UNIVERSITY OF SOUTHAMPTON

THE EFFECTS OF ACTIVATING METACOGNITIVE AWARENESS ON COMPREHENSION PROFICIENCY OF THAI STUDENTS

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June, 2001

UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL SCIENCES

RESEARCH AND GRADUATE SCHOOL OF EDUCATION

ABSTRACT

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This experimental research investigates the effects of strategy instruction on the English reading proficiency and strategy use of Thai students. The subjects were 74 first year science students at King Mongkut's Institute of Technology North Bangkok (KMITNB), Thailand from June to September 1999. A programme of strategy instruction was introduced to an experimental class of 37 students, while the same number of students were taught as a control group through traditional English reading instruction. A mixed research approach using both quantitative and qualitative techniques was adopted to investigate the impact of the introduced programme on students'reading achievement and strategy use. A test of reading achievement and a strategy questionnaire were administered to all subjects before and after the course. Six students from each group were also selected for a think-aloud and diary study. These twelve subjects were asked to verbalise their thoughts while reading English texts, and to keep diaries about their reading activities at home for ten weeks.

The results indicated that while both groups improved their reading test scores and strategy use in the course of the study, the experimental group showed a significantly higher gain in reading ability and reported more frequent strategy use than the control group. The findings also indicated a significant correlation between strategy use and reading proficiency. The results of this study lead to a better understanding of the impact of activating metacognitive awareness, and suggest that explicit instruction in reading strategy use can override the effect of language proficiency limitations on readers' use of effective reading strategies.

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ACKNOWLEDGEMENTS

I would like to express my warmest and foremost appreciation to Professor Rosamond Mitchell, my supervisor for her perceptive comments, feedback and support with patience and understanding throughout the period of my supervision. My gratitude to Professor Christopher Brumfit for his expert advice throughout the first two years of my research study. I also would like to thank the staff of the Research and Graduate School of Education for their academic support especially to Mr. Keith Jones for his clear explanation in statistics and advice in quantitative design.

This research would not have been possible without the support of the Thai Government. My sincere acknowledgement to Associated Professor Rossukon Srivarakan, the head of the department of language and social sciences, KMITNB for her encouragement and moral support. I also would like to thank all participating students of KMITNB whose eagerness and dedication made this research fieldwork successful.

All my friends and colleagues who have helped brightened my long days of research writing. My sincere thanks to Rosie Flewitt for her thorough editing on the Appendices and for her friendship. Finally, I wish to thank everyone in my family for their encouragement and moral support throughout the period of my study.

Chapter I

Introduction and Background to the Study

1.1 Introduction to the thesis

In Thailand, English is regarded as the most important foreign language. According to the 1996 National Profiles of Language Education survey for Thailand, English has become the most common and popular foreign language used as a means of communication in various fields, such as business and trade, tourism and mass media (Wongsothorn et al., 1996). In addition, it is the most widely studied foreign language in every educational institution. Due to the recognised importance of English, the eighth National Educational Development Plan: 1997-2001 proclaims English a compulsory academic subject starting from grade four onwards (Wongsothorn et al., 1996: 95-96). It is also a required subject for entry into tertiary education.

English reading proficiency is important for success in higher education in Thailand. Among the four language skills (listening, speaking, reading and writing), reading in English has been considered the most important and the most attainable skill for Thai students since the opportunity to practise speaking and listening skills in real life is very limited. Students, however, have to read textbooks, journal articles and research reports published in English to access specialist knowledge in their fields. The importance of reading in second language situation is stated by Carrell et al. (1988) as presented in the quotation below:

'In second language teaching/learning situations for academic purposes, especially in higher education, university or other programmes that make extensive use of academic materials written in English, reading is paramount. Quite simply, without solid reading proficiency, second language readers cannot perform at levels they must in order to succeed.'(Carrell et al. 1988:1)

Dubin and Bycina (1991) also support the importance of reading by stating that

besides EFL (English as a foreign language) teachers'responsibility to teach language to students, it is expected that they also act as reading skills teachers because reading has become an essential concern in the second and foreign language curriculum. 'In fact, reading is often the chief goal of learners in countries where English is taught as a foreign language'(p.195). It is also stated in a study by Tansiengsom (1986: 4) that English instruction at the secondary and university levels in Thailand is devoted largely to reading. Reading is an especially indispensable skill for science students and scientists since a great number of science related research and papers are written mainly in English (Johns and Dudley-Evans, 1993:4)

According to my own experience, students at King Mongkut's Institute of Technology North Bangkok (KMITN) have to read extensively in English . After 9-12 years of formal instruction in the English language from elementary school to high school, it could be expected that students entering the university would have acquired a considerable knowledge of English and would have reached a reading competence level that would enable them to read effectively. However, despite the known concentration on the reading skill, Thai university students' ability to read English remains poor as documented by Charoensilpanith (1994: 5). Her study showed that undergraduate science students experience great difficulty while they are reading academic texts in English. The results from her interviews showed that the students sometimes understand almost every word, however, they say they cannot comprehend the key ideas from the texts. Students usually complain that they do not understand the English language textbooks they read even in their own field of study.

