealed that 67% of experimental group students had adequate or good understanding of the reading, compared with the 44% of control group students whose work was judged in this way. Summaries reflecting "good" comprehension, specifically, were produced by 37% of the "scaffolded" group whereas only 10% of those control group subjects produced such summaries.



A summary demonstrating good comprehension would be one ranking positively on the following three continua used for marking, with the total of the three scores divided by three for a final score between 0 (no comprehension) and 3 (good comprehension):

0 (no) ---------- 1 (weak) ---------- 2 (adequate) ---------- 3 (good) Comprehension
Insufficient ---------- Sufficient content
Irrelevant / incorrect ---------- Relevant / correct content
Plagiarised ---------- Own words (meaning, not expression)

The example of such a summary that follows covers the key points in Botting and Morrison's argument for animal research: that animals and humans are similar enough for results from animal experiments to be generalised to humans, and that animal experiments in the past have allowed scientists to develop effective vaccines, surgical techniques, and to test for the safety of numerous drugs. Misunderstanding of explanations given in the reading is not evident in this summary. Explanation in the student's own words suggests that the text has been understood as phrases have not

merely been lifted from the text. Despite non-standard forms of expression, the student writer's meaning is clear.

Sample summary 1:
"Botting and Morrison believe that animal research has played an important role in finding vaccines. They say that there is no different between humans and animal. Animals have same body functioning as humans which means that if animals are cured by a certain medication that means humans will be cured too. In using animal for research, they have found medicines for certain diseases. Surgery is possible because researchers have practise with animals."

In the next sample, the student discusses few of the points covered in Barnard and Kauffman's argument against animal research, with limited explanation of the issues mentioned. The writer does, however, use her own words to touch on some relevant points argued in the reading: the physiological differences that make it misleading to test drug safety for humans on animals, the artificial introduction of a disease for testing on animals which does not accurately model what happens naturally in humans, and the stressful conditions associated with laboratory experiments which can alter normal physiological reactions and produce misleading results. The student does not make any statements indicating misunderstanding of particular issues discussed in the text, either. Thus this student's summary is judged to be an adequate indication of reading comprehension.

Sample 2:
"According to Barnard and Kauffman animal research is misleading because most animals including rats are unique and different from humans. Animals are infected wrongly with human diseases, and are highly stressed up, as a result they give false feedback about the disease they are infected with."

The third sample indicates understanding of one of the main reasons animals are used in medical research: to test the safety of drugs. Despite the logical explanation given in the

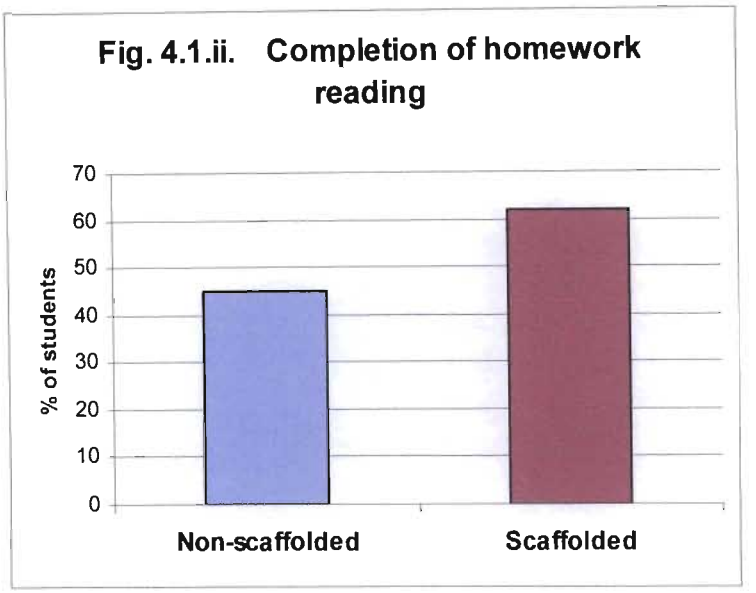
writer's own words, however, little reference is made to the points of the argument discussed in the reading. The summary thus demonstrates poor understanding of the text because key ideas from the text are not summarised. Misunderstanding is also evident when the writer discusses testing the suitability of the animals for use in making, rather than testing, medicine. Although the authors of the reading did mention the use of animal tissue in the production of insulin in the past, it is possible that this student is drawing on his own frame of reference regarding the use of animal parts in the manufacture of traditional medicine in South Africa. This student thus scores poorly in terms of sufficient and relevant content.

Sample 3:
"Botting and Morrison believe that animal research is vital to medicine because they cannot risk with the lives of human beings, they risk in the lives of animals. They believe they have to test the medicine by giving it to an animal. They have to know which animals are suitable for a specific medicine, and not all animals are suitable for making medicine."

Summaries indicating no comprehension could consist of plagiarised phrases that do not cover relevant points from the reading, or an explanation of issues that demonstrates a complete misunderstanding of the authors' argument. Alternatively, a student may discuss issues that have no connection to the topic discussed in the reading.

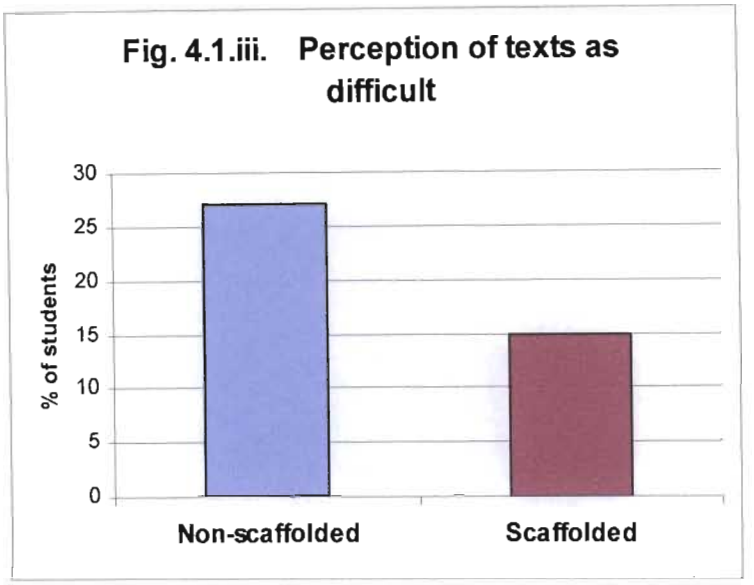
Comprehension of the two different texts used in the experiment was also analysed to see how comparable they were. Students who received no scaffolding before reading the text performed better in response to the second reading than the first (37% and 52% adequate or good for Texts 1 and 2 respectively), though comprehension of the two readings was roughly the same when some scaffolding was provided, with 69% and 65% in this category for the two texts.

When asked whether or not they did actually read the assigned texts, more students (62% compared to 45%) read the whole text when it was first paraphrased orally.

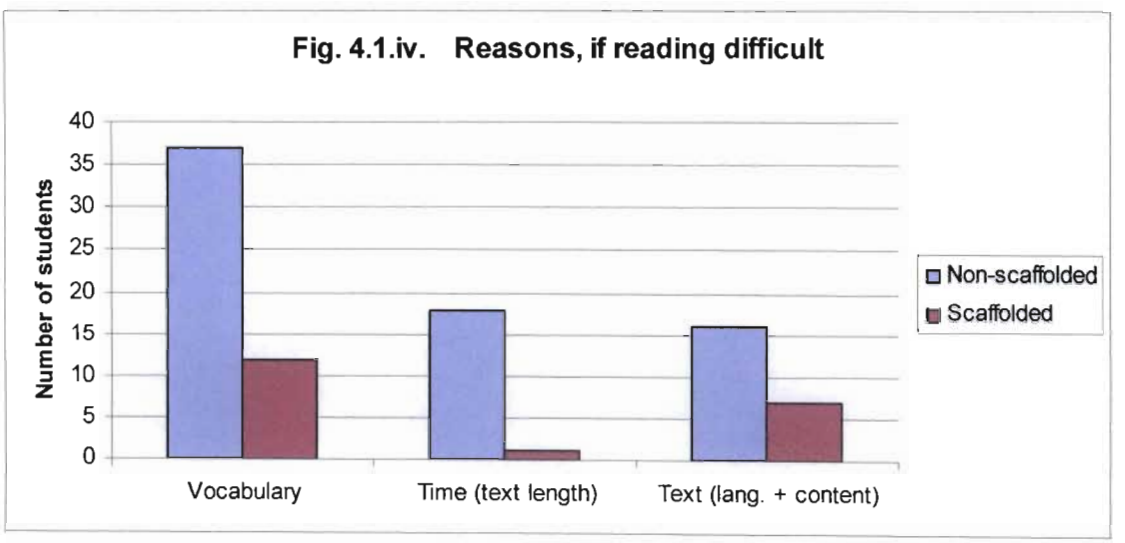


The most common reason given, overall, for not having read the assigned text was having too little time (some blamed this on too much other work to do, while others referred only to the length of the text). 52% of control group students who had not read gave this reason, while 34% of experimental students did. Having forgotten to read the text was the next most popular reason, with 17% and 19% of control and experimental subjects referring to this respectively. Of course only experimental group students could cite having already "covered" the text in class as a reason for not reading, and 10% of them did give this reason.

Overall, fewer experimental group students found the readings difficult, with 15% as opposed to 27% of control group students describing the reading as such. Whether or not it had first been paraphrased, the second reading was perceived as difficult by more students (18% versus 25% describing Text 1 and Text 2 respectively), even though more students showed better comprehension of the second reading.



In all, only 20 experimental group students expressed reasons for the reading difficulties they experienced, while 71 students in the control group referred to particular difficulties. Difficult vocabulary was the most common reason put forward by all students (37 control and 12 experimental group subjects) who gave reasons for difficulties.



The following example is a comment from a student about a text read without initial scaffolding:

"It was difficult because the English that use was difficult. Some of the words I never meet before."

Insufficient time was the second most common complaint that control group students raised about both readings, whereas more of those who had received initial scaffolding referred rather to general difficulties with the text. Only one student who had been talked through the text, and 18 who had not, referred to time limitations because of the length of the text.

Reasons for the difficulties of the text read without initial scaffolding include the following comments which express the frustration of ploughing through a text with no sense of where it is going or of beginning to read a text without relevant background knowledge:

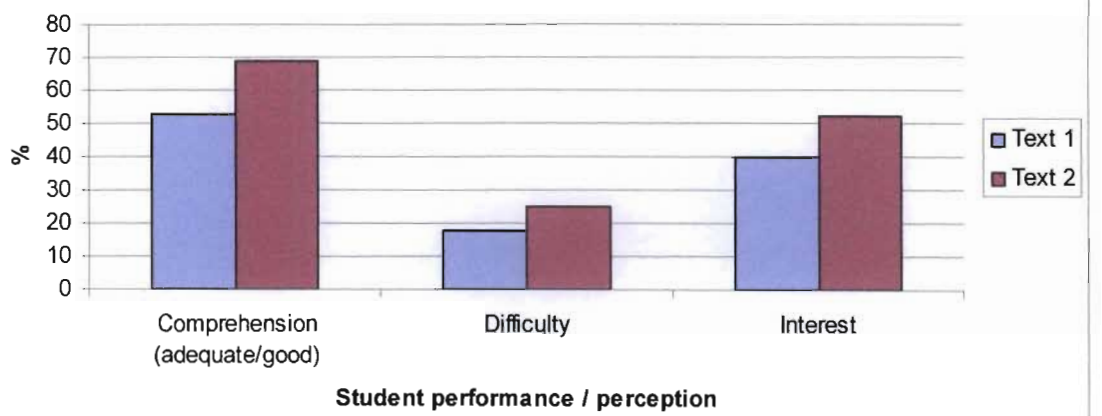
"I couldn't follow through the text."

"At the beginning I didn't know what it is all about. I was confused."

Patterns to emerge when reasons for difficulty were analysed separately for the two texts, were virtually the same.

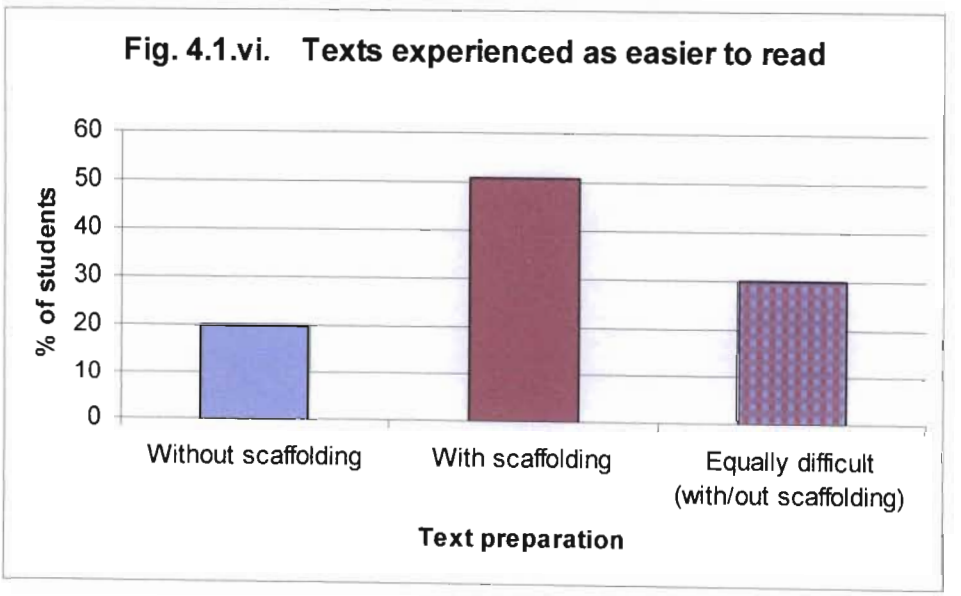
When students were questioned after the first text they read, with or without initial scaffolding, about how interesting they found it, Text 2 emerged as the more interesting one, with 52% describing it as such while 40% described Text 1 in this way.

Fig. 4.1.v. Comparison of responses to Text 1 and Text 2



When asked to compare both texts read in terms of difficulty, at least half of the students (51%) opted for the one that had been scaffolded as the easier reading. 30% rated them as equal in terms of facility and 20% chose as the easier the one that had not been paraphrased for them first.

Fig. 4.1.vi. Texts experienced as easier to read



Amongst experimental group students who selected the text read after initial scaffolding as the easier text to read, the fact that the text had already been discussed in class was most commonly given as a reason.

Comments to put forward this reason for a text being "easier" to read express the way in which some students experienced the provision of an initial commonsense paraphrase. The following comments suggest that the scaffolding aided understanding by making the bigger picture or gist of the text clear from the start, or by motivating them to read and work at understanding the article:

> *"It because you give us the picture of what is happening to the topic."*

> *"It was explained before I read it. I knew what was going on before I read it."*
> *"It was introduced before I went through it. Then I fought strongly to understand it clearly."*

> *"It was explained in class first and it sounded interesting."*

Closely behind the 17 students to give this reason were almost as many (15) who wrote of finding the content of the text easier, more familiar or more relevant. Like the 11 respondents who maintained that the text itself was easier than that of the one that they had read independently, these 15 students did not explicitly link such reasons to the fact that they had been exposed to an oral summary.

Student responses included the following comments about the text read after initial scaffolding:

> *"Because they are talking about straight and forward facts."*

> *"Some of the words used were easier to understand."*

Although both texts were roughly the same length, one student compared what she considered the easier text with the one she had read without initial scaffolding, explaining that it was "too long and one would panic by just looking at it".

Having had sufficient time to get through the text was a reason given by a few (five) of those who believed the initially paraphrased text to be the easier of the two.

Those to whom the text read without scaffolding appeared to be easier, could not point to this preparation as a reason. Other than that, similar reasons to those above were cited. Easier content was, again, slightly more frequently referred to (nine mentioned this) but for students who found independent reading easier, the facility of the text itself and the time required to read it, were equally supported reasons (by six students in both cases).

4.4.2 Reading rate

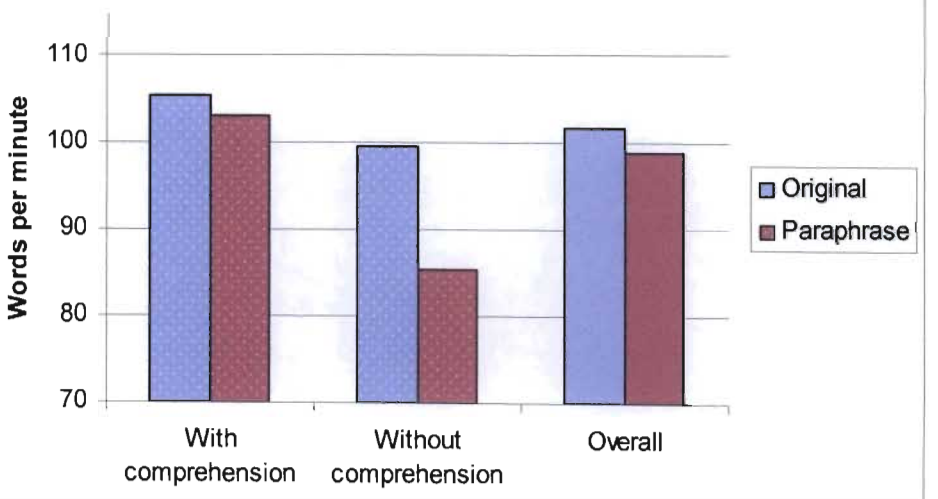
Average reading rates calculated for students in the experimental group, who read a paraphrased version of a course text, were compared with those generated by the control group who used the original text. What emerged is that there is not a significant difference in the rate at which the original and paraphrased versions of the text were read.

If we consider as the official reading rate, that at which students read with comprehension, then the experimental group students actually read slightly more slowly (at 103 Wpm) than those in the control group whose average reading rate was 105.5 words per minute. As in the initial measure of reading rate, the rate of those, in both control and experimental groups, to have read without comprehension, is slightly lower than those who read with understanding. Of those to have read without demonstrating adequate comprehension, original text readers read at 99.5 Wpm while, contrary to what was expected, paraphrased version readers read at the even slower rate of 85.3 Wpm. Overall, individual reading rates range from 49 Wpm to 209 Wpm for those reading the paraphrased version, while control group subjects reading the original version of the text did so at between 14 Wpm and 247 Wpm.

To eliminate the interference of linguistic factors on comprehension scores, an overall reading rate, regardless of whether or not reading was done with comprehension, was

calculated. Being very similar, and with the rate without comprehension less rather than more than that with comprehension, the two figures suggest that students who did not comprehend the text adequately did not merely scan through it at a rapid rate which in turn implies that this overall measure gives an acceptable indication of the actual rate at which students read. At 101.7 Wpm for the control group and 98.8 Wpm for the experimental group, the paraphrased version did not effect an improved reading speed. On the contrary, the simpler text took the majority of students slightly longer to read.

Fig. 4.2. Reading rate



Comprehension was significantly affected by the version read. 77% of students who had read the paraphrased version answered at least 75% correctly, compared with well under half the control group students (42%) whose answers demonstrated that they had understood the original text.