Teachers and researchers have all observed that some students approach language learning tasks in more successful ways than others. That is, all other things being equal, some students will be more successful than others in learning a second language. This

observation sparked off the researcher's interest in considering the learning tasks from the learners' point of view. According to the learning strategy literature (see Chapter II), it is assumed that successful learners will differ to some extent in the particular sets of cognitive processes and behaviours which they use to enable them to succeed. This assumption led the researcher to another issue: whether teachers can promote effective strategy use. In response to the situation described above, the research on reading strategy development described in this thesis was designed and implemented to introduce an alternative model of English reading instruction for the tertiary level in Thailand.

In this chapter, the researcher will first discuss in more detail the place of the English language in Thai society and in the Thai education curriculum. After that some key current problems will be discussed, followed by an outline of the purposes of the study, and its significance. Finally, the scope and the limitations of the study will be presented.

1.2 The place of English in the Thai educational system

Thailand is situated in the heart of the Southeast Asian mainland, covering an area of 200,000 sq. miles, with the Lao People's Democratic Republic and Myanmar to the north, Cambodia and the Gulf of Thailand to the east, Myanmar and the Indian Ocean to the west, and Malaysia to the south. Although the great majority of Thailand's 60 million people are Thai (Bank of Thailand, 1997), the country has a number of minority groups: Chinese, Lao, Khmer, Indian, plus assorted hill tribes. In overview, Thailand has long been prosperous and has been the only Southeast Asian country which has never been colonized. This accounts for the unique character of its social nature at large and its development in education in particular. During the past two decades, Thailand has emerged as one of the most promising developing nations in the world. Education has,

thus, played an important role in economic and social development in this country, and has especially influenced the quality of life for Thai people, who are the key to overall development of the nation.

The official national language, able to be written and spoken by almost 100% of the population (Office of National Education Commission, 1997), is Thai. Other languages are Chinese and Malay and various hill tribe languages. However, English is the most popular foreign language and is widely used in Bangkok and other major cities for business purposes. The Thai language has a unique language script which is read from left to right and top to bottom. The term 'Thai' is commonly used in literature to refer to Tai dialects and languages spoken in Thailand, whereas 'Tai' refers to the whole family of Tai languages and dialects spoken in Thailand, Laos, the Shan States of Burma, North Vietnam, Southwest and Southeast China, and Assam in India.

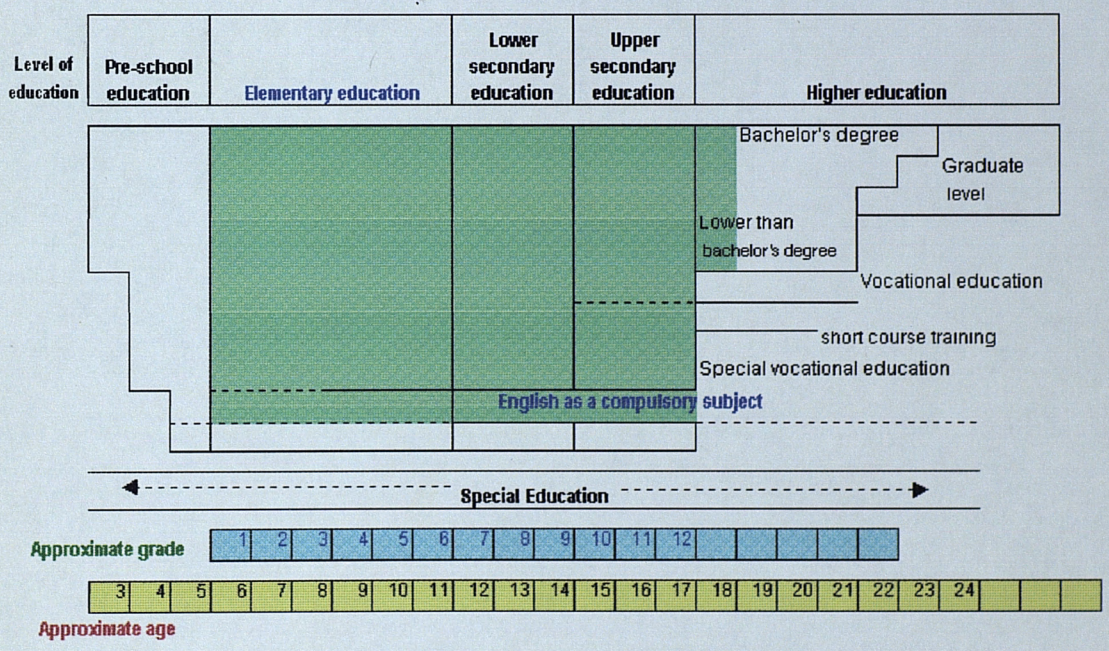
Thailand can be divided into four major dialect areas. The four regional Thai dialects are Northern Thai (Kam Mueng, Yuan), Northeastern Thai (Isan, Lao), Central (standard Thai), and Southern Thai (Pak Tai). However, Thailand has only one official language, Standard or Central Thai, which is used for all communication purposes.