These findings provide a picture of SFP students as readers. Such data will be discussed in terms of the academic reading abilities and needs that they reveal for the group, as well as the implications that these, and findings about the effectiveness of scaffolding student reading, have for facilitating SFP students' academic development to give them access to the knowledge and skills they will need to master as they are apprenticed into the field of scientific study.

Chapter 5

Discussion of findings

Foundation year students are, by definition, educationally disadvantaged. One would thus expect limited access to books and reading before and even during secondary schooling to have a detrimental effect on their academic reading ability. What is not clear from the tests that select students for the Science Foundation Programme, according to the potential they show for success in a number of science subjects, is the extent to which their reading skills differ from those of mainstream students. This is crucial for establishing the development that must take place over the year if students are to cope with the demands of mainstream study.

A cohort of almost 200 students will, of course, include a range of reading abilities and needs. As these are not explicitly identified as part of the initial and ongoing testing of SFP students, it is difficult for lecturers, across subjects, to distinguish conceptual difficulties from those associated with the limited academic literacy skills that hinder students from accessing content knowledge in the first instance, before they can attempt to express their understanding.

Reading ability is only one, but a nevertheless important, element of preparedness for tertiary study. To provide some profile of the individual reading abilities and experiences brought by students making up the 2005 cohort, findings of the various reading-related tests and questionnaires administered to the group will be discussed.

5.1 Initial findings

To gain insight into the academic reading abilities and difficulties that the 2005 SFP cohort bring to their studies, initial findings about students' background linguistic and literacy experience are considered in conjunction with feedback from a homework reading task and data collected from measures of academic reading proficiency in the specific areas of comprehension of the gist of a text, general academic vocabulary, reading rate, and academic language and literacy assessed in a test based on responses to texts read. Grouping students according to performance on this language test suggests that this measure of academic reading ability is linked to the specific aspects of general academic vocabulary, reading rate, and comprehension of the gist of independently read texts, as students in each band demonstrate increased average scores for the vocabulary, reading rate, and comprehension tests, as the language test performance of the band improves.

5.1.1 Background linguistic and literacy experience

Given that SFP students are selected on condition that they have been educationally disadvantaged, feedback on their previous literacy experiences largely quantifies what one would expect.

Questionnaire items about medium of instruction were not specific enough to probe whether, for students taught in a combination of English and home language at primary school, the change from mother-tongue to English as a second or additional language had allowed sufficient time for students to develop CALP in their mother-tongue, so that underlying knowledge and concepts could be transferred into English as this medium of instruction was gradually introduced in other subjects (Luckett 1995, Clarence-Fincham 2000). Although the study did not aim to explore in any great detail the effects mother-tongue or an additional language as media of instruction at different levels of school

education, it would have been useful to ask students when the changeover from mother-tongue to English took place at primary school, if this was the case, to gain a better understanding of their initial experiences with, and consequent attitudes towards reading, by establishing whether they had the opportunity to first learn to read and write in their own language or whether they had to grapple with a new language at the same time as learning to read and write. What is clear, however, is that over a quarter of the SFP cohort had English-only instruction at primary school. While this was probably in the later years (Peacock 1996), many are likely to have been learning a new language, English, at the same time as learning new concepts, as well as to read and write, in a language other than their own.

The response option of "both" (mother-tongue and English) to the question of language used for primary and secondary school teaching also yields rather vague information. We do not gain any sense of students' exposure to written texts in English or mother-tongue, and are unable to establish whether a teacher taught through the medium of English with occasional mother-tongue code-switching, or whether most tasks were carried out in a language other than English which, by secondary level, would have been the language used for assessment in most cases. While some students had been able to learn in their mother-tongue at primary school, a small percentage had been taught exclusively in this language at secondary school level, and had thus never been exposed to English as a language of learning and teaching prior to embarking on tertiary science study. Despite having somehow written English matric examinations, and presumably being numerate enough as to be accepted into the SFP, these students would be at the distinct disadvantage of having extremely limited exposure to general conversational English, let alone the academic language of science.

The importance of developing emergent literacy skills before starting primary school (Rose 2004, Heath 1994), as demonstrated in the local context by Ntuli and Pretorius (2005), suggests that the majority of SFP students began their schooling at a disadvantage, with well under half the cohort having been read to before school. The remainder would thus have had to begin learning to master the technical skill of decoding

printed text before developing familiarity with the discourse patterns of stories and the language of written text, apart from before becoming familiar with the idea of interacting with words and pictures to derive meaning, enjoying reading as a pleasurable activity, or even learning to handle books.

It would thus be little wonder that reading is so negatively perceived and avoided as much as possible. The 2005 SFP students, however, demonstrated an overwhelmingly positive attitude towards reading in response to questionnaires administered, answering that they sometimes or often read for pleasure while still at school, and now read for fun. The questionnaire did not probe what students read for fun, which may include more reading of comics and short texts in magazines than anything else. Although the question was included to get a broad sense of particularly positive or negative attitudes towards reading, being able to follow up the question with a probe of the type of texts read would have give a much clearer sense of participants' experience as readers. Perhaps these, being more academically inclined students who want to pursue their studies, may have seen reading in a positive light, appreciating its value in contributing to their academic success. A number may also have responded with what they knew their lecturers would expect to hear of "good" students. Casual observation of these students on campus did little to support the impression that most are keen readers. Perhaps the pressure of their studies meant they never had time to do so while on campus, or had less access to the kinds of reading materials that they may have previously read for pleasure. Popular magazines are not accessible from campus libraries, and newspapers must be read in the library, a place most students seem to avoid unless course assignments explicitly require that they find information there.

Such "educationally disadvantaged" students as the SFP cohort did have limited access to libraries, as would be expected. With less than a quarter having attended a school with a library, the picture only improves if public libraries are also considered. A fifth of students used neither a school nor public library, though, and students who did use one or both of these were not required to provide any sense of how well-resourced these were, in terms of availability of appropriate materials.

While the largest portion of students to respond to the question of access to copies of written texts for reading at school indicated that they only enjoyed such access a few times per term, and almost as many did so on a weekly basis, such students account for under half the cohort. Daily access, across subjects, would be far more conducive to the development of adequate academic literacy skills necessary for university study. Worryingly, nearly 15% would be starting their SFP year having only had a copy of a class text to read for themselves a few times in the year, if at all.

Such information provides us with some idea of why most SFP students do not cope with the independent reading tasks assigned to them. They may have hardly ever had a copy of a written text to read in class, let alone to take home to read independently. Thus, they have been denied opportunities for the extensive practice required for effective, efficient reading (Grabe 2001) and may be too overwhelmed to complete, or even begin, the reading that has been set. Rather than assume that students just need the discipline to work through a prescribed text, lecturers should be aware that many may require some modelling of how to go about the process, along with plenty of practice, to develop the skills that university students would generally be assumed to have mastered at school.

Despite limited preparedness when it comes to academic reading, when questioned about reading difficulty before they had started their university work, less than 20% of the SFP students described reading as difficult. This could have been that the school reading tasks they would have to have based their responses on, at this stage, would have been fairly short, and for many students, rather infrequent. With no standardised reading tests (Pretorius and Machet 2004), marks would not have been awarded for reading, and so written work, instead, may have been seen as an area of greater difficulty. As more of a receptive skill, reading involves abilities that are not as easily "judged" as writing and so one may not be consciously aware of problems. As one cannot comment on one's reading ability without some outward measure to refer to, a question of how difficult one finds the act of reading is limited to probing one's attitude towards it. That is, a good reader may not necessarily perceive the act of reading to be "easy", just as a weaker reader, with less of an idea of the level of text comprehension possible, may be more tolerant of

uncertainty, and hence find the process relatively "easy". Student attitudes towards perceived facility of reading would be more meaningfully probed when investigated in the context of specific texts of a particular length, level of language and content, and which are connected to measures of comprehension.

What can be probed from the initial question of perceived difficulty of academic reading, in English, are the reasons why some students may have negative attitudes towards reading in terms of the difficulty associated with the activity. Most find reading daunting because of the unfamiliar vocabulary that they, as second language English speakers, are likely to encounter quite frequently and similarly, as many SFP students mentioned, because of the difficult language that makes it hard for them to unpack a text's meaning. What is particularly interesting is that a number of students describe reading as difficult because of the length of time that they require to work through a text. In view of what researchers in the field have argued about the strain placed on short-term memory when readers take too long to decode the texts that they are reading (Rasinski 2000, Anderson 1999a, Grabe 1991, Carver 1990, Celce-Murcia and Olshtain 2000, Eskey and Grabe 1988), it is hardly surprising that some SFP students recognise for themselves this particular reason for reading difficulties. Anxiety associated with reading was a category used for those responses that referred to any kind of distress associated with reading. Sadly, some students had experienced punishment or ridicule when learning to read (Thornton, 2005) and still found it difficult as a consequence.

SFP students appear to demonstrate similar needs to those of the ESL students in the study carried out by Mokhtari and Sheorey (1994:60), who "specifically indicated that they would like to improve their vocabulary and reading comprehension and wanted to be able to read their academic study materials at higher reading speeds". Strategies to facilitate SFP students' development of academic reading skills should be informed by such feedback from the students themselves. This would mean specifically targeting vocabulary and grammatical difficulties, as well as focusing on improving reading rate. Providing students with the guidance and practice necessary for significantly improving their academic reading ability, when done in a supportive environment, should also go a

long way towards overcoming the detrimental effects of the anxiety previously associated with reading.

5.1.2 Reading comprehension and feedback

An initial investigation of students' comprehension of a text read independently demonstrates, as might be expected, that individual reading abilities range from no comprehension to good comprehension. More surprising is the discovery, confirming what lecturers may often suspect, that less than half the students actually read the text assigned for homework. One would imagine that students, at the beginning of the year, would be especially motivated to work hard to succeed. Why some students would read only part of a text under four pages long, and others not even attempt it at all, is enlightening in terms of increasing our understanding of SFP students as readers.

An interesting match emerges between reasons students give for reading difficulties in general, and why this particular reading task was not done. Problems with unfamiliar vocabulary and the difficult language of the text are reasons that feature in both cases, as does the explanation that reading takes too long. When specific difficulties with the prescribed reading task are probed, vocabulary, again, emerges as the major difficulty perceived by students. The length of the text, or time required to read it all, as well as the difficult language of the text, are also identified as reasons for difficulty. Results from the vocabulary, academic language and reading rate tests also carried out at the beginning of the year provide quantifiable evidence to support such observations from students.

The specification, in some responses, that the reading was too long to do because of "other work" assigned to students hints at the dangerous perception that reading, because it does not result directly in a tangible product to be submitted for marks, is less important than other homework. Thus students get left behind, waiting for lecturers to rather tell them what is important, and struggle with class work, written assignments and tests because the task that gives them access to the concepts that such work builds on, is the

first to be jettisoned. Until foundation year students are able to appreciate for themselves the importance of effective, and possibly repeated, reading, it could be helpful for content lecturers, as well as those teaching academic communication skills, to enforce this activity by following up assigned reading with specific tasks to be submitted in preparation for further work. If resources allow, feedback on such tasks could also give students valuable feedback on aspects they have misunderstood or not fully comprehended, prompting the learner to further engage with the prescribed text.

Comprehension scores, measured through summaries of the main ideas understood from the reading, indicate that textual understanding is difficult for most students with so few demonstrating good comprehension. Few students appear to be aware of their reading difficulties, though. Significantly more students, than the initial 19% to describe academic reading, in general, as difficult, did feed back that the particular text assigned for homework was difficult. The fact that they were questioned about a specific text, and required to demonstrate comprehension of the text, makes this probe into students' perceptions of reading facility more specific and thus more likely to produce a realistic picture of students' experiences of reading academic texts. As the percentage of SFP students to recognise that the particular prescribed text is problematic for them is, however, still lower than the number to display limited understanding of what has been read, steps need to be taken to provide students with a more accurate picture of their reading abilities and needs. The introduction of standardised reading comprehension tests could be judiciously used to provide students with a truer reflection of their reading abilities and hence a better idea of the progress necessary in this area if they are to succeed in mainstream study. This being the goal to which SFP students aspire, such input could be usefully motivating to students, so long as effective improvement strategies are presented to students.

To this end the suggestions of Eskey and Grabe (1988) are helpful. Devoting class time to reading instruction should focus on joint development of the bottom-up skills of efficient identification of words and grammatical forms, and the top-down skills of reading for global meaning where students learn to work out the meaning of unfamiliar structures

from the overall textual understanding that they build up. Neither of these skills, they argue, can be developed without "extensive reading over time", though, implying that classroom instruction is only the starting point for academic reading development (227).

5.1.3 Vocabulary test

Students' own perceptions of why they experience difficulty with academic reading focused largely on problems with unfamiliar vocabulary. Foundation year lecturers are very conscious of explaining, or providing glossaries to explain, the technical vocabulary that students may not have encountered or adequately conceptualised in their former education. Metaphorical or idiomatic language, and the general lexical items that academic writing draws on, however, are not often recognised for the difficulty they present to second language readers who have had limited, if any, experience with academic text. Exposure to English, for the most part, would have been limited to more conversational discourse, and the few text books that may have been available for independent reading are unlikely to have afforded students adequate opportunity to develop the receptive general academic vocabulary necessary for reading and comprehending their prescribed tertiary-level texts without the frustration of stopping to look up all unfamiliar words in a dictionary.

The average text prescribed for independent study contains many such words. Thus general words selected for testing from the different science subject-related readings used in the academic literacy course are not the technical, discipline-specific terms that are easily identified as problematic for students. As Levine and Reeves (1990, in Anderson 1999a:25) argue, "it is easier for the reader of academic texts to cope with special terminology than with general vocabulary". Misunderstanding these general lexical items could not only interrupt the process of reading for comprehension, but, in some cases, possibly leave students with a completely inaccurate understanding of what the text has been prescribed to teach them.

The vocabulary test administered at the beginning of the year does confirm, with an average score of 58%, that most students struggle with general academic vocabulary. This is particularly worrying if we consider Nassaji's (2003:650) reference to the work of Lui and Nation (1985) to suggest that "readers should know a high percentage (at least 95%) of the words in the text in order to be able to infer successfully". If SFP students are unfamiliar with the meaning of a number of words encountered in a given text, then they will not be able to draw on the surrounding context and the gist of the text as a whole to work out the meaning, forcing them to disrupt their reading by painstakingly looking up words in the dictionary, which offers no guarantee that accurate understanding of the meaning of a particular lexical item will be achieved. Alternatively, a student in such a position may ignore what is unknown, resulting in very poor comprehension of the text.

When investigating the academic reading abilities and needs of SFP students, it is not particularly meaningful to consider an average vocabulary test score without some sort of standard for comparison of SFP students with those in the mainstream. In the absence of such a standard, it is more useful to consider what such a test can reveal about the types of words with which students may struggle, and of which they may require explicit teaching. It is likely that the general words that teachers have encountered so often as to make them appear everyday, unproblematic items, may include non-technical terms that are nevertheless unfamiliar and hence problematic for students. Further research could usefully probe the difference between the words that teachers would identify as potentially difficult for students, and those that the students do, indeed, experience as such.

As Sanders and Nhlapho (1993) found, when scoring the vocabulary tests administered to secondary school biology students, items selected to give the meaning of a word were sometimes those with the opposite meaning. When 58% of the SFP cohort thinks, for example, that *receding* actually means *approaching*, tutors should be aware that texts set for homework reading require some paraphrasing in more commonsense terms. Feedback from such vocabulary tests provides a useful starting point when it comes to establishing which words need particular attention.

The fact that students were certain of the meanings selected almost a third of the time when these were actually incorrect, suggests that a number of responses are not merely unlucky guesses but rather misconceptions about a number of the words that students will encounter, and possibly quite frequently, in the academic reading required of them. While they cannot be expected to look up all unfamiliar words in the dictionary, as doing so would be too disruptive of the reading process and cause readers to lose a sense of the overall meaning being built up, incorrect understanding of such words could result in very poor comprehension of a given text.

Useful as it may be to teach students to work out the meaning of a word from the larger text context, accurate "guessing" is limited by their linguistic proficiency and adequate contextual cues available, hence Celce-Murcia and Olshtain's emphasis on the importance of ESL students learning to distinguish between words they must look up in a dictionary and those that can be guessed from context (2000). While strategies for dealing with unfamiliar words can be taught, it is difficult to help students to overcome vocabulary limitations when some of the words they encounter, perhaps because they can be easily decoded or are not new, are not recognised by students as problematic words that need explanation. As was the case when Sanders and Mogodi (1998) required their vocabulary test candidates to indicate their certainty that a particular answer was correct, SFP students often appear to believe that they know the correct meaning of a word when, in fact, their choice of answer indicates that this is not the case.

That of the words selected for the vocabulary test, nearly 10% happened to be understood by the largest number of students, in each case, as the exact opposite of the actual meaning, is of particular concern when we consider the proportion of students to demonstrate certainty about such meanings. This implies that a number of students will make no attempt to check incorrect understanding and hence lose an opportunity to learn the correct meaning and, in so doing, extend their existing vocabulary.

A student, for example, who is certain that "All surfaces *emit* radiant energy" means that they all *absorb* it, will leave the text with a completely inaccurate conceptual

understanding of the section, even if the notion of "radiant energy" has been carefully explained or dutifully looked up in the glossary. Such a student may be puzzled by the explanation but be oblivious to the fact that he or she has misunderstood. Required to express understanding of the section in a test, the student who does not rewrite such a sentence verbatim, but explains as he or she has understood, will be judged to have an inadequate understanding of science, when it may be a limited academic English vocabulary that is to blame for poor test results.

When concepts are explained verbally in class, with the support of gestures and diagrams, a student who has such a misperception of the term "emit" may gain a more accurate understanding. As tertiary study requires that a student is not limited to concepts discussed in class, but can correctly comprehend content provided only in assigned readings, it may be useful if foundation year students are spoken through the main ideas of a text in commonsense terms, before it is to be read independently. Such a strategy would only be of any benefit beyond the foundation year, however, if, by the time mainstream study begins, sufficient exposure to general academic words, through extensive reading, has allowed for the development of a more adequate receptive academic vocabulary for independent reading with comprehension. The repeated exposure to particular words, in context, that is necessary for such lexical development would probably only be possible if students read extensively outside of class, as well as when reading tasks are assigned as part of a course's requirements. It is thus important that all programme modules prioritise the assignment of readings to provide students with sufficient exposure to contextualised vocabulary. If such reading tasks are accompanied by a form of initial support or scaffolding to encourage students to engage with the text and to enable them to begin their reading with some understanding of the ideas to be encountered, students will have opportunities to develop their reading efficiency as well as increase the receptive vocabularies that they require for successful tertiary study.

5.1.4 Reading rate

At roughly 100 words per minute at the start of the year, SFP students seemed to be reading at half or even a third of the rate researchers believe to be adequate (Eskey and Grabe 1988, Anderson 1999a, Celce-Murcia and Olshtain 2000, Carver 1990). No relevant standard exists for comparison, though, as no reading rate, whether an optimum or minimum, has been established for South African students reading at tertiary level. Furthermore, in the absence of a standard test of reading rate, results from this measure of initial 2005 SFP reading are specific to the methodology, texts and questions used in this case. Thus it is difficult to establish the extent to which SFP students' reading speeds differ from the rate at which they should be capable of reading so as not to be disadvantaged in their studies by reading less efficiently than their mainstream peers. Further discussion of the initial reading rates will thus be more meaningful when analysed in comparison with end of year averages and those of mainstream science students, measured in the same way.