Standard Thai is the main language of instruction in Thai schools. Officially there are no second languages in Thailand. In practice, two commonly used foreign languages that almost attain the status of second languages in certain parts of the country are Pattani Malay and Chinese (Tae Chiu). For better integration of minority language groups into the main stream of Thai society, the Thai Government recommends that the Thai language be their major avenue to national integration at all levels of education. This is viewed as a means of promoting national identity and unity. Standard Thai is compulsory for all levels of primary and secondary education and Thai students are required to take Thai language tests in their university entrance examinations(Office of the National Education

of the national language. Now, demands for the study of modern foreign languages have been increasing since the economic boom of the 1980's. This has created a demand for individuals who not only are qualified in their chosen area of professional expertise but also can communicate with their foreign colleagues or customers orally and in writing with a reasonable degree of fluency. Thus, English has become more than just a tool to gain access to modern technology; it is now viewed as the key to professional advancement as well.

1.2.1 Structure of formal educational system

Figure 1.1: Thai education in the school-related system



(Office of the National Education Commission, 1993:2)

The Education Law promulgated in 1985 declares the adoption of a school ladder shown in Figure 1.1. Compulsory education is currently enforced through legislation which requires all Thais to participate in formal education for a total of 9 years.Education in Thailand follows a single track of 6-3-3-4, i.e., six years in elementary school, three years in

which requires all Thais to participate in formal education for a total of 9 years.Education in Thailand follows a single track of 6-3-3-4, i.e., six years in elementary school, three years in a lower secondary school, three years in upper secondary school and four years in college or university. The Education law states: 'All citizens have the right to receive education according to their ability; all children should receive at least secondary education' (Office of the National Education Commission, 1993:2).

1.2.2 The English curriculum in Thailand's compulsory education

The English curriculum in Thailand aims to ensure the readiness of Thai students to understand and use the language efficiently (Ministry of Education, 1996). This curriculum was emphasized in response to globalisation and the associated influx of information, which is mostly represented in English. The English curriculum, like other required subjects for primary and secondary education, is set by the Ministry of Education. The set objectives of the English curriculum for this compulsory level are:

- To establish learners' communicative proficiency in English with cultural and situational appropriateness.
- To conduct continuous English education through sequences of higher education programmes.
- To develop learners' English skills in all aspects: listening, speaking, reading and writing.
- To develop a positive attitude towards the English language and an understanding of its usefulness for knowledge acquisition and for world of work life (ONEC, 1997: 5).

The Eighth National Education Development Plan 1997-2001 also acknowledges the significance of the information superhighway and the role of information technology in education, and adopts the concept of the globalisation of education (p.7). Foreign languages, particularly English, will play a significant role in serving the emerging needs of the new society and the new generation of students.

According to the present curriculum, there are eight foreign languages which may be taught as a subject. These are English, Japanese, German, Chinese, Pali and Sanskrit,

French and Arabic. However, not many schools can offer students this range of foreign languages and only English is taught in most schools. At present, approximately 80% to 95% of primary schools teach English from Grade 5 for 5 periods of 20 minutes per week. At the secondary level, it is taught for 4-8 periods of 50 minutes per week.

According to the report of the Academic Department, Ministry of Education (Ministry of Education, 1996), the English curriculum, represented by subjects and required periods, is structured into 3 levels, according to learners' proficiency and formal educational levels. Details are shown in Table 1.1.

Primary English level

The curriculum for primary education is intended to prepare learners for English study, as well as to introduce English speaking, listening, reading, and writing skills and start combining all four skills. It is catergorised into 3 sub-levels:

- Preparatory English (PRE); There are 3 strands for learners in Grade 1 and Grade 2.
- Literacy English (LTE); There are 4 strands for learners in Grade 3 and Grade 4.
- Beginner Fundamental English (BFE); There are 4 strands for learners in Grade 5 and Grade 6.

Intermediate fundamental English (IFE)

This is the curriculum for lower secondary education. It consists of 6 subjects taught in Grades 7-9.

Advanced fundamental English (AFE)

This is the curriculum for upper secondary education. It consists of 6 subjects taught in Grades 10-12.

The intermediate and advanced fundamental levels (IFE and BFE), are intended to

develop the capability to integrate verbal and non-verbal language for communication. At all levels English is taught for 5 periods per week (i.e., as a 2-credit course).

Table 1.1: Structure of English curriculum in primary-secondary education (Phoonsiri, 1998: 35)

English level	Course	Grade	Educational level
Primary	PRE 1 PRE 2, 3 LTE 1, 2 LTE 3, 4 BFE 1, 2 BFE 3, 4	1 2 3 4 5 6	Primary
Intermediate fundamental	IFE 1, 2 IFE 3, 4 IFE 5, 6	7 8 9	Lower secondary
Advanced fundamental	AFE 1, 2 AFE 3, 4 AFE 5, 6	10 11 12	Upper secondary

There is also a supplementary curriculum for learners who have higher skills and motivation to develop their English in depth for further education or for professional use. This special curriculum, called 'English for English concentration' (EE), is designed for secondary school students as a series of 2-credit elective courses, as shown in Table 1.2. Students are eligible to choose one of these courses (2 credits/week) in each semester.

Table 1.2: Structure of elective English curriculum in secondary education

Courses	Abbreviation	Grade	Educational level
Listening and speaking	LSE 1-6	7-9	Lower secondary
Reading and writing	RWE 1-6	7-9	Lower secondary

Advanced listening and speaking	ALSE 1-6	10-12	Upper secondary
Reading	RE 1-6	10-12	Upper secondary
Writing	WE 1-6	10-12	Upper secondary

(Department of Curriculum and Instruction Development, 1990:17)

The schools set their programmes of study according to the curriculum. For example, they set the number of courses that each student has to take per semester. They also require the teachers for each course to prepare lists of learning objectives in the cumulative student records, and to write tests measuring the set learning objectives.

The textbooks commonly used to teach English at all levels of education are locally produced by international publishers. These textbooks have a market share of about 98%; learning materials usually include a student's book, a workbook, a teacher's book, one or two tape cassettes, a test booklet, and in some cases, a video and a CD. Teachers or groups of teachers develop supplementary materials, sometimes with guidance from native speakers of English who are either volunteers or contract teachers (Phoonsiri, 1998: 28). In practice, language skills at the secondary level are ranked in order of importance as follows: 1. reading skills 2. writing skills 3. listening skills 4. speaking skills (Wongsothorn, et al., 1996:98)

At the national level, the Department of Curriculum and Instruction of the Ministry of Education sets foreign language curricula and learning objectives. However, they do not provide detailed syllabi, or regulations for testing and evaluation. Thus, the schools set examination dates and report test results. They also announce the outcomes of learning and grant certificates to graduates at the end of Matayomsuksa 3 and 6 (Grade 9 and Grade 12).

Teachers and schools are also responsible for evaluating ongoing student progress and achievement. Internal evaluation is conducted through summative exams at the end of the term or at the end of the academic year and formative tests at other times at the teachers' discretion. The students'end of year scores come from both formative and summative tests. The formative or process scores (60%) consist of: quizzes or progress tests 20%, mid-term tests 30%, evaluation of student affective domain 10% (Wongsothorn, et al., 1996: 99). The summative tests (40%) are criterion-referenced. Objective test procedures are employed using multiple choice, matching, and gap-filling. Writing tests for the core course at Matayomsuksa levels 3 and 6 are also mostly objective-type with sentence completion, paragraph completion, reordering sentences, reordering words, and error correction but no essay writing. In the specific writing-skill course, writing is tested in the same way as in the core course, but with sentence writing and writing of short narrative or descriptive paragraphs. However, it should be noted that very few schools offer writing courses.

1.2.3 English language in King Mongkut's Institute of Technology, North Bangkok (KMITNB)

King Mongkut's Institute of Technology was founded in 1959 as the Thai German Technical school. As the operation has progressed, over the years, the academic programmes have developed from certificate to diploma to bachelor to master and, four years ago, to Doctor of Technical Education. The focus of the institute is on science and technology. The development plan of KMITNB states the roles of language in educational processes as follows:

'Due to the fact that the university recognises the importance of factors which enhance education and work in various disciplines, implementation in the Seventh Development Plan will give emphasis to components

which have direct effect on building up certain required skills and basic knowledge. These include skills in using Thai clearly and effectively, using English for communicative and instrumental purposes, using computers for study, research and occupational purposes, as well as acquiring basic knowledge specified in the general educational section.

At the same time KMITNB has pursued a policy of activity developing contacts abroad through membership of international organisations and by collaborating with universities and colleges in many overseas countries and this year will see the first Master's degree programme taught in English.'

(KMITNB Bulletin, 1996-1997: 2)

From the foregoing quotation, it can be seen that the institute recognizes two essential roles for language: as a means of internal communication and a means of transmission of knowledge. At undergraduate level, students are required to do at least 6 credits of English but they can do more, depending on the importance of English in their specific field of study. In addition, during the last few years the institute has started to mention the possibility of KMITNB becoming internationalized. It has given financial support for staff to study abroad to attend conferences and to present papers. These activities will help to promote the standard of teaching and research work and to increase experience and expertise to an internationally accepted level.