What is more informative, at this point, is the extent to which the texts used were comprehended. Admittedly, getting no more than one answer wrong in response to four text-based True / False questions is hardly an in-depth measure of adequate comprehension. This does, however, offer some superficial means of separating students in terms of whether or not they demonstrated an understanding of what had been read, without too much interference from the linguistic difficulties that would quite possibly have influenced results had students been required to express understanding in their own words or by selecting a response from a number of options. With less than half the cohort reading both texts with understanding, it is clear that the texts selected from authentic course materials are too difficult for most students to read and understand independently. This, again, serves to reinforce the fact that the majority of SFP students do not begin the year with adequate academic reading proficiency to cope with their reading materials and require some intervention from their lecturers across the curriculum if they are to develop the reading skills necessary for successful tertiary study.

5.1.5 Language test

With scores ranging from 18% to 89%, it is clear that there is a great range in the academic language skills with which SFP students begin their studies. An average score of 52% and pass rate of 56% for the group, however, implies that for the majority, adequate academic literacy skills (particularly academic reading proficiency, as academic language proficiency was largely tested by text comprehension) cannot be assumed. The development of academic reading skills needs to be prioritised for explicit teaching and extensive practice during the course of foundation year studies if students are to begin mainstream science study with the academic language and literacy levels that will be expected of them in first year, regardless of the content knowledge that they may have caught up on since a disadvantaged secondary schooling experience. As Devine (1988) argues, it is important to devote class time to reading because limited proficiency in a second language, though this inhibits reading, is remedied through exposure to written texts.

With the language placement test purporting to measure academic language proficiency, and this largely by way of text comprehension, it is not surprising that higher language test scores are associated with better performance on the test of general academic vocabulary and independent reading comprehension scores. Interestingly, a pattern also emerges between language proficiency test scores and reading rate. When the SFP cohort is grouped according to performance on the language test, average reading rates, vocabulary test scores and reading comprehension scores calculated for each band increased with an improvement in academic language proficiency.

Students were grouped into six bands according to performance on the initial SATAP test: those scoring below 30%, 40%, 50% and 60%; between 61% and 74%; and with a first class pass of 75% and above. As independent reading comprehension scores were represented by a zero for no comprehension and one, two and three for poor, adequate and good comprehension respectively, averages obtained for each band were multiplied

by ten rather than recorded with a decimal place. Thus each average represented a score out of a possible 30 points rather than three, and percentages were calculated accordingly.

Reading rates, from linguistically weakest to strongest groups, increased from an average of 78 Wpm to 131 Wpm. That is, students in the first group, with the weakest academic literacy skills, read at 78 Wpm on average, achieved a vocabulary test score of 44% on average and an average comprehension score of 33%, while the next two groups read at 88 and 98 Wpm respectively and scored 51% and 57% respectively on the vocabulary test and 47%, in both cases, in the measure of text comprehension. Those more adequately prepared students in terms of academic literacy (the next two groups that scored between 61% and 74% on the language test) read between 98 Wpm and 109 Wpm respectively, and passed the vocabulary test with 61% and 72% while independent reading comprehension was measured at 57% for both groups. The strongest group read, on average, at 131 Wpm and achieved an average vocabulary score of 82%, and a comprehension score of 77%.

Fig. 5.1. Relationship between various initial measures of academic reading ability

Initial academic language test (%)	Vocabulary test average (%)	Reading rate average (Wpm)	Independent comprehension average (%)
0 – 29 (n=7)	44	78	33
30 – 39 (n=30)	51	88	47
40 – 49 (n=53)	57	98	47
50 – 59 (n=44)	61	98	57
60 – 74 (n=50)	72	109	57
75 + (n=12)	82	131	77

This link between the performance of students on the different aspects of academic reading ability measured in this study and on the initial language placement test confirms

that the SATAP test does reflect aspects of academic reading ability, and therefore offers a useful means of triangulating the results of reading rate, comprehension and vocabulary tests in exploring the reading proficiency and needs of SFP students.

While causality cannot be empirically established, as it is not clear whether better academic literacy allows for quicker reading and understanding of more lexical items commonly found in written texts, or whether faster readers perform better on the language test because they have more time, and so on, it is clear that better academic language ability is associated not only with a more developed academic vocabulary and ability to read with comprehension, but also with an increased reading rate.

Eskey and Grabe argue that "good readers, by definition, read fast" (1998: 233). Just how fast undergraduate students need to read to be "good" enough readers to cope with their studies cannot be established from the average rates calculated for SFP students. What does emerge from the above comparison of data, however, is that in the case of the 2005 SFP cohort, 98 Wpm seems to be the rate below which reading is associated with weaker academic literacy, and above which reading is linked to stronger academic literacy skills. With 51% of the cohort falling into the former category of students initially reading fewer than 98 words a minute, the need for extensive development in the foundation year of not only reading efficiency, but also of academic literacy skills, as suggested by the low average for placement test scores, is confirmed.

Considering that the majority of SFP students embark on their studies with limited experience of reading extended discourse, let alone academic texts in English as an additional language, and have a limited vocabulary of general academic words to draw on to comprehend the texts that most read at a slow pace, and with limited comprehension, it is hardly surprising that so few do read the texts that their lecturers prescribe. The implications of the initial findings of what academic reading proficiency SFP students bring to their studies, to explain why they struggle with their reading, are similar to those that Mokhtari and Sheorey (1994:59) draw from their findings which "demonstrate the

need to emphasise reading skill improvement as a major component in the courses designed for ESL students as they begin their studies in an all English environment".

5.2 *Comparison of findings with final measures of reading rate and academic language skills, and with mainstream data*

The extent to which SFP students demonstrate improved academic reading ability and efficiency after their access year of study, and in comparison with a mainstream sample, will be considered for a sense of their preparedness for further study in mainstream science as well as the academic reading development needs that still need to be addressed if educationally disadvantaged students are to be ready for such study.

5.2.1 Reading rate

Initial reading rates and academic language test scores offer a useful indicator of the level at which SFP students begin their tertiary studies, providing some sense of their needs in terms of developing academic reading skills. To investigate the progress they have made, for some sense of their preparedness for mainstream study, the end-of-year measure of reading rate and academic literacy proficiency is telling, particularly when measured against a mainstream sample.

A 7% improvement in reading rate, from 100.4 to 107.8 Wpm, whether texts were read with or without comprehension, is a fairly significant average increase, but still well below the optimal rate suggested by most researchers. If only those reading both texts with comprehension are considered in comparing initial and final rates, the average increase is a mere 3%. This implies that SFP students' reading efficiency is an area of academic literacy development that requires specific targeting if adequate improvement is

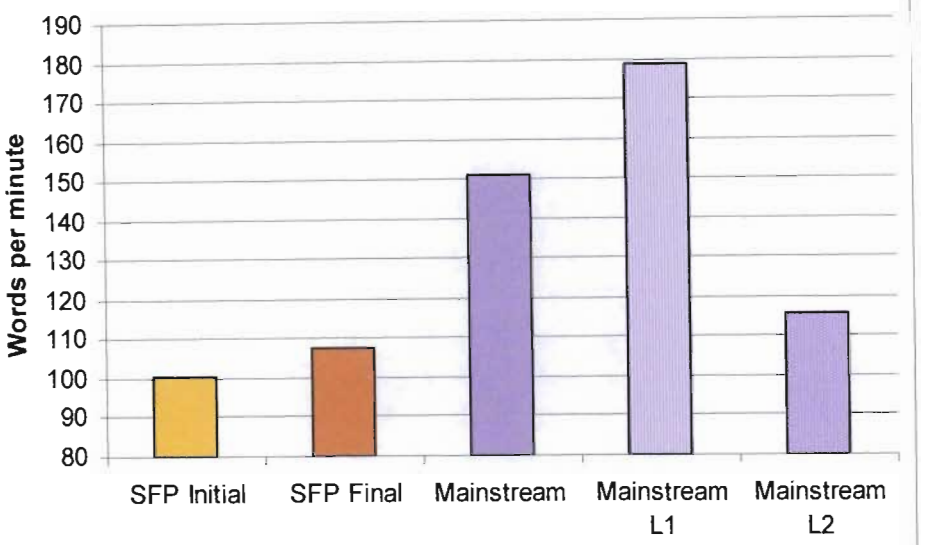
to take place. Exposure to academic texts in the course of the foundation year, of itself, does not appear to lead to sufficient improvement in reading rate in preparation for further study. It would thus be helpful if courses across the SFP curriculum could focus more explicitly on developing students' academic reading skills by devoting time to exploring effective reading strategies and promoting extensive reading. Given the emphasis in the literature on reading practice for significant improvement in reading efficiency (Rasinski 2000, Grabe 2001), it would appear that encouraging students to read – not only all their prescribed texts, but perhaps also more pleasurable ones to promote motivation for reading – would contribute to the greater improvement in reading efficiency necessary for mainstream study.

As previously argued, comparison of the same reading rate test administered to mainstream students would give the most realistic idea of where the 2005 SFP cohort are at in terms of coping with their first year reading tasks. Significant improvement in reading rate is still needed, by the end of the foundation year, if SFP students are to read at the 151 Wpm average rate at which the mainstream sample read. If reading with comprehension, an obvious requirement for successful study, is considered, then 164 Wpm, rather, is the goal.

Establishing an optimal reading rate average for SFP students to work towards is not so straightforward, however, if we distinguish between the mainstream data in terms of home language of the readers comprising the sample group. The average for first language English-speaking readers is close to 180 Wpm, whereas L2 readers' average rate of 116 Wpm is closer to that demonstrated by SFP students by the end of the year.

With the mainstream sample limited to a mere 34 students, including both first and second language English readers, it is essential that further, more extensive research be done, across disciplines, to establish a more representative standard reading rate as a realistic goal for SFP students to work towards as they read to become more practiced, and hence more efficient, readers.

Fig. 5.2.i. Comparison of reading rates



A comparison of SFP and ESL mainstream sample reading rates would imply that the SFP cohort is not as comparatively disadvantaged by limited reading speed as expected. If the ESL students in the mainstream group are truly representative of "successful mainstream students", then such low reading rates could not be considered a particular hindrance to tertiary study. However, it must be acknowledged that 27% of the L2 readers, being ex-SFP students, may not be representative of students who enter mainstream study directly. Although currently mainstream students, with two years experience in such an academic environment, they are quite likely to have begun tertiary study with similar reading experience and ability as those established for the 2005 cohort, on average. If, after two years of academic study, these students have not experienced significant improvement in their academic reading abilities, then it possible that their performance has contributed to ESL results that are more comparable with SFP averages than those of the L1 mainstream group. If this is the case and SFP students still lag behind their peers in later years of mainstream study, as far as reading proficiency is concerned, then the need to prioritise the development of academic reading efficiency, with comprehension, during the foundation year, is further highlighted.

SFP students, on average, do demonstrate an improvement in comprehension of texts read when rate measured by the end of the year is considered. While the increase from 48% to 58% to read both texts with comprehension is significant, the majority of SFP students need to develop their academic reading comprehension skills more significantly if they are to approach the 65% average displayed by the mainstream students tested. Again, the marked difference between L1 and ESL students to read both texts with comprehension – 95% and 27% respectively – does suggest that SFP students are no less prepared than mainstream ESL students, in terms of academic reading comprehension.

The low comprehension demonstrated by this segment of the mainstream group does imply that the majority may actually be struggling students, rather than typical of "successful" undergraduate students, whose reading proficiency levels do not provide a suitable standard for SFP students to aim for in this area of academic preparedness. Unfortunately, only the fact that four students in the group had come through the Science Foundation Programme could be ascertained, while the academic performance of the mainstream sample as a whole could not be tracked to establish how representative the group is of academically-able mainstream students, because their reading rate tests were completed on condition of anonymity.

Alternatively, it is possible that students are able to cope academically, despite slow reading and limited comprehension ability, because the academic reading demands placed on students, even by second year Bachelor of Science study, are not yet great enough to disadvantage weaker readers significantly. Further research could profitably investigate the quantity and range of reading required of students across disciplines to establish the role played by academic reading skills in academic performance before third year or post graduate study, when lectures and text books give way to more extensive independent reading for research.

When final SFP reading rate averages are calculated for the six bands grouped according to initial performance on the academic literacy test, a similar pattern emerges as for the initial measure, with reading rate averages increasing at each level of academic literacy

performance measured by the language placement test. Final averages are higher in all but one case, where 98 Wpm again appears as the rate at which students scoring below 50% for academic literacy or language skills read. When final language test scores are considered, an upward shift becomes evident for each band. Thus students initially scoring below 50% on the "ecotourism test" just pass the "fire test" at the end of the year, achieving an average score of 53%. Below this level, at which students read at an average rate of 98 Wpm, inadequate academic literacy scores are evident. This seems to suggest that SFP students reading below 98 Wpm by the end of the year are amongst those whose academic literacy and language skills have not been adequately developed. Though academic literacy and reading speed are not necessarily causally linked, this pattern does imply that such a reading rate is a realistic minimum for students to read at and suggests that those reading more slowly are particularly at risk and in need of extensive reading practice to further develop their academic reading skills.

Fig. 5.2.ii. Comparison of initial and final reading rate averages according to academic literacy levels

Initial academic language test (%)	Initial reading rate average (Wpm)	Final reading rate average (Wpm)	Final language test average (%)
0 – 29	78	88	43
30 – 39	88	93	49
40 – 49	98	98	53
50 – 59	98	106	65
60 – 74	109	123	71
75 +	131	141	81

It is clear is that SFP students read more slowly than their mainstream peers, and that slower reading rates are associated with poorer academic literacy skills, particularly reading comprehension. What still remains unclear is how much SFP students need to

improve their reading rates if their performance in mainstream science study is not to be too greatly hindered by limited reading efficiency for successful study. One would expect the small sample of ESL mainstream students to demonstrate greater reading efficiency than the SFP cohort as the former would have had exposure to academic reading for a further two years of academic study in the Science Faculty. When we acknowledge this opportunity for further reading development, the gap between the average reading rate of this group and that calculated for SFP students by the end of their foundation year, though significant, does not appear to be great enough to warrant particular concern. However it is unclear whether these mainstream students will successfully complete the third year of their B.Sc. degree, as is necessary if they are to be regarded as truly "successful" science students. Because their reading comprehension and reading rates were tested anonymously, the further progress of subjects in this mainstream sample could not be tracked to establish whether or not they successfully completed the rest of their undergraduate degree.

With the rate of 98 Wpm initially apparent as the dividing line between those SFP students who do and do not display adequate academic literacy skills, one might speculate that this figure represents a suitable minimum reading speed associated with adequate reading comprehension for successful mainstream study. This does not appear to be the case, however, when those students from the 2005 SFP cohort who pass all subjects in their first year of science study at UKZN, are considered. Tracking the progress of such students in 2006 revealed that over a third had not demonstrated reading rates of above 98 Wpm by the end of their SFP year. Thus we cannot conclude that scores of above 98 Wpm on the formal reading rate tests used are necessarily a requirement for success in the first year of mainstream study. Though consistent with performance in language, vocabulary and comprehension tests, reading rate scores are not in themselves an indicator of the reading efficiency necessary for successful first year study. While slower readers are sure to struggle more with course workload, the diverse reading requirements of different subjects, and of different levels of study, as well as such factors as assessment practices used in modules studied, apart from conceptual and linguistic

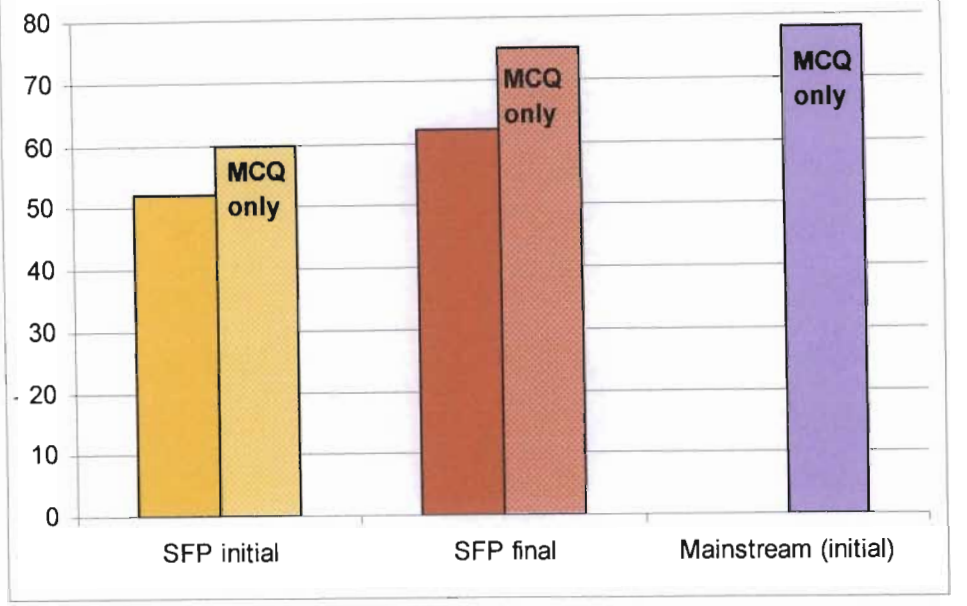
ability and the host of other factors that could affect academic performance, are likely to influence the extent to which reading rate impacts on academic progress.

5.2.2 Language test

By the end of the year, SFP students' academic language proficiency levels, as measured by the "fire" SATAP test, are much improved, if we compare the 92% pass rate with the initial "ecotourism" one of 56%. The fact that the academically weakest segment of the cohort would have been excluded from the programme by this stage is a possible reason for the improvement, but calculation of the initial SATAP average without the scores of those excluded in the second semester shows that this is not the case as this did not have a significant effect on the average. A year long academic communication course, along with exposure to academic English through the other content subjects taught in the programme, and familiarity with the test structure would, amongst a number of other possible factors, be reasons for the improved performance.

Although most SFP students pass the academic language test by the end of their foundation year, the average score of 62%, though indicative of a 10% improvement, still lags behind the 78% mainstream average at the start of first year. When we consider that the mainstream average is derived from performance on the multiple choice questions only, comparison with such results of SFP performance presents a far more positive picture. SFP students achieve almost as high an average final SATAP score on the "fire" test as students entering first year mainstream science study scored on the "ecotourism" test.

Fig. 5.2.iii. Comparison of performance on academic literacy / language test



Though statistical analysis suggests that MCQ performance is representative of overall performance for mainstream test candidates, the same cannot be said for SFP students who tend to perform much better on multiple choice items than those requiring written responses to demonstrate academic language proficiency. A breakdown of marks for initial ecotourism and final fire test versions reveals that SFP students initially score, on average, 60%, 41%, and 38% for multiple choice, cloze and written sections respectively, while these improve to 75%, 54%, and 49% in the final "fire" test.