On a faculty basis, many departments have begun to establish cooperation programmes with universities in Australia, and some departments offer programmes in English. These English-medium programmes in cooperation with world-renowned universities are expected to help improve the quality of teaching and learning, to enhance research work, and to attract students from abroad. Staff and students who have a good command of English will benefit from these programmes. Thus, English language can be anticipated to gain more importance in the institute's plan.

1.2.4 General description of English language courses in KMITNB

Like other state universities in Thailand, students entering the Institute have to take the National University Entrance Exam, English is one of the subjects students have to pass. The English test for the National University Entrance is developed by the state committee

as a screening test for Thai students entering tertiary level. As English is accepted as a means for transmission of knowledge, and international communication, the institute requires that all undergraduate students take at least 6 credits in English. Unlike the primary and secondary level, at the tertiary level, there is no explicit specified English language curriculum. The foreign language curriculum at the tertiary level may be divided into three main categories: language and skills for communication, literature for arts and humanistic values, and linguistics for the scientific study of language. Foreign language education is in three streams: liberal education, humanistic education, and career or utilitarian education. General English and literature courses are in the first and second streams whereas English for Specific Purposes courses are in the last stream (Wongsothorn et al.,1996).

At KMITNB, in the undergraduate degree programme, English is taught as a compulsory subject for 6-9 unit credits, depending on the requirement of each department. The overall objective, apart from the maintenance, consolidation and expansion of English knowledge gained from higher secondary school, is to provide English language skills to help students achieve a level of language proficiency that will be useful in their discipline or profession as stated in the course description below:

'Skills of reading, writing, listening and speaking are integrated in this course. Reading is practised so as to be able to comprehend passages of both general and specific interests. The length of the passage is about 200-300 words. Basic sentence structures and vocabulary are required as foundation of the students'reading and writing skills. The study includes listening and speaking skill practised in the language laboratory'.
(Department of Language and Social Science, 1999:1)

The compulsory language courses at King Mongkut's Institute of Technology, North Bangkok (KMITNB) are Foundation English I and II, which are designed to enable the students to develop the four skills in an integrated way. The time allocated is 4 periods of 60 minutes a week. The reading section in these courses concentrates on English for academic purposes. The objectives of the reading section are to enable students to read and

understand technical and scientific texts, and to transfer and apply information contained in the texts in order to write at paragraph level. According to the researcher's analysis, the traditional English teaching method relies on the bottom up model of reading and schema theory (see Chapter II), i.e. starting with vocabulary teaching, and declarative knowledge of the text to be read. The materials include textbooks, handouts, audio and video cassettes, developed by the staff of the Department of Language and Social Sciences. The course assessment includes 30% class-work, 30% midterm test, and 40% final test. The test is divided into three parts, language use, reading comprehension and writing. All students have to pass these two courses to finish their undergraduate degree.

The department staff consists of 14 lecturers of Social Sciences and 21 lecturers of English language of whose 5 are native speakers of English. About 90% of the lecturers hold a master's degree in their field of speciality, applied linguistics or English teaching.

With the advent of modern technology, English is not only a tool for study but also a means to benefit from the communication technology available in the Information Technology Age. It is agreed that studying English in class alone is not sufficient. The Department of Language and Social Sciences is now well equipped to offer the students a language laboratory, the language centre which is well appointed with a collection of English journals, audio tapes and video cassettes. The Institute's Resource Centre also provides up-to-date texts, tapes and equipment for language studies.

Apart from the two compulsory English courses mentioned above, the department provides students with upper courses such as Study skills in English, Academic Reading, Academic Writing, Technical English I, and II, English Conversation, Public Speaking, Business Correspondence, English at Work, and English for Internet (Department of Language and Social Science: 1999).

1.3 Presentation of the study

1.3.1 Rationale and background for this study

Reading in English is important without a doubt in the world of globalisation today, and already plays a vital role in almost all sectors in Thailand. Reading in English is an especially indispensable skill for scientists since a great number of science related research and papers are written mainly in English. Baldauf and Jermudd have found that in chemistry, biology, medicine, physics and mathematics more than 65% of all international journals are now in English (quoted by Johns and Dudley-Evans, 1993:2). Undergraduate science students at KMITNB are no exception. They will become scientists and in order to operate effectively in the academic world, science students must read English. The aim of any English reading course should be to equip students with the particular strategies that will enable them to continue to develop as mature, independent readers long after they have finished the course.

Reading in general is already a complex process, and foreign language reading adds an additional level of complexity to this already complicated process (Cotterall,1990). It involves a variety of factors, which could have an impact on learners' target language reading ability. Some of these factors have been suggested to include learners' lack of target language proficiency and vocabulary (Dubin & Bycina, 1991; Kasper, 1993; Koda, 1989; Pary, 1991), their unfamiliarity with the content and/or formal schemata of the texts to be read (Carrell, 1984; Carrell & Floyd, 1987) and their inefficient reading strategies caused by a lack of metacognitive awareness (Barnett, 1988; Carrell, 1989).