Possible reasons must be explored for the fact that SFP students perform better on multiple choice questions than those sections requiring written responses, while this does not appear to be the case when mainstream students are considered. A particularly important consideration is the fact that just over two thirds of the mainstream group who sit the SATAP test are first language English speakers. As the SFP cohort consists of students for whom English is an additional language, test candidates would be reading and responding to texts in a language with which some may have had very little experience, particularly when it comes to extended writing. The mass media is likely to

have afforded most students a fair amount of exposure to English, but few are likely to have enjoyed many opportunities to practice writing extended academic texts in English for feedback from first language English-speaking teachers. One would thus expect that productive skills in English for academic purposes would be less developed than receptive ones. This assumption implies that most students are capable of understanding the texts presented to them in the test, while it is a limited ability to express their ideas coherently that results in poor performance in written and, to a lesser extent, cloze tasks.

Another possibility is the time constraint for the academic literacy test. Students linguistically weaker in the target language or less prepared in terms of academic reading skills are likely to take longer to read the given texts and select responses to each multiple choice question. As this section is the first to follow the reading of the texts provided, too much time spent here would leave limited time for a student to return to the texts with a particular writing purpose in mind, to extract relevant information, and prepare a well thought out and carefully edited response in the written section, resulting in a lower score here, on average. Mainstream test candidates, on the other hand, are likely to be more practiced readers who, less educationally disadvantaged, have probably enjoyed more exposure to extended texts and writing tasks in the target language which, for many students in the mainstream sample, is actually their mother tongue as well as the language of learning and teaching in their previous education. Such students are thus probably more efficient readers, more familiar with the academic language and lexicon of the given texts, who would be able to devote sufficient time to all sections of the test. As a result, average scores on the first section are likely to be more representative of those of the later written and gap-fill tasks.

Thus it is perhaps more realistic to compare SFP students' performance on the SATAP test as a whole with the MCQ section results available for mainstream science students. Despite scoring significantly lower, at the end of their SFP year, than mainstream peers about to embark on university study in the science faculty, when results are compared in this way, an overall pass rate of 92% for SFP students (after one of 56% at the beginning of the year) is very promising and not too far behind the mainstream pass rate of 96%. It

is hoped that this high pass rate for final SFP results indicates sufficient progress for students to cope with further tertiary studies and means that they are generally not at much more of a disadvantage, in terms of academic literacy and reading skills, than the majority of their mainstream counterparts.

A further caution, when comparing SFP performance on the final "fire" SATAP test with that of mainstream studies on the "ecotourism" test at the start of the academic year, relates to the nature of the two tests. As previously mentioned, statistical comparison of performance on both tests by a number of subjects suggests that the tests are comparable in terms of difficulty. Although all information required to answer comprehension questions is to be found in the texts presented in the tests, familiarity with the everyday experience of fire is hardly comparable with that of the more abstract notion of ecotourism that has recently become popular. Rural SFP students are thus unlikely to approach such a possibly alienating topic as ecotourism as they would probably approach an investigation of texts relating to fire and fire prevention.

Furthermore, the familiarity that SFP students would have in dealing with a similarly structured SATAP test at the end of a year of study as that administered at the start must be taken into account. Although generally not as well prepared, academically, as their less educationally disadvantaged mainstream peers, SFP students are likely to approach a second version of the same type of text with more confidence, being less apprehensive about the unknown. One would also expect them to waste less time getting to grips with the steps of reading and filling in answers on multiple choice response sheets, and it is in this area of MCQ responses that students have shown the greatest improvement.

Some improved performance on the final language test is thus to be expected, but the significant average improvement, and particularly the far higher pass rate, must be indicative of improved academic reading ability in English, despite the other possible factors, including a year of exposure to conversational and academic English, that are likely to contribute to improved results.

Where no final measure of general academic vocabulary, comparable with initial measures, was possible at the end of the 2005 cohorts' SFP year, the link between bands of students' SATAP performance, and performance on the initial receptive vocabulary test does suggest that improved language test performance could be indicative of some development of academic vocabulary over the course of the SFP year.

Greatly improved MCQ results by the end of the year, almost on a par with those of mainstream candidates, imply that SFP students are better able to read with comprehension, and only differ considerably from those in the mainstream when it comes to written expression. This could mean that students end their Science Foundation year with adequate academic reading skills but have not yet developed their writing skills to the same level. The linguistic difficulties still experienced by educationally disadvantaged ESL speakers could also be more obvious in tasks that require productive ability, as is the case in the written and cloze sections, with the latter particularly focussed on language issues. The multiple choice questions do, however, also test linguistic ability in academic English, as well as reading comprehension.

While the role of linguistic and extended writing abilities no doubt play a significant role in causing the difference between scores on the different sections of the SATAP test, the discrepancy between MCQ and written section marks could quite possibly be related to the issue of time constraints. Though more SFP test candidates demonstrate particularly weak English expression in their written responses than mainstream candidates, a number of the former achieve low scores in the final written section because they do not finish, whereas this is not at all common in mainstream tests.

Considering that a number of SFP test candidates did not finish the SATAP tests, whereas mainstream candidates do not struggle to complete them within the allotted two hours, overall improved language test performance by SFP students at the end of the year could also be linked to improved reading speed. However, the disparity between scores for different sections could be seen to suggest that many SFP students are still reading too

slowly to complete the written section at the end of the paper, or to devote sufficient time to prepare an adequate response.

This situation implies that SFP students are, on average, slower readers than those in the mainstream cohort. It would thus be dangerous to assume that SFP students are just as proficient readers as their mainstream counterparts because they perform similarly on a multiple choice test of reading comprehension. The reality may well be that many foundation students will begin first year study reading significantly more slowly than their peers, and will thus run the risk of lagging behind or struggling to cope with the assigned workload.

Comparative data gained from analysis of SATAP scores is thus particularly helpful in offering not only a means of confirming the academic reading abilities of students measured by vocabulary and comprehension tests, but, by virtue of the time constraints under which candidates must read and respond to extended texts in the test, it offers an additional means of probing the time students require for their reading, as a useful means of triangulating reading rate test findings. The language test's indirect timing of students' reading of more extended texts than those used in the reading rate tests to measure words read per minute makes it possible to probe the relevant issue of reading and rereading to respond to a task, as is required in tertiary study, which the explicit reading rate measures do not reflect. When reading for the very real purpose of demonstrating ability on a large and formal test, students' authentic time requirements for reading may well be more realistically, though less specifically, revealed.

5.3 Experiment

Results of an experiment to explore the effectiveness of scaffolding students' academic reading by providing an initial commonsense oral paraphrase of a prescribed text are considered to answer the question of whether use of such a method is likely to facilitate students' academic reading development in preparation for further study in mainstream science. Results of an experiment investigating the effect, on reading rate, of providing a version of a text similarly paraphrased in everyday language is also discussed.

5.3.1 Reading comprehension and feedback

Initial reading scaffolding provided the first of any discussion in class on the topic of animal research and, judging from reactions to the introduction of the argument either for or against animal experiments, was completely new to most students. A particularly memorable student contribution to an introductory question of the possible disadvantages of using animals in research was the concern that the resulting death of laboratory rats could result in extinction of the species!

As expected, students who were initially exposed to a spoken, commonsense summary of a text prescribed for homework reading demonstrated better comprehension than those who read the text without any scaffolding.

Perhaps this is because scaffolding initially provides sufficient understanding of the gist of the reading for students to draw on in unpacking unfamiliar words and difficult structures as they are encountered in context. A spoken paraphrase may also contribute to better comprehension if, in providing an initial sense of where a longer text is going, it motivates students to complete their reading.

It is possible that the nature of the comprehension measure, being a summary of the main points in the argument, primed experimental group students for the test, as such scaffolding isolated the main points in the argument. Text comprehension does imply that the main points of a text are sufficiently unpacked for the general gist to be understood, though. Performance on such a test is thus a crucial indication of understanding, though it must be acknowledged that it is only one of a number of possible aspects that were not considered in the experiment.

Another valid criticism of the test is the possibility that experimental group students, expected to have acquired some general understanding of the text before even reading it independently, might have drawn on what they remembered from the oral input in class, rather than their own reading, in writing a summary. Such a possibility is unavoidable when the effects of an initial oral summary on reading comprehension are to be investigated, but could, it must be acknowledged, prevent summaries from always demonstrating the independent reading comprehension levels they were intended to measure. To reduce the extent to which comprehension scores would exclusively reflect oral memory, rather than reading comprehension ability, only those summaries produced by students indicating that they had read the text, were analysed. Also worth considering, in this regard, is the time lapse of at least two days between initial scaffolding and summary writing, where students, without the oral paraphrase fresh in their minds, were instructed to summarise what they had *read*. It would seem that such instructions were generally followed as responses to the summary task more commonly referred to specific examples discussed in the reading than the generalised claims presented in the oral paraphrase.

As half the student cohort read one of the two texts under experimental conditions, the other text under controlled conditions, and the remaining students read the opposite texts under controlled and experimental conditions, findings should not be influenced by the individual students making up control or experimental groups. Thus differences evident, when findings for the two texts are considered separately, appear to be caused by differences between the two texts.

Interestingly, while the two texts presented to control group subjects were read with different levels of comprehension, suggesting differences in the texts in terms of the difficulties they presented to SFP students, the scaffolding provided by a commonsense paraphrase seemed to even out the accessibility of the two, with similar percentages of adequate comprehension scores demonstrated by students reading either text. Although both experimental and control group subjects described Text 2 as the more difficult to read, comprehension of this text by experimental group subjects was roughly the same as that of the first text. Comprehension demonstrated by control subjects, on the other hand, was better in response to Text 2. This would suggest that somewhat more difficult texts, in a student's opinion, can be scaffolded to provide the initial help that students need to read them with just as much comprehension as they would read a text that they would experience as easier to read. This being the case, similar scaffolding strategies could be profitably utilised across disciplines to expose students to varying levels of authentic academic readings to be required of them in their university studies, without their confidence suffering from being left to flounder through a text that is beyond their current ability to comprehend independently.

Apart from finding Text 2 more difficult, a perception contradicted by control subjects' better comprehension of this text, both control and experimental group subjects more frequently selected Text 2 as the more interesting of the two texts. Perhaps more interest is shown in a text that can be better understood, despite the perception that it is more difficult, as students would have a greater ability to "get involved", and hence to find it interesting, if they are better able to follow the argument. Why such a text would be perceived as more difficult by those students who have demonstrated better understanding could perhaps be that, with a better grasp of the text on the whole, they are less tolerant of any uncertainty or particular aspects that they do not understand.

Experimental group students, whose comprehension scores were only minimally influenced by the particular text read, still perceived Text 2 to be more difficult and more interesting, so it is quite possible that differences in the texts themselves, whether related to the language and vocabulary choices or the actual content, rather than students'

comprehension ability, are responsible for the difference in perceptions of the two. It seems more likely that text content, rather than linguistic factors, influenced the interest shown in a text as analysis of the two showed a similar lexical density, while the topic of Text 2, an argument in favour of animal experimentation in medical research, is quite possibly a more attractive one to SFP students. Many are aspiring medical students who would perhaps expect to carry out such research themselves, and thus be less accepting of arguments against animal research.

As reading provides the access to the conceptual understanding a student must demonstrate to succeed, it is particularly important that students are not only able to comprehend the texts assigned to them, but that they are convinced to even attempt the reading in the first place, and persevere when difficulties are experienced. Thus, more significant than the fact that scaffolding is associated with better comprehension, is perhaps the finding that experimental subjects are noticeably more likely to complete the homework reading assigned. If nothing else, introducing students to a text by way of an initial summary spoken in everyday terms would be beneficial for the vital purpose of encouraging more students to do their reading. Getting students reading is surely a vital goal, given that the reading and associated academic literacy skills required for tertiary study are developed through extensive reading practice (Nel et al 2004, Grabe 1991, Nation 1990). Tracking the individual students who responded that they read, in full, the texts assigned as homework reading during initial and experimental data collection yielded the dismal figure of 6% of the second semester cohort. Such a finding makes the urgency of the need to utilise an intervention method associated with increased motivation to read prescribed texts quite apparent.

There are a number of possible reasons why more than 60% of the experimental group read for homework, while less than half the control group did. Initial feedback from students on reading difficulties and reasons for not reading an assigned text emphasized such factors as unfamiliar vocabulary, limited reading rate or limited time to read because of other work, difficulties with the language of the texts, anxiety or negative emotions associated with reading, and merely forgetting to read. When initially spoken through the

main ideas of a text, in understandable language, a student is likely to be less intimidated by the difficult language and vocabulary of a text that he or she approaches with some understanding. This general understanding could also provide a student with enough of a sense of the general meaning as to work out, from contextual clues, the meaning of any unfamiliar wordings not explicitly dealt with or remembered from the paraphrase. Instead of being overwhelmed by the task of reaching for a dictionary every time an unfamiliar word is encountered, or alternatively comprehending so little of a difficult text as to be reading close to frustration level, the student has at least an understanding of the general gist of the text as a resource to draw on in making sense of the problematic wordings encountered. This is likely to be far less disruptive to the reading process which would imply that a more rapid reading rate is possible. The problem of a reading being too long for a slow reader to get through in the limited time available is also likely to be addressed by the scaffolding process which, in giving a student an understanding of the bigger picture, could provide some sense of an end in sight, so their reading can be perceived as a task that can be completed, rather than one that drags on and does not seem worth perseverance. Such possibilities seem all the more likely when we consider that a majority of over half the control group explained that they did not read because of limited time or too long a text, while closer to a third of those who gave a reason for not reading, after being exposed to an initial paraphrase, complained of this.

More motivated by a perception that the text is not too difficult to understand, having already grasped what it is essentially about, a student is likely to approach the assigned reading with more confidence and more enthusiasm. The implications of this are important not only in academic literacy courses, but also in students' science courses where subject-specific content is taught. Initial discussion of the content of a reading could increase motivation and hence the likelihood of students doing the reading by piquing interest in the subject. Similarly motivating is perhaps the impression generated by an initial class session around the text, that it is not an unimportant, supplementary text suggested for homework reading because it has no place in official lecture time, but is rather central to work on a particular topic. Dealing explicitly with the text in class, rather than merely relegating it to the frequently ignored homework context, could go

some way towards counteracting the lack of reading because a student has forgotten about it.

The fact that significantly fewer experimental group students perceived the reading to be difficult is perhaps also related to the increased confidence they would have in approaching the reading with a general understanding of the text still to be read. Although problems with vocabulary were generally the most common difficulty identified, far fewer experimental group students than control group subjects attributed difficulties experienced to problems with vocabulary. With a commonsense explanation to draw on, the former should be better able to unpack the more technical elements encountered. Without the benefit of starting the reading with the end already in sight, as students would do when exposed to an initial spoken summary, control group subjects would be more likely to get lost in the details of the different arguments presented and find the text monotonous as a result. Perhaps this is why experimental group subjects, with the text already reduced to the main ideas for them, may have felt more like they were making progress as they read and thus been less inclined to describe the text as difficult because of the length of time required to read it.

While more subjects described a reading as difficult when it was read without initial scaffolding, a significant mismatch still appears between the percentage of students who describe a reading as such, and the percentage who experience difficulty with the reading as demonstrated by performance on comprehension tests. Even the 27% of control group students who describe a text as difficult is significantly lower than the 66% of such subjects who display weak or no comprehension. Similarly, the lower 33% of experimental group students who demonstrate such limited comprehension, in contrast to the 15% who described the text as difficult, implies that students are generally more optimistic about the comprehensibility of a text than their actual comprehension test performance would suggest. If academic reading ability is not recognised by students as quite as problematic as actual performance suggests that it is, then it is unlikely that students will devote the amount of time required for reading practice to sufficiently improve their reading ability in order to better cope with their academic load.

Administering reading comprehension tests throughout the year could provide students with a useful set of results for monitoring their progress and motivating weaker students to increase the amount of reading they attempt to improve in this crucial area of academic development.

As expected, when asked to compare the texts read with and without support, the majority of students identified whichever text had initially been scaffolded as the easier of the two. This is hardly surprising as a student is more likely to be more confident about his or her ability to comprehend a text whose major arguments have already been discussed in everyday language. Some students, however, when probed for the reasons they chose as such, did not explicitly acknowledge the initial support provided, locating reasons within the text itself and pointing to a more interesting, more familiar, or more simply written text. It would probably be better if students were less likely to consider initial scaffolding as the reason a text was more accessible to them, as this would counteract the danger of students becoming too dependent on initial support from the teacher and having little confidence in their ability to deal with a text on their own once such scaffolding is no longer provided, as is necessary if students are to be prepared for mainstream study by the end of their SFP year.

The fact that a significant number of students perceived the two texts to be equally difficult, while a smaller though nevertheless significant percentage selected the non-scaffolded reading as the easier, suggests that the provision of initial scaffolding may not necessarily make a text appear easier to students.

Perhaps the initial scaffolding provided was insufficient for some students to gain a general understanding of the text before reading or, if an initial understanding was developed, a student may have become aware of complex details that may otherwise have been overlooked rather than grappled with. Such a student may also be less tolerant of limits on comprehension when particular difficulties are encountered, perceiving the text to be more difficult as a result.

Almost two-thirds (63%) of the 20% who chose the text read without support as the easier, were students who had read Text 2 without initial scaffolding. Although more students perceived this text to be difficult when questioned about text facility, regardless of whether they had read it under controlled or experimental conditions, control group students did, on average, demonstrate better comprehension of this text. It is possible that rather than differences in the conditions under which a text was read being responsible for perceptions of text facility, differences between the two texts, appearing in the same journal article, yet authored by different writers and dealing with opposite sides of an argument, caused students to experience different levels of difficulty. It could be that more chose Text 2 as the easier of the two because, as aspiring doctors and research scientists, they could better relate to the arguments presented in this text that argued in favour of animal experiments in medical research. Alternatively, given the higher comprehension scores of students who had read this text without any scaffolding, it is also possible that this was, in itself, a somewhat more accessible text than the other.

Reasons for the successful contribution that scaffolding has been shown to make to improved reading comprehension could include the fact that, by providing students with background information about the text, it helps them to overcome the problem of limited background knowledge which Carrell believes could, in some cases, actually be responsible for the appearance of "reading problems" (1988b:245). Considering how unfamiliar issues such as animal experimentation proved to be for the vast majority of SFP students, it seems very likely that launching straight into an academic reading on the arguments around this issue would certainly result in poor comprehension of the text and the appearance of limited reading ability as a result.

The content and genre of the text, being initially clarified for students, would also help to make them aware of the text's rhetorical structure to facilitate engagement with the text, as Carrell argues (1988b). A commonsense paraphrase of the text prior to independent reading would also help to fulfil Cooper's (1984) condition for successful learning through reading, that sufficient known information is available to students to draw on to understand the unknown elements encountered in the text. With "successful" readers

being identified as those that keep overall passage meaning in mind when reading (Hosenfeld 1984), the less able readers of the SFP cohort, through exposure to the "big picture" of a text in understandable language before independent reading, are given a means of doing this.

To provide students with initial scaffolding to facilitate access to meaning for text comprehension, a commonsense paraphrase appears to be useful. What is essential is that this does not replace the original text for independent reading and is thus perhaps better presented orally, with the benefits of careful reading of the entire text emphasised to discourage students from ignoring their homework reading, as some experimental group subjects did, on the basis of the excuse that it had already been dealt with in class. With such initial scaffolding, even the weakest readers should be able to approach the task with some understanding. Initial paraphrases could become increasingly less detailed, and the language of summaries increasingly closer to that of the original, as scaffolding is gradually withdrawn in response to students' increasing confidence and reading ability.

5.3.2 Reading rate for original versus paraphrased texts

Providing an experimental group of students with a simpler paraphrase of the original article given to a control group to read did not appear to affect the rate at which students read. One might expect the higher lexical density and numerous complex noun phrases as a result of nominalization in the original to slow students down in their reading. That the original text was a difficult one for students to understand is clear from their low comprehension scores in contrast to those of paraphrased version readers. Average reading rate was fairly similar across both groups, though, suggesting that that the students generally read at a fairly constant rate, regardless of text difficulty. Thus it appears that SFP students are not slow readers because their texts are too difficult for them, but rather that they are generally unpracticed readers whose reading rates will remain roughly the same without extensive reading practice. This average reading rate, as

may be expected after a semester in a foundation programme, is slightly higher than the average reading rate calculated for SFP students at the beginning of the year.

If we compare the average reading rates of control and experimental group subjects who read without comprehension, then a difference in reading rate is apparent. Surprisingly, readers of the paraphrased version read at a significantly slower rate than those who read the original text without comprehension. Perhaps the former tried harder to make sense of the text, taking longer over it, because it is a more accessible text which students may have tried to read with understanding rather than resorting to a mere bottom-up decoding as is more likely to have been the case where the less accessible original text is concerned. What must be considered is that those students who cannot adequately comprehend a text paraphrased in everyday language are likely to be amongst the weakest of the cohort in terms of academic literacy skills. As reading rate has been shown to increase with an increase in academic vocabulary and reading comprehension, it stands to reason that such weak students would be amongst the slowest readers. With overall comprehension of the original version at 42%, it is quite likely that it would have been too difficult for some of the stronger students, in terms of academic reading ability and the increased reading rate associated with this, to achieve an adequate comprehension score. The fact that a number of academically stronger students would possibly have been included in the group of those unable to comprehend the original text adequately could account for the higher average reading rate of those who had read the original without full comprehension, than those who had read the paraphrase in this way.

Reading rate researchers, testing comprehension to discount the scores of subjects who may skim through a text without actually reading sentence by sentence, have concentrated on findings for subjects who read, with comprehension, at a particular rate. Comparative findings of possible differences between the rates at which subjects read without demonstrating adequate comprehension are thus lacking. Carver's (1990) assertion that an individual reads at a relatively constant rate, as long as reading purpose remains the same, does support the above explanation for slower reading of the paraphrased text as we can assume that subjects of similar reading ability are likely to

read different texts at a similar pace, as is evident in these findings. If grouped according to the comprehension they demonstrate, more academically stronger subjects, who are likely to read more quickly, would probably misunderstand the difficult original text than the more accessible paraphrase. Similarly, those who fall into the group who cannot comprehend the paraphrased version are more likely to be amongst the academically weaker students with generally slower reading rates and would thus lower the average reading rate of the group reading this text without comprehension.

More significant than findings about reading rate is surely the finding that the commonsense version of the text was comprehensible to 77% of students while only 42% could understand the original. The fact that less than half the class would have understood an authentic text prescribed for homework reading argues the importance of providing students with some kind of reading support. Labouring through an entire text in class is hardly viable, given the limited contact time available and amount of subject content to be covered across disciplines. Independent reading skills must also be developed over the course of the foundation year if SFP students are to be adequately prepared for first year study, so a form of reading support that does not require too much class time, still promotes independent reading, and can be gradually reduced, is vital.

Chapter 6

Conclusion

Dreyer and Klopper (2004) issue a challenge for South African universities: "to recognise the diversity of reading needs and cater for this changing and heterogeneous population of students" by introducing "specialised reading enhancement programmes" (100).

To facilitate such recognition of the reading needs of Pietermaritzburg's SFP students, as a starting point for developing strategies to better equip them for the demands of tertiary study, the current project has attempted to clarify the extent to which students struggle with their academic reading, and to probe specific aspects to emerge as particularly problematic. Findings help to offer a more specific, quantifiable picture of the challenge to be met, and recognise the potential of initially scaffolding academic reading to better equip students to read independently.

6.1 Findings and implications

In summary, nearly half the 2005 cohort of SFP students, comprised almost entirely of ESL speakers, studied exclusively in English at secondary school before embarking on tertiary study at an institution where English is the sole medium of instruction. Only 20% of these students were apprenticed into the joys of reading before being taught to decode written text at school, where well under half were able to access copies of classroom texts regularly to practice independent reading. Many of these students attribute reading difficulties to unfamiliar vocabulary, while others mention difficulties with the language

and length of texts, as well as anxiety associated with reading because of negative experiences with reading at school.

Less than half the cohort read the whole of the first text assigned to them for independent homework reading. The length of the text or insufficient time to read it was the most popular reason given for not reading, though a number of students pointed to difficulties with vocabulary or the text itself. No comprehension or weak comprehension of the assigned text was demonstrated by nearly half of the group to have attempted the reading and less than 10% of the cohort responded that they found the text easy to read.

As for students' receptive general, academic vocabularies, nearly a third of the lexical items tested were misunderstood by the majority of students.

Reading rate tests revealed that students initially read, on average, between 91 and 102 standard words per minute (depending on the extent to which reading with comprehension was used as a criterion for calculating reading rate), with less than half the cohort demonstrating adequate comprehension of both texts used to time their reading. Improvement of up to 10% was evident by the end of the year, though, with the majority of students reading between 100 and 113 Wpm, just above the 98 Wpm rate that appears to be associated with adequate performance on language, vocabulary and comprehension tests. Although, by the end of their foundation year, the majority read at about 70% of the rate at which the mainstream sample tested read, SFP students actually only read at 60% of the rate at which the first language students in the mainstream sample read, while 70% of the first language reading rate is believed to be necessary for effective reading (Anderson 1999a). Comprehension of both texts read increased to nearly 60% by the end of the year, but this still leaves a large proportion of the cohort unable to demonstrate adequate comprehension of texts prescribed for independent reading.

Just over half the 2005 cohort passed an initial language placement text which 97% of the Pietermaritzburg campus intake of mainstream science students passed. A great improvement was evident by the end of the year, when 92% of the SFP cohort passed a

comparable test with an average score of 62%, representing an average increase of 10% from the initial one. High scores in the multiple choice section mask an average performance still below a 50% pass rate in the written section, however, suggesting that the ability to read and extract relevant information for an articulate response, within the allocated time, is still underdeveloped for the majority of SFP students.

Given these reading difficulties demonstrated by most SFP students, a potential strategy was explored to encourage more students to engage with prescribed readings and to better facilitate their ability to access the meaning that they contain. Scaffolding students' academic reading by introducing the text with a discussion of relevant background information and then presenting an oral summary, in everyday language, to paraphrase core ideas for students, was tested.

It appears that students are significantly more likely to read a text assigned for homework when initially spoken through the structure and main ideas to be encountered. 62% of such students responded that they did read the text, whereas well under half of the group that did not receive this initial scaffolding, responded as such. Most students experienced fewer difficulties when reading after exposure to initial scaffolding, with the majority judging the text prepared in this way as easier than one read without such intervention.

Comprehension is also positively influenced by the provision of this scaffolding. On average, students initially spoken through the text performed much better in a summary produced to demonstrate understanding of what had been read, with nearly 40% demonstrating "good' comprehension in comparison with the 10% of control group summaries to be scored as such.

These benefits of scaffolded reading support suggest that the method should be employed more frequently to help students to access the meaning buried in their prescribed readings. Helpful as this form of reading intervention has proved to be in this particular experimental context, the extent of its usefulness in helping SFP students to sufficiently develop their academic reading skills can really only be investigated if consistently

implemented over the course of the foundation year before progress is measured. As the original conception of "scaffolding" implies, to be beneficial beyond one particular reading task, the support must be gradually reduced over the course of the year until students are able to read authentic academic texts independently, as they will be expected to do in their mainstream studies.

Arguably more significant than the positive influence of an initial commonsense paraphrase on students' ability to read with comprehension, is the impact it has on the likelihood of students actually attempting the prescribed reading. Motivation and confidence to read what has been assigned cannot be absent if a student is to gain access to the information and discourse conventions of the scientific disciplines he or she must be apprenticed into for academic success.

The pedagogical implications of such findings include the need to recognise and address the academic reading difficulties particular to educationally disadvantaged ESL students preparing to study in the Faculty of Science. To this end, explicit intervention is suggested to better facilitate the development of academic reading skills, as one area necessary for academic success, if students are to succeed in obtaining a B.Sc. degree.

Student feedback about limited previous reading experience and difficulties experienced with texts assigned for independent reading suggests that lecturers across communication and content courses cannot assume that SFP students know how to go about reading an assigned text. The method of scaffolding reading can provide lecturers with a means of assisting students by modelling the process of engaging with technical written text to arrive at everyday meaning. By paraphrasing a text so that students can understand its gist before attempting to read it themselves, lecturers are able to give their students an oral resource to draw on when they engage in the reading process independently. To assist students who struggle to comprehend prescribed texts, provision of background information and some idea of what the text is about, as well as a sense of how the text is organised, as is included in the initial scaffolding process, would provide students with

the "critical mass of knowledge" that Grabe (1986, in Devine 1988:267) insists is necessary for successful ESL reading to learn.

No pedagogical method or intervention programme can compensate, in two time-tabled periods per week over the course of one academic year, for students' previous experience of poorly facilitated academic literacy development and limited reading practice. Thus suggestions for academic literacy specialists teaching such educationally disadvantaged students as those in the SFP merely focus on narrowing the gap between the reading ability of foundation students and those able to enter mainstream study without any support. The importance of extending attempts to address academic reading development beyond communication classes and across the curriculum is also emphasised to deal more adequately with student needs.

Firstly, recommendations for those teaching language or academic literacy skills include recognising that limited reading proficiency is often the reason for the poor writing problems displayed by foundation level students. Although under pressure to address the "language problems" evident in students' work across their courses, unless communication lecturers prioritise extensive reading of the text types typical to the field in which their students are studying, they will deny their students access to authentic models of the type of writing they are expected to produce themselves. Students will also have insufficient opportunity for vocabulary development, by exposure to new terms in meaningful context, to cope at tertiary level.

In light of the fact that students commonly attribute reading difficulties to unfamiliar vocabulary, it is also vital that this problem be specifically addressed by language teachers. In modelling the process of drawing meaning from a written text, as is done by paraphrasing key ideas from the original, teachers can emphasise the importance of comprehending the gist of parts of a text, rather than isolating specific unfamiliar words from the context in which they carry meaning. Though dictionary skills need to be taught, students should be encouraged to read a text holistically rather than stop at every unfamiliar word encountered. Explicitly teaching students to deal with unfamiliar

vocabulary, by working out the meaning from the context so as to minimise disturbance of the reading process, can only help a student who has an adequate overall understanding of the text, so an initial oral paraphrase that makes key meanings clear in commonsense terms is particularly helpful.

The rate at which students read can give literacy specialists valuable insight into their academic reading abilities more generally. Not only does completion of any tests or examinations become problematic if students take too long to read, but it appears that if SFP students are reading at an average of below 98 words per minute, then it is likely that their academic vocabulary and comprehension will also be particularly problematic and thus require much attention in class. Improvement to more adequate levels of reading ability (passing scores on the tests utilised in the study, in this case) requires much reading practice. If they do not get to practice reading academic texts in their communication classes, where lecturers can model the process of unpacking meaning from written texts when they provide initial scaffolding, it is unlikely that students will have much opportunity to develop their reading proficiency.

Sufficient time, taking into account the slow rate at which most students read, should be allocated for completion of a text assigned for independent reading. However, students do need to be encouraged to increase the rate at which they are able to read with understanding as fluent readers decode texts automatically, freeing attention for comprehension (Anderson 1999a:63). Rate-building activities such as rereading a text and keeping a record of the increased speed each time as a means of motivating students, as well as reading short passages within a given time constraint, are potentially helpful exercises that Anderson suggests, but encouragement of more extensive reading, in term and vacation time, will probably have the greatest impact on increased reading rate.

Given the limited reading rate demonstrated by most SFP students, attempts to encourage them to become more practiced readers, by reading more extensively, should not ignore the promotion of reading for pleasure. This could be facilitated in the language and literacy classroom by making resources such as popular magazines and novels available.

Opportunities to share about their reading could also help to promote reading. By giving up a small amount of class time for such activities, communication lecturers would reinforce the value of reading, particularly in connection with academic success.

Important as it is for students to be exposed to appropriate written texts, prescribed reading will only be beneficial if students are able to read academic texts with adequate comprehension. For this reason, an initial commonsense paraphrase is recommended as a means of supporting students' reading so that even weaker readers are not alienated by a text that they are unable to make sense of. Although students do ultimately need to develop the ability to read independently, affording them opportunities to grapple with difficult wordings together with a tutor or even their peers will enable them to practice the process of engaging with texts to make meaning. With some general understanding of the text before they begin reading independently, students will be in a better position to negotiate meaning as they read and, more confident and motivated to read, they will gain practice reading academic text.

The issue of motivation to read is an important one for academic literacy tutors to address as a student cannot begin to develop his or her reading ability without sufficient reading practice. Scaffolding student reading provides some way of addressing this issue by prompting, in the initial discussion and overview, interest in the subject to be explored in more detail in the text itself. This is particularly evident when students become more confident about raising questions and sharing their views in such discussion around a text to be read. Students who already have a sense of what a text is all about would also be less intimidated by difficult terminology and language constructions encountered in a text because their confidence in their ability to understand the big picture has already been established. The problem of prescribed reading being ignored or only partially completed because it is perceived as an activity of limited importance, containing information peripheral to what is explicitly taught in class, is also addressed when a reading is introduced in class and its centrality to class work is thus perceived.

Recommended strategies to deal with low motivation to read also include means of enforcing reading of prescribed texts by ensuring that it is tested, by way of quizzes, summaries or prepared responses to a topic, so it cannot be ignored by "marks conscious" students who may be tempted to leave their reading to focus on written work for submission or on test preparation. Such testing will allow language teachers to monitor students' reading and understanding, enabling them to gain insight into their students' understanding of concepts, as well as their ability to cope with the language of specific texts, before this is formally tested at the end of a section when it is often too late for such information to inform the teaching process. Similarly, such reading testing will afford students a means of checking their progress and help them to identify areas of difficulty so that relevant assistance can be sought specifically and timeously.

To increase motivation by ensuring that relevant texts are selected for work in the language classroom, collaboration with subject-area specialists is crucial. If students are able to appreciate the connection between such work and the attainment of their goal of becoming science graduates, then they will place far more value on the reading tasks assigned. If texts are to be relevant and authentic models of science discourse, then collaboration with content lecturers is not only necessary for language specialists to point out to students anything that has been covered in another course, but for those without a background in science to check their understanding of any unfamiliar concepts before a text is discussed in class. Closer collaboration between language and science lecturers will also facilitate the sharing of insights gained into students' reading difficulties, useful strategies for addressing these, and improvements noticed at individual or group level.

Reading being so central to successful apprenticeship into any field of study, its development cannot be limited, as a discrete skill, to the literacy or communication component of a foundation programme. It is in their science classes across the curriculum that students have the opportunity to develop reading proficiency because it is such courses which, together, can expose students to a number of authentic science texts of direct relevance to their studies. Science lecturers, faced with the problem of limited reading proficiency amongst their students, have limited opportunities to address this for

the material that needs to be covered in a semester makes detailed reading and explanation of an entire text, during contact time, impossible. The form of reading scaffolding that has been discussed is thus recommended as a practical strategy for use in content courses as well as those focussed on developing academic literacy proficiency.

The importance of reading, as a means of accessing knowledge and becoming familiar with accepted ways of communicating this in a particular field, needs to be emphasised in content courses if students are to appreciate the importance of developing, through extensive practice, the reading ability necessary for successful study. Motivation to read particular texts assigned should also be addressed by ensuring that they are not too difficult for students to comprehend with assistance, yet can be recognised as authentic and relevant to their studies. Initial scaffolding, in providing discussion of the background of the text and ideas to be encountered, allows content lecturers to make this explicit for students by pointing out links to concepts discussed in class and conventions to be followed in their own writing.

It is important that attempts to help students get to grips with key content, while recognising the problem of slow reading, do not result in a reduction in the amount of authentic texts to which students are exposed. If only summaries and course manuals are prescribed for independent reading, students will be denied the opportunity to practice reading extended academic texts and will thus have limited opportunities to improve their reading efficiency as well as encounter, in meaningful context, the academic vocabulary with which they will need to be familiar to cope with course content. On the other hand, it is important that students are not overwhelmed with the reading load, but are instead given sufficient time to work through prescribed texts, as well as sufficient support or scaffolding to ensure that even the weakest readers are able to approach texts with confidence in their understanding of the main ideas to be encountered.

Academic reading difficulties are not limited to foundation level. With almost as many ESL students as first language speakers in most undergraduate courses, many of whom would have experienced similar educational disadvantage and limited exposure to reading

as SFP students, mainstream lecturers are also faced with the need to facilitate students' academic reading development. Though difficulties often surface in student writing, this is likely to be a symptom of limited reading or inadequate comprehension of the ideas presented in assigned texts. As scaffolding students' reading with an initial commonsense paraphrase can be adapted to the needs of a particular group and the time available, recommendations concerning the provision of such scaffolding are also addressed to mainstream lecturers.

Scaffolding, by definition, is aimed at learners' current ability level, and is gradually reduced to enable them to carry out such tasks as academic reading independently. A mainstream lecturer can thus initially present background information and an overview that is less detailed than what would be presented at foundation level, and may be expressed in language that is closer to that of the original text. Thus reading support can be given that will not bore or patronise more adequately prepared readers, but will provide the point of entry and motivation that others may need if they are not to be alienated by the reading material assigned.

General recommendations, to both language and science content lecturers at foundation level, as well as mainstream lecturers, address the limited reading proficiency evident in the findings. The encouragement of extensive reading should, ideally, go beyond prescribed course reading, but is essential within both academic communication courses and science content subjects. Only if sufficient reading is done for students to become more practiced readers, can hindrances to motivation and comprehension, such as slow reading speed and limited academic vocabulary, be overcome. Repeated exposure to general academic vocabulary in context, for the lexical development necessary for adequate comprehension, can be facilitated by extensive reading, but unless students are provided not only with suitable texts, but sufficient time and encouragement to ensure that they do engage with academic texts, it is unlikely that this will take place.

To emphasise to students the importance of reading to gain an understanding of relevant information and familiarity with the discourse conventions in the field of study, as well as

the need for them to become more proficient readers who able to keep up with the demands of tertiary science study, lecturers teaching science content as well as literacy specialists need to ensure that reading tasks are assigned as core activities in themselves rather than supplementary ones to be overlooked by students in favour of apparently more pressing assignments that are taken more seriously as they involve submission of some product as evidence that work has been done.