As already indicated in the introduction, Thai students still have problems in their scientific reading in spite of several years of English learning. According to the study by Tangsiengsom (1990:2) science students in Thailand have difficulty in comprehending scientific texts. First, they concentrate more on vocabulary, they waste their time by consulting the dictionary and in the end they miss the gist. Second their fear impedes their success in reading. They are afraid of reading scientific papers in English because they often think that they cannot read nor understand them. This point of view is supported by Hosenfeld (1977:10) who states that unsuccessful readers have a negative self-concept as readers. Informal interviews with instructors and undergraduate science students at KMITNB, conducted during the pilot study for this project, also confirmed that these students experience great difficulty while they are reading. The first reading obstacles reported had to do with the complexity of vocabulary and frequency of technical terms in scientific texts. This is in line with Dubin and Bycina (1991:217), who claim that vocabulary knowledge is an important feature of reading ability. Second, the interviews showed that many scientific textbooks and papers are felt to be incoherent, and over complicated and, therefore, students cannot understand them. This idea is also supported by Anderson and Armbruster (1984:659), who claim that a great number of textbooks are obscure and incoherent. Third, the results of these pilot interviews showed that students sometimes understand almost every word; however, they cannot comprehend the most important ideas. This finding is also consistent with Drobnic's statements (1985:119) that science students often understand the vocabulary but cannot comprehend the overall concept underlying what they read. Consequently, these problems delay progress in reading. Fourthly, the results of the interviews show that the subjects need background knowledge in order to comprehend the texts. Pearson and Fielding (1994:11) suggest that background knowledge plays a significant role in text comprehension, that is to say, while

reading students need to be familiar with the concepts or schemata underlying the text. Students can tolerate a lot of new vocabulary if they have background knowledge. And finally, the interview findings suggest that one of the most likely barriers to Thai students' comprehension may be attributed to a lack of self awareness in reading strategies.

The problems stated above indicate students' belief that the difficulties in reading are mainly the results of problems in vocabulary, grammatical structure and text organisation, ie. they believe they have language problems even though they have studied English for 9-12 years before entering the university. This is not surprising, as according to the researcher's analysis, the traditional English teaching method, which will be explained more in section 3.1.5, relies on bottom up model and schema theory. The presentation of grammatical structures and vocabulary are essential for English reading teaching as well as the preparation of the procedural knowledge of the text. Thus, the students concentrate more on the language itself rather than other components of the reading process. The interview also showed that most of the students were not aware of using reading strategies. In order to comprehend the English texts students rely heavily on using a dictionary or asking their teachers. However, they say they sometimes guess meaning from the context and use knowledge of word formation to help them in guessing unknown words. Some evidence has suggested, however, that language proficiency alone does not determine the level of reading proficiency (Cummins,1979,1991).

Due to the situation described above, it would be worthwhile to find an alternative model to teach English reading. Kern (1989) points out that L2 readers tend to be more linguistically bound to the text than L1 readers. That is, they are most attentive to the surface structure of the language. They are often not able to allocate sufficient cognitive resources to carry out higher level interpretive processes effectively, which results in ineffective reading. 'If cognitive resources could be released from surface level processes

such as word recognition, more mental energy could be made available for meaning processing'(p.136). By providing L2 readers with activities designed to activate their metacognitive awareness, lower level processing skills might be automatised to a greater degree and cognitive resources might be used more effectively. Moreover, the explicit taught strategies would likely be those already effectively used by readers in L1. Training, therefore, involves bringing these already possessed strategies into conscious awareness so they might be used in an L2 context.

Moreover, research on learning strategies (Rubin, 1975; Naiman, et al., 1978; Oxford, 1990; Nyikos, 1991) has shown that the most effective learners are the ones who are aware of learning strategies. Therefore, it was hoped that activating the Thai students' metacognitive awareness through explicit strategy instruction would help them develop their reading skill and result in improvement in overall reading proficiency.

1.3.2 Aim of research and research questions

1.3.2.1 Aim of the research

The aim of this study is to find a more effective approach to teaching reading comprehension which will enable students to better understand texts on their own. This is done by investigating the effects of explicit strategy instruction on the reading comprehension performance of EFL students in the faculty of science at King Mongkut's Institute of Technology North Bangkok (KMITNB), Thailand. The study will, first, explore the relative effectiveness of two approaches to teaching reading comprehension – explicit strategy instruction, and traditional English reading instruction. Secondly, the study aims to investigate the reading strategies employed by the first year science students when reading English texts. In addition, this study also investigates whether strategies taught in class can be transferred to the extensive, out-of-class reading process.

1.3.2.2 Research questions

The research questions addressed in this study are as follows:

1. Is there any reading ability improvement after applying the two approaches: the traditional reading teaching approach, and explicit strategy instruction?
2. Is there any significant difference in the level of reading ability of the students resulting from the two approaches?
3. What reading strategies do the Thai students apply in order to understand English texts?
4. Do readers transfer learned strategies to their extensive reading processes?
5. Is there any significant difference in strategy use between students taught using the traditional and experimental approaches?
6. Is there any relationship between reported patterns of strategy use and students' scores on reading comprehension tests?