Although there will always be a range of reading abilities within any one class, it is important that lecturers monitor students' comprehension to ensure that adequate scaffolding is provided so that students are generally able to cope with a given text. Important as it is to expose students to authentic written genres which they will not only be expected to read in their studies, but which they will be required to produce in their own writing, it is necessary to ensure that texts prescribed are not of a level too far beyond the linguistic and conceptual level of students so as to alienate them as readers, preventing them from benefiting from the reading practice as they are unable to work towards any accurate understanding of the text, even with a commonsense paraphrase to draw on.

While the difficulty of texts assigned should increase over the foundation year, the degree of scaffolded support provided in the beginning should be gradually decreased as students become more practised readers, with more extensive receptive vocabularies, who have learned, from the paraphrasing modelled by their lecturers across subjects, to work out what an author means by interacting with extended written texts, and have gained confidence in their ability to do so.

While sufficient scaffolding should be provided to enable the weakest students to begin reading with an overall understanding of the text, if they are to develop the proficiency necessary for successful independent reading, it is important that these, as well as the strongest students in the group, have opportunities to practice grappling with the wording of the written text on their own. The oral paraphrase initially presented to students therefore does not replace independent reading. The benefits of close independent reading

of an entire text should be made explicit to students so that they can appreciate the linguistic and discourse development that takes place as a result of their reading practice, as well as the obvious opportunity it offers them to improve their reading proficiency and extend their knowledge of a particular subject relevant to their studies.

Vital as it is to take practical steps, informed by contextualised research, to address the academic reading needs of educationally disadvantaged students entering foundation study at university, it is ideally at school level that changes need to be implemented to better facilitate the development of reading skills that will provide the foundation for students' further academic development. Furthermore, evidence of similar reading difficulties demonstrated by the mainstream ESL students to whom the reading rate and comprehension tests were administered, suggests that even in mainstream science modules many students would be likely to benefit from additional reading support such as the initial scaffolding that has been discussed. Even some of those students who have obtained sufficient matric points to enter straight into mainstream study are likely to have experienced similar backgrounds, in terms of literacy and educational experiences, to SFP students. Until both pleasurable and academic reading is extensively practiced at school level so that university entrants are adequately prepared for the reading demands of tertiary study, both foundation-level and mainstream lecturers need workable strategies to implement in their teaching to provide their students with the varying degrees of support they need to access the knowledge that is made available to them in their courses.

6.2 Limitations of the study and questions for further research

This study of SFP students' academic reading has, necessarily, focused on very few aspects of their reading, and this in limited detail. To gain a quantifiable sense of the reading proficiencies and experiences that the majority of students bring to their studies, and to determine the effectiveness of a strategy aimed at addressing these, questionnaires and tests were administered to the entire 2005 cohort. While such methods have offered a clear picture of the range of reading speed, comprehension and vocabulary of a large

sample group, enriched with student perspectives on their reading, they have limited the research in a number of ways.

Initial questionnaires aimed at eliciting a broad sense of students' linguistic backgrounds and reading experience were limited in the sense that responses could not be probed further and clarification could not be sought on issues such as media of instruction at different levels of schooling and reading for pleasure.

Questionnaires administered to elicit feedback from students about independent reading tasks assigned were, to a lesser extent, limited by closed questions. Although respondents were free to express their reasons for not reading, finding a text difficult to read or choosing one as easier to read than another text, findings were limited to what a student wrote down and particularly insightful or ambiguous comments could not be probed further as an interview or focus group discussion would have allowed.

The effects of initially scaffolding students' reading have been investigated experimentally in this study, but this was limited to a once-off implementation of the method in the Scientific Communication course, and relies on the validity of performance on a summary as an indicator of overall text comprehension.

Positive results in this case could be used to motivate for the consistent use of such scaffolding (with gradually reduced levels of tutor support) over the course of the academic literacy module to facilitate academic reading development. This would provide an opportunity to explore the effectiveness of such intervention on reading ability and academic literacy proficiency more generally, beyond the single case that has been investigated. Results from this study of the effectiveness of initial reading scaffolding in encouraging students to read as well as improving their comprehension could also provide justification for further researching the method in the context of content courses. Subject specialists could be encouraged to observe the effects of such reading preparation of a text they prescribe in Chemistry, Physics, Mathematics or Biology modules. Student feedback could be explored in more detail through the use of focus groups, and the input

of science subject lecturers on the effectiveness and logistical viability of using the method in their content teaching could be elicited through interviews, supported, perhaps, by tests of student performance.

Findings from the background linguistic and literacy experience questionnaire could be a starting point for more detailed qualitative research. Students identified from questionnaire data as particularly representative of the SFP cohort could be interviewed for a deeper understanding of their school experiences and attitudes towards reading of particular texts. Students' performance on measures of academic reading ability could also be used to identify those who represent weaker and stronger readers. More detailed research into the reading practices of such readers could then be carried out to obtain insight into successful reading practices to be encouraged while recognising those that hinder readers.

Having established a profile of average and individual reading proficiency in terms of performance on comprehension, vocabulary, rate and language tests, this study could provide a point of departure for longitudinal studies tracking the progress of particular students throughout their studies in the Science Faculty to investigate such questions as the longer term effectiveness of scaffolded reading intervention offered in the foundation year. Detailed interviews with students selected as case studies in such research could yield valuable data about the extent to which students are able to transfer improved reading motivation and comprehension ability to their independent reading in subsequent years of study when reading scaffolding is not provided by lecturers or tutors. The nature and amount of reading prescribed at such levels would also usefully feed back into course design, including the selection and adaptation of texts, for foundation level academic literacy courses to help students to develop appropriate academic reading and writing skills.

As much has been made of the importance of promoting more reading to develop greater reading proficiency, investigation of the effectiveness of extensive reading programmes is another area of academic reading research that needs to be carried out. Design of such

programmes to be piloted could usefully be informed by the general level and range of student academic reading abilities that have emerged from this study.

Poor results in a test of general academic vocabulary, though lacking a mainstream sample for comparison, are confirmed by students' own frequent reference to vocabulary difficulties as a hindrance to their reading. The test is useful in giving an idea of some of the lexical items the majority of students struggle with, but action planned to address this particular reading difficulty that students face could be further informed by research that gives students an opportunity to identify words in prescribed texts that they find particularly problematic. This would help tutors in preparing to scaffold a text for students by alerting them to the items that need to be replaced or explained in the everyday paraphrase initially presented. An interesting study on this issue could contrast the words identified by students with those that their tutors may select as potentially problematic, to prove that teachers may not easily anticipate the words that students will struggle to comprehend.

Slow reading has emerged as one of the particular difficulties hindering SFP students in their academic reading. The provision of an initial commonsense paraphrase appears to motivate students to read and to aid comprehension which, if it promotes more reading, should ultimately lead to increased reading efficiency. However no specific rate-building activities to facilitate improvements in this area were explored in this study. Further research could be helpful in this respect, particularly if attempts to increase students' reading speeds are investigated in terms of their effect on comprehension ability. Standardised measures of reading rate still need to be established. Although better reading rates were associated with better performance on language, vocabulary and comprehension tests, it is not clear whether a timed reading of a short portion of a text gives an adequate picture of student reading ability in terms of reading speed. A means of exploring students' ability to read and comprehend an extended text within a limited period of time may offer a more realistic indication of adequate reading speed, as this represents what is actually required of students in their academic study. Standard reading rate tests also need to be administered to a larger sample of successful mainstream

students if a suitable goal is to be determined for SFP students to work towards in developing their proficiency as academic readers, prepared for the demands of mainstream study. The sample used in this study to establish a mainstream reading rate average was greatly limited by size and by the fact that the student subjects, tested anonymously, could not be confirmed as representative of truly successful students as the academic performance of individuals could not be tracked.

Another aspect of reading proficiency which was not explored in this study but could usefully inform the design of intervention strategies to assist students with academic reading development is an investigation of the interaction between students and scientific text, as a student works towards comprehension of the text. This would give us a greater understanding of the specific difficulties students may face in reading a course text, as well as insight into the strategies used by the more proficient, as opposed to weaker readers, identified by performance on the various tests administered as part of the current study.

In conclusion, this study has, as a starting point in addressing the needs of Science Foundation students developing as readers so as to access the knowledge and skills on which their academic progress relies, attempted to establish what they initially bring and what they need to achieve as academic readers. Scaffolding reading has been explored as a potential means of facilitating SFP students' progress across this gap, and appears to be a viable method of encouraging students to engage with their prescribed texts and to do this with greater understanding.

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Table of Appendices

Appendix 1

Texts

Appendix 1.1.1

Schistosomiasis: The Zimbabwe Experience

In Zimbabwe, a combination of research and knowledge of local conditions may alleviate the suffering of the thousands of people infected by schistosomiasis.

Researchers in rich northern countries may find solutions to health problems that plague the developing world. But tailoring the treatment to fit local conditions is often unsuccessful. Some drugs, for example, require multiple doses to kill the parasite. If roads and transport are poor, the chances arte that people won't get the doses they need. In Zimbabwe, scientists working to control schistosomiasis, a parasitic infection, believe that they will succeed in curbing the spread of the parasite only if they work within the constraints of local conditions.

Schistosomiasis, or bilharzia, affects 200 million people throughout the tropics and subtropics, which is why it is a target for research in Zimbabwe. The World Health Organisation rates schistosomiasis as one of the most serious health problems in developing countries. At least three species of schistosome infect people. Two exist in Africa, *Schistosoma haematobium*, which causes urinary schistosomiasis, and *S. mansoni*, which causes the intestinal form of the disease. Both species are common in Zimbabwe where the health service ranks schistosomiasis alongside malaria and infant diarrhoea as the biggest threats to health. Few African countries can afford to invest heavily in programmes to combat schistosomiasis. Zimbabwe is unusual in that the country is prepared, despite limited resources, to do research and to set up control projects with local facilities and personnel.

A recent survey of Zimbabwean children revealed that in many rural areas as many as 80 per cent of the children harboured *Schistosoma haematobium*. In some areas, *S. mansoni* infected more than 20 per cent. The parasite is commonest in children – rising to the highest rate of infection in teenage children, then declining in older people. Most of Zimbabwe's 8 million people live in rural areas, half of whom are less than 15 years old. The disease obviously poses formidable health problems.

Researchers find it extremely difficult to assess the impact of schistosomiasis on Zimbabwe. But, if a large part of the agricultural workforce is suffering prolonged ill health, the effects must be substancial. Many teachers believe that children with schistosomiasis do less well at school. Yet, because no one has estimated the the economic cost of schistosomiasis or or the number of people who die as a direct result of infections, most African countries put research into schistosomiasis low on their list of priorities. Few can afford the additional strain on already overstretched economies. Nevertheless, the government of Zimbabwe invests in control programmes, and the Ministry of Health supports applied research, most of which is based at the Blair Research Laboratory in Harare. These efforts now enjoy international recognition and support.

Efforts to control schistosomiasis aim at breaking the transmission cycle at one of four points: by preventing infective larvae reaching people; stopping eggs from reaching the water; eliminating the flukes in the human host; and controlling the carrier snails.

The only way to reduce human contact with infected water is to provide alternative safe water supplies. Most communities go to ponds, rivers and canals to wash, bathe, swim and to do their laundry and other domestic chores. More specialist occupations, such as fishing,

watering gardens, cutting reeds for thatch and panning for gold, also bring people into contact with water which may contain schistosome larvae.

The Zimbabwean government has provided many communities with simple boreholes, pumps, and wells that tap springs or groundwater. The government aims to install 7000 new boreholes or wells every year. However, although people usually accept these sources for their drinking water, they often prefer to go to their traditional watering places for other purposes. Bathing is more convenient and more private by a river or stream. You can do your laundry more easily on rocks by flowing water than at a muddy borehole, and pumps and wells are often slow, causing queues and delays. Not surprisingly, people continue to make heavy use of ponds, rivers and canals. The government is unlikely to be able to afford to pipe water to individual households in the foreseeable future, so people will still come into contact with open water.

Water is a problem, however, only if urine or faeces from infected people contaminate it – and if the right kind of snails are present. In principle, you can prevent contamination by providing enough latrines. The Blair toilet, which was developed locally, is an outstanding example of successful "appropriate technology". It is cheap, at Z$100-150 (US$80-120) a unit. You can make the toilets from local materials with local labour, and it is pleasant to use and easy to keep clean. The government is funding the construction of Blair toilets in communities throughout Zimbabwe. Neighbouring countries have also shown interest in the design.

Provision of a toilet for every household is a relatively costly and long-term goal: current targets are to provide 70 000 new toilets each year for the next 20 years. The benefits of this plan will extend beyond the control of schistosomiasis to the prevention of other waterborne diseases, such as cholera, which the housefly spreads by treading in faeces that contain the spirochaetes causing the disease, and then contaminating food or water. Flies also spread typhoid and yaws in the same way. Overall, health conditions in rural areas should improve enormously as a result of this simple move to introduce toilets.

A vigorous programme of health education would also help to reduce infection by pointing out the dangers of contact with contaminated water, particularly for children. Recently, in schools around Harare, children answering a questionnaire showed how little they know about the disease. More than half believed that you caught schistosomiasis by contact with human urine. Five per cent of the children still believed a local tale that you could catch the disease from jumping over a fire. Even so, health workers can hope to have only limited success through education if they cannot provide alternative water supplies and adequate sanitation. In the absence of latrines, a riverbed offers privacy that is hard to find in an otherwise flat and treeless landscape. Even though the local Shona people do not defecate directly into water, they risk contaminating the water, especially during the rainy season, when faeces may wash into rivers. Children enjoy swimming and playing in water, and may urinate in the river.

Another difficulty is that schistosomiasis is sufficiently widespread for people to accept infection as a fact of life. Health workers often find it hard to arouse concern in the community because the symptoms are neither as obvious nor as dramatic as those of other parasitic infections, such as malaria. A more direct approach to control of the disease is to provide drugs that kill adult schistosmes or to vaccinate people against the disease. Although researchers in many countries are working on vaccines, none has proved successful yet. A number of drugs, however, are highly effective. Metriphonate kills S. haematobium flukes,

but, for the best results, patients need three doses taken over several weeks. Many never complete the course, especially if they have to travel long distances to a clinic. Health workers prefer to prescribe Praziquante,l which kills all species of human schistosomes and can be given in only one dose. Unfortunately, Praziquantel is expensive at about Z$5 (US$4) for each treatment.the cost is eight times higher for private prescriptions. In Zimbabwe, the national health budget is only Z$30 (US$24) per person each year. Treatment on a large scale is out of the question: in any case, the patients must receive a dose of Praziquantel every few years to prevent reinfection. Any attempt to eradicate the disease from whole communities, using drugs, is almost certainly doomed to failure because people in rural areas travel extensively from place to place. Their mobility almost guarantees the eventual reintroduction of the disease from untreated areas.

Freshwater snails, the secondary hosts for schistosomes, are a more attractive target for control. Steven Chandiwana and Jerry Ndamba, of the Blair Research Laboratory, concentrate their research on this stage of the schistosome's development. In Zimbabwe, the vectors of schistosomiasis are planorbid snails, *Bulinus globosus* for *S. haemotobium* and *Biomphalaria pfeifferi* for *S. mansoni*. Both snails commonly live in permanent and semi-permanent bodies of water, which range from irrigation ditches to the massive Lake Kariba. The two species have similar ways of life. Rarely longer than 15 mm, the snails browse on algae and detritus and live for several months. The snails are hermaphrodite and extremely fecund. A single snail can produce up to 100 eggs a week. No one has found a predator or competitor that might reduce the populations of snails to a suitable low level. The mainstays of control are molluscicides – pesticideas aimed at snails and their kin. Niclosamides, such as Bayluscide, kill both adult snails and their eggs but the pesticide works only for a short time. As snail populations can increase very quickly, you have to repeat the treatment. Even if molluscicides were completely effective, snails from untreated streams might recolonise the area. Snails are surprisingly good travellers; heavy rain can wash them hundreds of metres downstream. Comprehensive treatment of large rivers and reservoirs is prohibitively expensive. Enough molluscicides to treat 100m of shoreline costs Z$5 (US$4) excluding the cost of labour. Eradication of snails from all but small, isolated water bodies is just not feasible.

Scientists at Blair research and in the field are investigating the effectiveness of a longer acting molluscicide in the form of slow-release copper pellets. The pellets dissolve in water, releasing wnough copper to kill snails for up to six months.

An alternative to conventional chemical pesticides is a natural molluscicide, extracted from the plant endod or African soapberry, *Phytolacca dodecandra*. Researchers first noticed the moluuscicidal properties of endod in Ethiopia. Now scientists at Blair Research are looking into the best way to grow and use the plant in Zimbabwe. If people can grow endod locally, it will reduce their dependence on costly, imported molluscicides. Unfortunately, endod's active ingredient is a broad-spectrum toxin, which kills fish and other aquatic animals.

In artificial bodies of water there are more elegant ways to control snails other than killing them with molluscicides. You can build irrigation channels so that the water flows so quickly, the snails cannot keep a grip on the bottom. If you drain reservoirs and storage tanks regularly, most snails will die, although they can lie dormant in the mud. Clearing plants from the water can also make the habitat less attractive for snails. A resettlement scheme at Mushandike, in the southeast of the country, is trying all these options as part of a broader programme to control schistosomiasis. The Technical and Extension Services of the

Department of Agriculture funds this project with technical expertise from Blair Research and the Hydraulics Research Institute at Wallingford in Britain.

Many epidemiologists now accept that it is impossible to eradicate schistosomiasis over large areas. They believe that the aim of a control programme should be to reduce infection to a low level and especially to reduce the number of people with serious symptoms who are heavily infected. The best way to achieve these aims is an integrated approach that combines improved sanitation, better water supplies, health education, selective drug therapy and molluscicides. A trial of such a programme is underway at Mushandike. Paul Taylor, the director of Blair Research, is directing a similar project in the Madziwa district, north of Harare.

One important feature of schistosomiasis is that transmission takes place only at a few contact sites – and only at a certain time of year. In Zimbabwe, most infection occurs towards the end of October and November. Only a few people in one community suffer the worst symptoms of the disease. Any attempts at control and treatment will be most cost effective if you select carefully the people, places and the time to treat. Steven Chandiwana and I supervise a study in the Burma Valley on Zimbabwe's border with Mozanbique. The study will help to pinpoint the best times and places to attack the schistosomes.

Schistosomiasis is a community problem and solutions must work on a community level. The control of schistosomiasis is closely linked to economic development and education in rural areas. In Zimbabwe, however, as in most African countries, there are still severe economic and social constraints. The sheer scale of the problem remains daunting. Zimabwe's research – staffed mostly by Zimbabwean nationals – is making an important contribution.

Appendix 1.1.2a

Animal Research is Wasteful and Misleading

The use of animals for research is only one of many investigative techniques available. We believe that animal experiments are poorly suited to addressing the urgent health problems of our era, such as heart disease, cancer, stroke, AIDS and birth defects. Even worse, animal research can mislead researchers or even contribute to illnesses or deaths by failing to predict the toxic effects of drugs. Many of the apparent anomalies seen in animal experiments reflect the unique biology of the species being studied, the unnatural means by which the disease was introduced, or the stressful environment of the laboratory. Fortunately, other, more reliable methods that represent a far better investment of research funds can be employed.

The majority of animals in laboratories are used as so-called animal models: through genetic manipulation, surgical intervention or injection of foreign substances, researchers produce ailments in these animals that "model" human conditions. This research paradigm is fraught with difficulties, however. Evolutionary pressures have resulted in innumerable subtle, but significant, differences between species. This severely undermines the extrapolation of animal data to other species, including humans.

Important medical advances have been delayed because of misleading results derived from animal experiments. David Wiebers and his colleagues at the Mayo Clinic, writing in the journal *Stroke* in 1990, described a study showing that of the 25 compounds found to reduce the damage from isochemic stroke (caused by lack of blood flow to the brain) in rodents, cats and other animals, none proved to be effective when tried with humans. The researchers attributed the disappointing results to differences between how strokes naturally occur in humans and how they are artificially triggered in the animals. For instance, a healthy animal that experiences a sudden stroke does not undergo the slow arterial damage that eventually plays a crucial role in human strokes.

During the 1920s and 1930s, studies on monkeys lead to gross misconceptions that delayed the fight against poliomyelitis. These experiments indicated that the polio virus infects mainly the nervous system but this was only because the virus had been administered to monkeys through the nose and had therefore attacked brain tissue. The incorrect conclusion, which contradicted previous human studies demonstrating that the gastrointestinal system was the primary route of infection, resulted in incorrect measures being taken to prevent the disease, delaying the development of a polio vaccine. Research with human cell cultures in 1949 first showed that the virus could be cultivated on human tissues taken from the intestine and grown in the laboratory. Despite this, cell cultures from monkeys rather than humans were used to produce vaccines in the early 1950s. This meant that millions of people were exposed to potentially harmful monkey viruses.

It seems that human cancer research is particularly sensitive to the differences in physiology between humans and other animals. In a striking illustration of the inadequacy of animal research, scientists in the 1960s deduced, from numerous animal experiments, that inhaled tobacco smoke did not cause lung cancer. For many years afterward, the tobacco industry used these studies to delay government warnings and to discourage doctors from intervening in their patients' smoking habits. Of course, human population studies provided strong evidence of the tobacco-cancer connection, and recent human DNA studies have shown how tobacco targets human genes, causing cancer. Many animals, particularly rats and mice,

synthesize approximately 100 times more vitamin C in their bodies than the recommended daily allowance of vitamin C for humans. This is significant as vitamin C is believed to help the body ward off cancer.

The stress of handling, confinement and isolation alters an animal's physiology and introduces yet another experimental variable that makes extrapolating results to humans even more difficult. Stress on animals in laboratories can increase susceptibility to infectious diseases and certain tumours, as well as influence levels of hormones and antibodies, which in turn can alter the functioning of various organs.

Tests on different species often provide conflicting results. For instance, in 1988 Lester Lave of Carnegie Mellon University reported in the journal *Nature* that dual experiments to test the carcinogenicity of 214 compounds on both rats and mice agreed with each other only 70 percent of the time. The correlation between rodents and humans would probably be lower. David Salsburg of Pfizer Central research has noted that of the 19 chemicals known to cause cancer in humans when ingested, only seven caused cancer in mice and rats.

Many substances that appeared safe in animal studies and received approval from the U.S. Food and Drug Administration for use in humans later proved to be dangerous to people. The drug milrinone, which raises cardiac output, increased the survival of rats with artificially induced heart failure but when humans took this drug there was a 30 percent increase in mortality rate. The antiviral drug fialuradine seemed safe in animal trials yet caused liver failure in seven of the 15 humans taking the drug. Five of these patients died as a result of the medication, and the other two had to receive liver transplants. The antidepressant nomifensine, which was shown to have minimal toxicity when tested on rats, rabbits, dogs and monkeys, caused liver toxicity and anaemia in humans. These effects were rare but severe and sometimes fatal, so the product had to be taken off the market. The U.S. General Accounting Office found that 52 percent of the drugs tested between 1976 and 1985 had serious risks for humans that were not predicted by animal tests. These risks were defined as negative reactions that could lead to hospitalisation, disability or death. Of course it is also impossible to estimate how many drugs have been needlessly abandoned because animal tests falsely suggested they were ineffective or toxic.

Today researchers have better methods at their disposal. These techniques include epidemiological studies, clinical observation and laboratory testing as well as clinical intervention trials, the use of human tissue and cell cultures, autopsy studies and new imaging methods.

Epidemiological studies in humans, such as the Framingham Heart Study that began in 1948, have been effective in revealing the risk factors for heart disease, such as smoking, high cholesterol levels and high blood pressure. Autopsy results and chemical studies have provided additional information on the effect of diet on heart disease and studies of patients have revealed the effectiveness of a low-fat vegetarian diet, regular exercise, quitting smoking and managing stress in reversing atherosclerotic blockages.

Observations of humans have proved to be invaluable in cancer research as well. Several studies have shown that cancer patients who follow diets low in fat and rich in vegetables and fruit live longer and have a lower risk of recurrence.

Similarly, human population studies of HIV infection have shown how the virus is transmitted and have guided intervention programs. In vitro studies using human cells

allowed researchers to identify the AIDS virus and determine how it causes disease. Investigators also used in vitro studies to assess the effectiveness and safety of important new AIDS drugs such as AZT. Human studies are also giving rise to new information about possible genetic and environmental factors that contribute to this disease or provide resistance to it.

Research into the causes of birth defects has relied heavily on animal experiments, but these have typically proved to be poor predictors of what can happen in humans. Animal experimenters have asserted that animal tests could have predicted the birth defects caused by the drug thalidomide, yet most animal species used in laboratories do not develop the kind of limb defects seen in humans after thalidomide exposure.

The issue of what role, if any, animal experimentation played in past discoveries is not relevant to what is necessary now for research and safety testing. Before scientists developed the cell and tissue cultures common today, animals were used for vaccines, but modern methods can now be used to produce vaccines for most diseases. These are safer and more efficient that producing the vaccines in animals. Animal toxicity tests to determine the potency of drugs such as digitalis and insulin have largely been replaced with sophisticated laboratory teats that do not involve animals.

Animal experiments may have played a part in medical advances in the past, but these need to be carefully considered. For example, proponents of animal use often point to the significance of animals in diabetes research. However human studies by Thomas Cawley, Richard Bright and Appollinaire Bouchardat in the 18th and 19th centuries first revealed the importance of pancreatic damage in diabetes. In addition, human studies by Paul Langerhans in 1869 led to the discovery of insulin-producing islet cells. Although cows and pigs were once the primary sources of insulin to treat diabetes, human insulin is now the standard therapy, revolutionizing how patients manage the disease.

In this discussion, we have not broached the ethical objections to animal experimentation. These are critically important issues. In the past few decades, scientists have come to a new appreciation of the tremendous complexity of animals' lives, including their ability to communicate, their social structures and ability to show complex emotions.

Appendix 1.1.2b

Animal research is Vital to Medicine

Experiments using animals have played a crucial role in the development of modern medical treatments, and they will continue to be necessary as researchers seek to alleviate existing ailments and respond to the emergence of new diseases. As any medical scientist will admit, animal research is just one of many complementary approaches. Some questions, however, can only be answered through animal research. We intend to show exactly where we regard animal research to have been essential in the past and to point to where we think it will be vital in the future.

In the mid-19th century, most serious diseases resulted from bacterial or viral infections but at that time, people believed that it was something inside a person that caused illness. The proof that such diseases did in fact derive from microorganisms originated with work done by the French Chemist, Louis Pasteur and his conemporaries who studied infectious diseases in domestic animals. Because of his knowledge of how microorganisms could contaminate wine and beer, causing them to spoil, Pasteur became convinced that microbes were also responsible for diseases such as cholera and anthrax. To test his hypothesis, Pasteur examined the contents of the guts of chickens suffering from cholera. He isolated a possible causative microbe and then grew the organism in culture in the laboratory. Samples of the culture that were given to healthy chickens and rabbits caused them to develop cholera, thus proving that Pasteur had correctly identified the organism causing the disease. By co-incidence, he noticed that after some time the cultures of microorganisms lost their ability to infect birds with the disease. These birds became resistant to the new batches of the disease which were lethal to other birds that had not been given the ineffective microbe cultures. Doctors had previously noticed that people who survived a severe infection of a disease generally did not become infected with it again. Pasteur had discovered how to produce resistance in people so that they could become immune without them having to become infected with a dangerous disease. In similar studies on rabbits and guinea pigs, Pasteur isolated the microbe that causes anthrax and then developed a vaccine against this deadly disease. With information from animal experiments it was proven that not only could infectious diseases be caused by microorganisms, but also that immunization was possible to protect people against these diseases.

Joseph Lister, a British surgeon, was another medical scientist who relied on animal research. He was influenced by Pasteur's research and pioneered the use of carbolic acid to sterilize surgical instruments, sutures and wound dressings to prevent the infection of wounds.

Following the work of Pasteur and others, scientists have established the causes of and developed vaccines for dozens of infectious diseases including diphtheria, rabies, tetanus, whooping cough, tuberculosis, poliomyelitis, measles, mumps and rubella. The investigation of these ailments relied indisputably on animal experimentation.

Similar work continues to this day. Recently, scientists developed a vaccine against *Hemophilus influenzae* type B (Hib), a major cause of meningitis which, before 1993, resulted in death or severe brain damage in more than 800 children each year in the U.S. the new vaccine, prepared and tested in mice and rabbits, proved to be highly effective and is now in routine use.

Animal research not only produced new vaccines for the treatment of infectious diseases, it also led to the development of antibacterial and antibiotic drugs. Sulfanomide drugs greatly reduced the number of mothers who contracted peuperal sepsis as a result of bacterial infection after childbirth, and the number of men who contracted lobar pneumonia as a result of bacterial infection was also dramatically decreased. The team investigating these sulfonamide drugs, Gerhard Domagk's group at Beyer Laboratories in Germany, insisted that all compounds be tested on infected mice rather than only on bacteria grown in the laboratory. The compound protonsil, for example, was shown to be very effective on mice but had no effect on the bacteria in vitro. For his work on antibacterial drugs, Domagk won the Nobel Prize in 1939. Alexander Flemming did not use mice to examine the effectiveness of his cultures containing penicillin. Only when other researchers later used the mouse protection test was penicillin shown to be dramatically effective as an antibiotic.

Despite the success of vaccines and antibacterial therapy, infectious disease remains the greatest threat to human life worldwide. There is no effective vaccine against malaria or AIDS and new infectious diseases and bacteria resistant to current antibacterial drugs continue to emerge. It is hard to envisage how new and better vaccines and medicines against infectious diseases can be developed without experiments involving animals.

Research on animals has been vital to numerous other areas in medicine. Open heart surgery, which saves the lives of an estimated 440 000 people every year in the U.S. alone, is now routine thanks to 20 years of animal research. Replacement heart valves also emerged after years of animal experimentation. Only animal experimentation could have led to treatment of the cardiac condition known as mitral valve insufficiency which is caused by a defect in the heart's mitral valve. The production of prosthetic heart valves stemmed from years of development and testing for effectiveness in dogs and calves.

The development of treatments for kidney failure has relied on improvement techniques through animal experiments. Today kidney dialysis and even kidney transplants can save the lives of patients suffering from renal failure. A drug essential for dialysis, heparin, must be extracted from animal tissues and tested for safety on anaesthetized animals.

Transplantation of a kidney or any major organ presents a host of complications. Animal research has been instrumental in generating solutions to these problems. Experiments on cats, for example, helped develop techniques for suturing blood vessels from the host to the donor organ so that the vessels would be strong enough to withstand arterial pressure. Investigators working with rabbits, rodents, dogs and monkeys have also discovered ways to suppress the immune system to avoid rejection of the donor organ.

Before the introduction of insulin, patients with diabetes typically died from the disease. For more than 50 years, this lifesaving hormone had to be extracted from the pancreas of cattle and pigs before being tested for safety and effectiveness on rabbits or mice.

Research on anaesthetized cats in the 1950s led to improved hypertensive medicines so that today treatment of hypertension is effective. Similarly, gastric ulcers often necessitated surgery with a high risk of death. Now antiulcer drugs, developed from tests in rats and dogs, can control the condition.

Opponents of animal research frequently site the drug thalidomide as an example of a medicine that was thoroughly tested on animals but only showed its ability to cause birth defects when given to humans. However, scientists never tested thalidomide in pregnant

animals until after foetal deformities were seen in humans. Once they ran these tests, researchers recognized that the drug did in fact cause foetal abnormalities in rabbits, mice, rats, hamsters and several species of monkeys.

In truth, there are no basic differences between the physiology of laboratory animals and humans. Both control their internal biochemistry by releasing endocrine hormones that are all essentially the same. Both humans and laboratory animals send out similar chemical transmitters from nerve cells in the central and peripheral nervous systems, and both react in the same way to infection or tissue injury.

Our opponents in this debate claim that even if animal experiments have played a part in the development of medical advances in the past, this does not mean that they were essential. They argue that researchers would have been more creative and thus would have developed superior technologies for research if animal testing had not been allowed. However, no significant progress in the treatment of disease occurred until biomedical science was placed on a sound, empirical basis through experiments on animals. Early researchers, such as Pasteur and the 17th-century scientist William Harvey, who studied blood circulation in animals, were not drawn to animal experiments as an easy option. To answer their questions, they drew on all the available techniques at that time, such as dissection of cadavers, observation of patients and examination of bacteria in culture. At other times, though, they considered experimentation on animals to be necessary.

Transgenic animals with a single mutant gene have already provided a wealth of new information on the functions of proteins and their roles in disease. We also anticipate major progress in the treatment of traumatic injury to the central nervous system. The belief that it is impossible to restore function to damaged nerve cells in the mammalian spinal cord has to be reassessed in the light of recent animal research indicating that nerve regeneration is indeed possible. It is only a matter of time before treatments begin to work. We find it difficult to imagine how progress in this field, and so many others in biological and medical science, can be achieved in future without animal experiments.

Appendix 1.2.1a

Bilharzia

Bilharzia is the common name for the disease, Schistosomiasis. This is caused by parasitic worms infecting humans when the skin comes in contact with contaminated fresh water. Schistosomiasis affects approximately 200 million people, mainly in developing countries, and causes significant illness and in some cases, death.

Fresh water becomes contaminated by *Schistosoma* eggs when infected people urinate or defecate in non-chlorinated fresh water, or when poor sanitation systems deposit infected waste in rivers and lakes.

The eggs hatch, and if certain types of snails are present in the water, the *Schistosoma* parasites can grow and develop inside the snails. Parasites can then leave their snail hosts and enter the water where they can survive for about 48 hours. The parasites can penetrate the skin of people who are wading, swimming or washing in contaminated water.

After infecting a human, the schistosoma flukes migrate to the liver where they mature into male and female adults. These worms feed on red blood cells and dissolved nutrients such as sugars and amino acids. This may cause anaemia and decreased resistance to other diseases.

Within several weeks of infecting a person, the worms that are growing inside the blood vessels of the body produce eggs. Some of the eggs travel to the bladder or intestines, lungs or liver. These eggs that have been deposited by the female worms work their way through the walls of organs.

Symptoms of schistosomiasis are caused by the body's reaction to the eggs produced by the worms. These symptoms can include a rash or itchy skin at first, and fever, coughing and muscle aches can begin within a few months of infection. The parasites may not start causing illness for some years, though. Illness is mostly caused by the large number of eggs accumulating in organs. These eggs can prevent the liver and kidneys, in particular, from functioning. The adult worms can remain in a human host for decades. Here, they continually produce more eggs.

Eggs are passed out of the body in the faeces or the urine so when sanitation is poor, they can reach rivers or lakes. Here the eggs hatch and infect snails, thus completing the life cycle.

Appendix 1.2.1b

The African Dog – *Canis Africanis*

The African dog is generally seen as an outcast in South Africa. Most people think that they are just bony, unattractive disease-ridden mongrels. However, John Gallant, author of "The Story of the African Dog" believes that this breed, *Canis africanis,* has evolved by natural selection to cope superbly with conditions in Africa and is part of the cultural and biological heritage of Africa.

Gallant is worried that *Canis africanis* could be an endangered species. There are few dogs left that are still as they were in ancient human civilisations. The African dog is one of the few remaining examples of a 'natural' dog species. Most have been disappearing rapidly because of the popularity of new types of dogs that have been bred artificially for their fashionable appearance.

Dogs have been around in Africa for a long time. *Africanis* is a descendant of the early Egyptian dogs that can be seen on Egyptian murals from as far back as 4700 BC. When the Portuguese arrived in South Africa in the 15th Century they found that the San, or Bushmen people and the Hottentots living in the Cape already had their own dogs. The earliest remains of a dog to be found in Southern Africa are dated to 570 AD and Gallant believes that on the continent as a whole they go back at least 7,000 years. This suggests that *Canis africanis* has had plenty of time to develop a genetic heritage well suited to local conditions. Today, *Africanis* is found all over the Southern African subcontinent.

The *Africanis* is a medium sized dog, slenderly built and well muscled. It is agile and can run at great speed. The dog is found in a wide range of colours, with or without markings. The head is wedge shaped and the ears may be erect, half erect or drooping. The carriage of ears and tail is linked to the dog's awareness of the environment. When in good condition, the ribs are just visible. The coat adapts to the seasons, and can be kept shiny with the minimum of care.

The harsh conditions imposed on the *Africanis* by its environment have led to its development of an energy conserving lifestyle. Because it has, for centuries, roamed freely in and around rural settlements, it combines attachment to humans with a need for space. These dogs can be described as friendly companions to humans, displaying watchful territorial behaviour. They are able to work with livestock and domestic animals and their speed, good vision and ability to sniff out prey makes them useful hunting companions. The *Africanis* is not used to the western concept of dog obedience training but, because of its high sense of attachment to a pack leader, it follows its handler naturally.

Appendix 1.2.2a

Factors influencing the rate of methane formation in landfills (Original adaptation)

The production of methane gas from deep landfills is a natural process resulting from the biodegradation of organic material in association with bacteria.

This process also produces carbon dioxide and the overall reaction can be summarized as $2(CH2O)n \rightarrow nCO2 + nCH4$, with carbon dioxide and methane generated in equal amounts. Trace amounts of volatile components such as fatty acids, organosulphur compounds, thiophenes and hydrogen sulphide are also produced in the landfills. The characteristic unpleasant smell of landfill gas is attributed to these trace components.

Another property of landfill gas which contributes to its being a potential hazard is a reaction that takes place causing methane to explode or burn in the air. Unless steps are taken, landfill gas will naturally migrate from the sites where it is produced. Such emission has resulted in serious explosions up to a kilometre from the source (Senior and Shibani 1990). In Europe and America it is mandatory to pump landfill gas away from landfills. Unfortunately, there is no such law in South Africa.

Linked to the production of methane gas in landfills is the formation of organic acids which solubalize metals such as mercury and lead from waste material and, with bacteria, form a solution known as leachate. It is toxic and poses an enormous threat to the environment.