1.3.3 Significance of the study

The study is based on classroom instruction which explores the effects of strategy instruction. It is hoped that the result of the experimental study will contribute towards solving the problems of teaching reading comprehension to Thai students, and will also be likely to be relevant to other similar groups of learners. It will be also develop our understanding of the way Thai students manage their reading strategies when working with English texts, and how these strategies are related to reading comprehension, thus making a more general contribution to the theory of second language reading.

1.3.4 Scope and limitations of the study

The data for this study were collected from the first week of June, 1999 until the second week of September, 1999 (the first semester of the Thai academic year). This study confines itself to students in the first year of their B.Sc. degree course at KMITNB, Thailand. It focuses first on the effects of two approaches to teaching reading comprehension - explicit strategy instruction and traditional English reading instruction. Then, secondly, it provides a case study of reading strategies used by first year Thai science students when reading English texts. Since the study is limited to this particular learner group and to the comparison of two approaches taught by a single teacher-researcher over one semester, generalisations can be made only with populations who come from a similar background.

1.4 Conclusion

Chapter I has introduced the general background to the study including the importance of L2 reading and the different reading problems which second language readers encounter. Some general information about Thailand and its educational system was given to enable the readers to understand more about the setting where this research was conducted. Chapter I also reviewed briefly the purpose of the study, introduced the proposed research questions, and outlined the scope and limitations of the study. Details of the theoretical framework and a review of related research are presented in Chapter II. In Chapter III, a full overview is given of the research design and procedures.

Chapter II

Review of Literature and Related Research

In Chapter I, a broad introduction to the research has been given, which explained its rationale, objectives, research questions, assumptions, and limitations. This chapter will review related literature to give the theoretical background of the study, and will include six major sections. The first part of the review of literature aims at presenting some current reading models and how they are applied to reading teaching. The second part focuses on foreign language reading, its similarities and differences from first language reading. This part also includes consideration of the question of whether foreign language reading is a language problem or a reading problem. The third part will discuss metacognitive knowledge, and how it links to general language learning strategy studies as well as to studies of reading strategies. The fourth part discusses language learning strategies, research in this area and its application to this research. Section five explores a selection of research studies on reading strategies which have influenced on the design, research tools and the analysis of this research study. Section six explores the frameworks of strategy instruction, followed by a brief conclusion of the chapter.

2.1 Types of reading models

Reading is an important source of target language experience in countries such as Thailand where English is taught as a foreign language. In EFL learning, learners are unlikely to be exposed regularly to the target language in authentic face to face situations. Reading is the skill to which most learners are most exposed. As already stated in Chapter I, the aim of this study is to find a more effective approach to teaching reading which will

help solve the English reading problems of Thai students. It is important for language teachers to understand the nature of reading as stated by Alderson (2000): 'how can we possibly diagnose somebody's reading problem if we have no idea what might constitute a problem and what the possible cause might be?' (p.2). Several researchers (Devine, 1981; Connor, 1984; Kern, 1989) have concluded that first and second/ foreign language reading processes resemble each other.

Moreover, many of the major issues in reading addressed by first language reading models are equally central to the second language reading process (Barnett, 1989:11). First language reading professionals explore the reading process and propose a variety of theories, which influence reading teaching approaches. In order to understand more about the nature of second language reading, three of the most frequently referred to reading models and a main variable that affects the nature of reading will be discussed.

2.1.1 Bottom-up models of the reading process

Early assumptions about the reading process stated 1) that identification of individual letters is a necessary preliminary to word identification and 2) that identification of words is a prerequisite for comprehension. The two assumptions are frequently combined in the premise that reading involves transforming visual into spoken language. Venezky (1967) stated that ' Learning to read requires primarily the translation from written symbols to sound, a procedure which is the basis of the reading process' (Venezky, 1967:102). Also Reid (1993) stated ' The heart of the matter is surely the process of decoding the written symbols to speech' (p.139). Such a proposition is also made by Carver (1984) who suggested a close relationship between reading and listening abilities. Carver presents what he calls a theory of reading comprehension and rauding. The term rauding links reading and listening comprehension (audio) and refers to 'those frequently occurring