With the rapid increase in urbanization in South Africa and the encroachment of housing near established landfill sites, the production of leachate and landfill gas is of great concern. One way to address the problem within a limited time scale is to ensure that the biodegradation process in landfills takes place as rapidly as possible so that the land can be rehabilitated for sports fields, for example, without the fear of noxious gases, explosions or leachate contamination.

The rate of methane production is central to the whole process. Only the organic component of landfills (largely plant material and paper) will biodegrade to methane. This process begins with the breakdown of the large cellulose molecules and ends with the formation of methane, carbon dioxide and water. The bacteria responsible for the degradation are naturally present in plant material or at the site and multiply very rapidly when conditions are right (Pfeffer 1979).

In many parts of the world, the methane from landfills is being used for heating purposes or for energy regeneration (Mearns and Dancig 1993). If refuse entering the site is separated, with domestic and biodegradeable material placed in one area, the rate of methane production is increased and it is easier to collect as much of the landfill gas as possible.

Laboratory experiments (Daneel 1994) have shown that high moisture levels lead to high rates of methane production. Water acts as the transport medium for the microorganisms and allows them to penetrate deep into piles of organic materials, including compressed paper. To ensure high rates of methane production, landfills should be designed to facilitate entry of the correct amount of rainwater.

Results of laboratory experiments (Kasali and Senior 1989) also show that the production of methane is faster at higher temperatures, possibly doubling when the temperature in the

landfill site rises 10 degrees celcius. A daily cover of soil or clay will help to trap the air and the heat. In this way temperatures in excess of 45 degrees can be sustained deep inside the landfills. The resulting acceleration in the rate of decomposition of the waste means that rehabilitation of the site can begin sooner.

Appendix 1.2.2b

Factors influencing the rate of methane formation in landfills (Paraphrase)

Bacteria help organic material to break down. This happens naturally in rubbish dumps. Bacteria break down organic rubbish in deep rubbish dumps and then methane gas is produced and the same amount of carbon dioxide is also released. There are also small amounts of substances that turn into gases and this is what causes rubbish dumps to smell.

Rubbish dumps can be very dangerous because methane can explode. This gas can move far from the rubbish dump and there have even been explosions a kilometre away. In Europe and America there are laws to force people to pump the gas away from the rubbish dumps but unfortunately there are no laws about this in South Africa.

Organic acids are also formed in rubbish dumps or "landfills" and they make it possible for dangerous metals in the rubbish, like mercury and lead, to dissolve. When these dissolved metals mix with the bacteria in the rubbish dump, they form a dangerous solution called "leachate". It is poisonous and it is bad for the environment.

We should be very worried about the leachate and landfill gas that rubbish dumps produce. This is because more and more people are now moving into towns so houses are being built closer and closer to rubbish dumps. One way we can try and solve the problem of landfills in a hurry is if we make sure that rubbish in the dumps breaks down as quickly as possible. People can then safely use the land again, for example to make sports fields. Then people won't have to worry about poisonous gases or explosions or leachate.

The more quickly methane is produced in the rubbish dumps, the more quickly the rubbish can be broken down. Only organic rubbish, like plant material and paper, will break down to form methane gas. There are plenty of bacteria at the dump and in the rubbish and they break down the cellulose molecules in the organic rubbish and, in the end, methane, carbon dioxide and water are formed.

People in many places in the world are now using the methane from rubbish dumps for electricity. Methane is produced more quickly if organic rubbish only is put together in a separate part of each rubbish dump. Then it is also easier for people to collect as much of the landfill gas as possible to use for electricity.

The bacteria that break down the rubbish move around through water, so rubbish dumps produce more methane more quickly if there is enough water. Water lets the bacteria get deep inside piles of organic rubbish to break it down more quickly. Therefore it is important for engineers to design rubbish dumps in a way that allows the right amount of rainwater to get in.

Scientists have also done experiments that have shown them that methane is produced more quickly when temperatures in the landfills are high. We can make sure that it stays hot enough in the landfills if we use soil or clay to cover the rubbish every day. This means that the rubbish breaks down more quickly so it is safe to use the land again sooner.

Appendix 1.2.3a

Energy from Fossil Fuels (I)

Fossil fuels pose a dilemma for human society. Worldwide, the combustion of coal, oil and natural gas supplies about 88 percent of the energy we purchase and makes much of what we do possible. Yet gases emitted during burning can harm the environment, perhaps to the extent of altering the climate and threatening the future habitability of the planet.

Technologies now being developed should go a long way toward alleviating two environmental disturbances associated with fossil-fuel combustion: acid deposition and urban smog. Solutions are also being sought to for a third and potentially more devastating disturbance – increased global warming caused by rising levels of carbon dioxide (CO2) and other so-called greenhouse gases in the atmosphere. CO2 is emitted whenever fossil fuels are burned. Like other greenhouse gases, it captures heat radiated from the earth and traps it near the surface.

The problem of global warming is difficult to resolve, in part because there is disagreement over how real and dangerous the threat is and, consequently, how much money and effort should be devoted to coping with it.

Society needs to be aware that fossil-fuel consumption will have to be drastically and rapidly curtailed to prevent global climate change. A number of relatively inexpensive strategies worth considering are beginning to emerge. These range from increasing the efficiency of fossil-fuel use, which would reduce emissions by producing more energy services with the same amount of fuel, to developing improved non-fossil sources that can be substituted economically on a large scale.

The fossil supplies were laid down over millennia, as ancient plants and animals died and became buried in swamps, lakes and sea beds. Much fuel remains, especially coal, but these supplies are being depleted much faster than they are being replenished. If environmental stress does not force a shift to other fuels, the finite supply of fossil fuels will eventually force such a change.

In conventional power plants, pulverized coal is burned in a boiler, where the heat vaporizes water in steam tubes. The resulting steam turns the blades of a turbine, and the mechanical energy of the turbine is converted to electricity by a generator. Waste gases produced in the boiler during combustion are released into the air.

Today it is common to reduce SO2 emissions by flue gas scrubbing. This involves bringing waste gases in contact with a form of limestone which causes a reaction resulting in a compound that can be removed as solid waste. Even before combustion begins, coal can be cleansed of some sulphur. For instance, commercially available processing methods crush the coal and separate the resulting particles on the basis of density, thereby removing up to 30 percent of the sulphur. As a result of scrubbing and an increased use of low-sulphur coals, sulphur dioxide emissions have decreased by 33 percent in the U.S. in the last 15 years, even though coal use has increased by about 50 percent.

Appendix 1.2.3b

Energy from Fossil Fuels (II)

The option of using natural gas is also appealing for various reasons. Compared with coal, combustion of natural gas, which is mainly methane, yields about 70 percent more energy for each unit of carbon dioxide released. Also, natural gas can be burned efficiently because of the simplicity of gas-handling equipment, because it lacks ash, which is unburnable material, and because it typically contains much less sulphur than is found in coal, which means that more energy does not have to be used for cleanup devices.

Although the technologies for using natural gas efficiently are improving, there are some significant limitations to the strategy of substituting gas for coal. First, natural gas is much less abundant. At the current worldwide rate for consumption, and with existing technology, estimated economically recoverable resources of coal would last perhaps 1 500 years. In contrast, reserves of natural gas would last only 120 years. If natural gas was substituted for all coal used, the gas resources might last only 55 years.

Secondly, leakage of natural gas during extraction and transport could partially offset the advantage of its use because methane is a greenhouse gas which actually absorbs more radiation than carbon dioxide, even though it stays in the atmosphere for a shorter time.

The uneven distribution of gas resources makes matters more problematic. For instance, U.S. supplies would last only 18 years if natural gas replaced coal for all uses, while those of Russia would last 70 to 80 years. Such uneven distribution raises concern about access.

Whether nations of the world are willing to make a major transition from coal to gas is another question. At the moment, gas is more expensive to buy than coal and may become more so as demand increases. Also, the U.S. and other countries that have abundant supplies of coal and smaller supplies of gas might be unwilling to significantly increase their reliance on outside sources of the fuel. Every nation is, after all, concerned about having secure and stable priced sources of energy.

Until research makes more progress, it will probably remain hard to wean the world from fossil fuels. For all their faults, they remain relatively inexpensive, widely available and readily adaptable to different uses.

Appendix 2

Tests

Appendix 2.1

Student number: _____ **Group:** _____

In each of the 32 sentences below, one word has been underlined.

Choose the word or phrase with the most similar meaning from the three options below each sentence. Put a circle around the correct number only.

How sure you are about your answer? Choose one box to tick each time.

1. The number of people infected with bilharzia is declining.

1. increasing 2. being announced 3. going down

I'm sure	I think so	I don't know

2. Molecules in the air collide with molecules that are receding.

1. moving further away 2. shrinking 3. approaching

I'm sure	I think so	I don't know

3. Governments should deal with solid wastes by integrating certain methods.

1. combining 2. cutting down 3. testing

I'm sure	I think so	I don't know

4. It is impossible to eradicate bilharzia across huge areas.

1. cure it 2. educate people about it 3. completely destroy it

I'm sure	I think so	I don't know

5. When coal is burned, gases are produced that could alter weather patterns.

1. damage 2. change 3. stop

I'm sure	I think so	I don't know

6. Atoms and free electrons sometimes collide.

1. collect together 2. rise upwards 3. hit together

I'm sure	I think so	I don't know

7. Some buildings retain more heat than others.

1. keep 2. recycle 3. lose

I'm sure	I think so	I don't know

8. Heated molecules <u>impart</u> some of their energy.

1. keep 2. divide up 3. give away

I'm sure	I think so	I don't know

9. There are different ways to <u>dispose</u> of paper.

1. get rid of 2. make use of 3. change

I'm sure	I think so	I don't know

10. One way to deal with the problem of solid waste is to <u>incinerate</u> it.

1. sort it into categories 2. dissolve it in acid 3. burn it completely

I'm sure	I think so	I don't know

11. All surfaces <u>emit</u> radiant energy.

1. absorb 2. send out 3. require

I'm sure	I think so	I don't know

12. Some substances <u>impede</u> the flow of heat.

1. speed up the flow of heat 2. make it difficult for heat to flow
3. change the direction of the flow of heat

I'm sure	I think so	I don't know

13. Scientists have <u>speculated</u> that wolves helped humans to hunt.

1. discovered 2. argued 3. guessed

I'm sure	I think so	I don't know

14. Different dog breeds have been <u>depicted</u> in Egypt.

1. shown 2. selected 3. destroyed

I'm sure	I think so	I don't know

15. Diseases to be studied are <u>triggered</u> in animals by scientists.

1. injected 2. made to start 3. treated

I'm sure	I think so	I don't know

16. We cannot always ensure that animals are not <u>harmed</u> in experiments.

1. killed 2. used 3. injured

I'm sure	I think so	I don't know

17. Rubbish is <u>compressed</u> after it is dumped at a landfill site.

1. exposed to air 2. squeezed into a smaller space 3. buried under the ground

I'm sure	I think so	I don't know

18. There is a debate about the <u>ethics</u> of using animals in experiments.

1. How expensive it is 2. How acceptable/ right it is 3. How accurate it is

I'm sure	I think so	I don't know

19. Fibreglass thus acts as a <u>barrier</u> to the flow of heat.

1. It prevents the easy movement of heat 2. It transfers the heat to the ground
3. It carries the flow of heat to the other side

I'm sure	I think so	I don't know

20. Toilets can be made from <u>local</u> materials.

1. materials made nearby 2. cheap materials 3. imported materials

I'm sure	I think so	I don't know

21. It is important to supply people with <u>adequate</u> water.

1. purified 2. enough 3. additional

I'm sure	I think so	I don't know

22. It is easier to kill snails in <u>artificial</u> bodies of water.

1. natural 2. man-made 3. officially recognised

I'm sure	I think so	I don't know

23. Humans have tried to breed <u>docile</u> dogs.

1. dogs that are easy to influence 2. aggressive dogs 3. strong dogs

I'm sure	I think so	I don't know

24. African dogs have adapted to conditions in Africa in a <u>spontaneous</u> way.

1. easy way 2. similar way 3. unplanned way

I'm sure	I think so	I don't know

25. There are <u>viable</u> alternative power supplies.

1. affordable 2. successful 3. valuable

I'm sure	I think so	I don't know

26. There is a <u>finite</u> supply of oil.

1. a supply that will end 2. an endless supply 3. a narrow supply

I'm sure	I think so	I don't know

27. It is necessary to test if new medicines are <u>toxic</u>.

1. safe 2. poisonous 3. cancer-causing

I'm sure	I think so	I don't know

28. Some scientists have studied <u>infectious</u> diseases in animals.

1. diseases that can cause death 2. diseases that can easily be spread
3. diseases that have serious effects

I'm sure	I think so	I don't know

29. In some areas frost is <u>infrequent</u>.

1. not common 2. happens often 3. heavy

I'm sure	I think so	I don't know

30. The heat from a fire may be <u>stationery</u>.

1. charged with electricity 2. sinking 3. not moving

I'm sure	I think so	I don't know

31. The different types of heat transfer can happen <u>simultaneously</u>.

1. They can happen equally 2. They can happen at the same time
3. They can happen without being planned

I'm sure	I think so	I don't know

32. The trees in the forest <u>rarely</u> burn.

1. They frequently burn 2. They burn quickly 3. They don't often burn

I'm sure	I think so	I don't know

Appendix 2.2.1

Independent comprehension:

Student number: _____ **Group:** _____

Bilharzia (Woolhouse 1987)

Using your own words, write a paragraph in which you briefly summarise the different ways of controlling Bilharzia in Zimbabwe.

Appendix 2.2.2

Text 1

Student number: _____ **Group:** _____

Animal Research (Barnard and Kaufman)

Using your own words, write a paragraph in which you briefly summarise the main reasons why Barnard and Kauffman believe that animal research is wasteful and misleading.

Appendix 2.2.3

Text 2

Student number: _____ **Group:** _____

Animal Research (Botting and Morrison)

Using your own words, write a paragraph in which you briefly summarise the main reasons why Botting and Morrison believe that animal research is vital to medicine.

Appendix 2.3.1

Student no. _____ **Group:** _____

Bilharzia reading quiz

Read the following statements and decide whether they are true or false.
Indicate the correct answer with a cross.

1. Bilharzia (Schistosoma) parasites cannot survive in water for longer than 48 hours without a snail host.

True	False

2. A person can only become infected with Bilharzia by drinking contaminated water.

True	False

3. Illness is caused by the eggs damaging human organs.

True	False

4. Once the eggs pass out of a person's body, he or she will be free of Bilharzia.

True	False

Appendix 2.3.2

Student no. _____ **Group:** _____

***The African dog* reading quiz**

Read the following statements and decide whether they are true or false.
Indicate the correct answer with a cross.

1. The African dog has been admired in South Africa for many years.

True	False

2. *Canas africanis* has evolved naturally instead of being bred artificially.

True	False

3. African dogs were first introduced in Southern Africa by Portuguese settlers.

True	False

4. African dogs generally avoid human settlements.

True	False

Appendix 2.3.3

Student no. _____ **Group:** _____

Landfills reading quiz

Read the following statements and decide whether they are true or false.
Indicate the correct answer with a cross.

1. Methane gas is produced when organic material decomposes.

True	False

2. Methane gas can explode.

True	False

3. Leachate is a dangerous gas produced in landfills.

True	False

4. Methane gas can be used to generate electricity.

True	False

Appendix 2.3.4a

Student no. _____ **Group:** _____

***Energy from fossil fuels I (Fulkerson)* reading quiz**

Read the following statements and decide whether they are true or false.
Indicate the correct answer with a cross.

1. Coal is the only type of fossil fuel.

True	False

2. Increased levels of carbon dioxide can change the earth's weather patterns.

True	False

3. It takes a few years to produce new fossil fuels.

True	False

4. Some sulphur can be removed from coal that is burned to produce energy.

True	False

Appendix 2.3.4b

Student no. _____ **Group:** _____

***Energy from fossil fuels II (Fulkerson)* reading quiz**

Read the following statements and decide whether they are true or false.
Indicate the correct answer with a cross.

1. Burning natural gas to provide energy produces more carbon dioxide than burning coal does.

True	False

2. Less natural gas is available than coal.

True	False

3. Natural gas is mostly made up of methane.

True	False

4. An advantage of using gas is that it is cheaper than coal.

True	False

Appendix 3

Questionnaires

Appendix 3.1

Reading Questionnaire

Student no. _____ **Group:** _____

1. What is your home language? _____

2. What language did your teachers use to teach you at primary school?

☐ English ☐ Your home language ☐ Both ☐ Another language

3. What language did your teachers use to teach you at secondary school?

☐ English ☐ Your home language ☐ Both ☐ Another language

4. When were books *first* read to you?

☐ At home, before you started school

☐ At pre-school

☐ At primary school

☐ Never (You read for yourself when you had learned to read)

5. At high school, how often did you get your own copy of a text to read?

☐ Weekly

☐ A few times per term

☐ Once or twice per year

☐ Never

6. Tick the statement about libraries that is true in your case

☐ There was a library at my secondary school ☐ I regularly used a public library

☐ I used both a school and a public library ☐ I used neither

7. Do you enjoy reading for fun / entertainment now?

☐ Yes ☐ No

8. When you were at school, how often did you read for fun / entertainment?

☐ Never ☐ Sometimes ☐ As often as I could

9. Do you find English reading difficult?

☐ Yes ☐ No

If you do find it difficult…

10. Explain why.

_____

Appendix 3.2

Student no. _____ **Group:** _____

NB: This is NOT for marks. Please answer honestly!

1. **Did you read the text for homework?**

   ☐ Yes ☐ No ☐ Some of it

2. ***If* you did not read it or if you only read some of it, Explain why.**

_____

_____

3. **How easy or difficult was this text to read?**

   ☐ Easy ☐ Difficult ☐ OK

4. **If you found it difficult, please explain why.**

_____

_____

_____

5. **Did you find it interesting?**

   ☐ Yes ☐ No ☐ A little bit

Appendix 3.3.1

Student no. _____ **Group:** _____

Reading text: _____

NB: This is NOT for marks. Please answer honestly!

1. Did you read the text for homework?

☐ Yes ☐ No ☐ Some of it

2. *If* you did not read it or if you only read some of it, Explain why.

_____

_____

3. How easy or difficult was this text to read?

☐ Easy ☐ Difficult ☐ OK

4. If you found it difficult, please explain why.

_____

_____

_____

5. Did you find it interesting?

☐ Yes ☐ No ☐ A little bit

Appendix 3.3.2

Student no. _____ **Group:** _____

NB: This is NOT for marks. Please answer honestly!

1. **Did you read the text for homework?**

   ☐ Yes ☐ No ☐ Some of it

2. ***If* you did not read it or if you only read some of it, Explain why.**

_____

_____

3. **How easy or difficult was this text to read?**

   ☐ Easy ☐ Difficult ☐ OK

4. **If you found it difficult, please explain why.**

_____

_____

_____

5. **Which reading did you find easier?**

   ☐ Animal experiments are wasteful and misleading.

   ☐ Animal research is vital to medicine.

   ☐ Both the same

6. **Can you explain what made one easier to read than the other?**

_____

_____