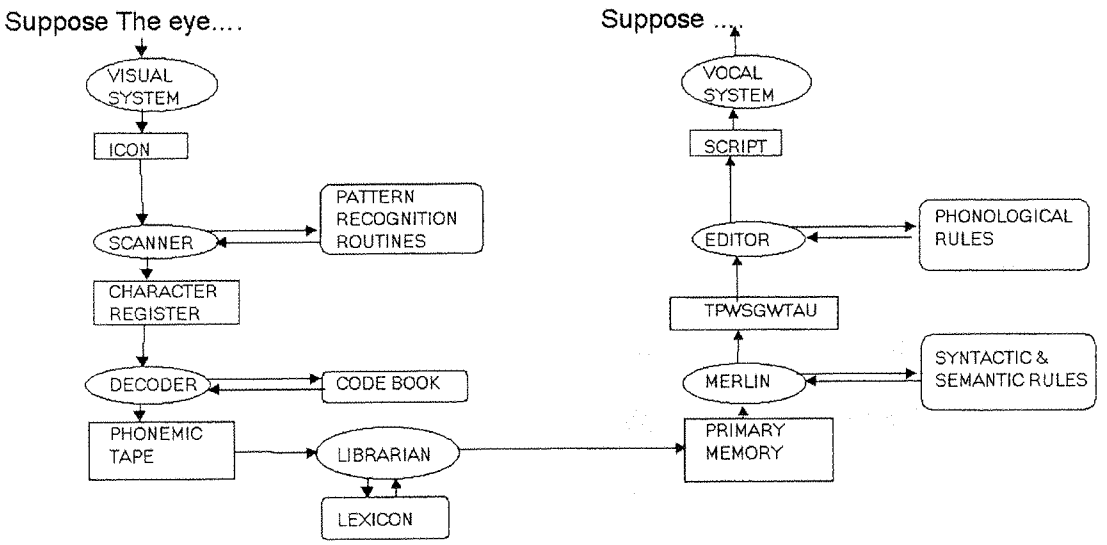
language comprehension situations where most of the thoughts being presented in the form of sentences are being comprehended as they are being presented' (Carver, 1984: 206). For Carver, the sentence is the basic unit for expression of the thoughts of writers and speakers. Carver hypothesises that external articulation aids comprehension, and he thus attributes a major role to phonological encoding.

It follows that children must know the alphabetic writing principle to become independent readers. Lee and Gupta (1995: 271) define the alphabetic system as rules which relate letters or groups of letters to sounds. These are called grapheme-phoneme correspondence rules (GPC rules) because they state the relations between small units of written language (graphemes) and small units of spoken language (phonemes). However, an alphabetical system can be very difficult for beginning readers. In Thai for example there are 66 writing characters, which include 44 consonants, 22 vowels, and 5 tones. It is difficult for a beginning reader to analyse words into phonemes. Thus, most children begin to read words as visual patterns - they may recognise individual letters, but do not use the letter-sound mappings to help them. They rely on salient visual features of the word. However, such strategies soon become unreliable as the number of words they try to learn increases (Lee and Gupta, 1995: 271-272).

In the bottom-up processing model, readers comprehend the printed material by recognition of words and are controlled by textual input. This is a data-driven or text-based process. Readers begin with the written text (the bottom) and construct meaning by first identifying the letters, combining them to identify words, then combining the words to form the phrases, clauses and sentences of the text (Dubin & Eskey, 1986:11). From a bottom-up processing perspective, the meaning of the data must be obtained from the text before higher cognitive levels of understanding can occur (Barnett, 1989:13). For

example, Gough's model presented in Figure 2.1 shows how a reader processes text from the first moment of looking at the written words until the meaning is derived.

Figure 2.1: A bottom-up model of reading (Gough, 1985: 674)



Gough sees the process of reading as a decoding process. Reading begins with an eye fixation until the time when meaning is derived from the words. According to this model, readers read letter by letter from left to right. While they are reading, the letters must make sense in the mental lexicon that is stored in the human brain. After this, sounds of letters and word representations are identified respectively. Then, when the contents of primary memory (first step) are understood, the sentence goes into what he calls PWSGWTAU (the Place Where Sentences Go When They Are Understood). After this, the accessing of memory for meaning can occur (Gough, 1985: 662-675). Gough hypothesises that the reader's fixation on the text leads to the formation of an icon. An icon is ' a relatively direct representation of a visual stimulus' (Gough, 1985: 662). Supposing that this icon takes in about 15 to 20 letters and spaces; Gough suggests that it will become legible in

about 100 milliseconds, allowing the reader to recognise the lines, curves, and angles as the familiar patterns of letters. The reader then creates a new icon from the next fixation. Clearly, Gough's primary focus is on the letter and word level of the text.

Like Gough, La Berge and Samuels (1985: 689-719) assume that the reader's understanding depends on what appears in the text and that the reader performs two tasks when reading: decoding and comprehending. Decoding is going from the printed word to some articulatory or phonological representation of the printed stimulus. Comprehending is deriving meaning from the decoded material. However, La Berge and Samuels take the readers into account more than Gough. In their theory of automaticity they say that as letters and words become familiar, less attention will be needed to process them, and reading will become more fluent (La Berge and Samuels, 1985: 690-691).

The reading teaching approach influenced by this model is a skill development view using basal readers (Cox and Zarrillo, 1993). It is this view of reading that has dominated instruction in Thai schools for decades (Phoonsiri, 1998:17). In this view, reading is seen as a series of discrete skills, and reading instruction is designed to help children develop these skills. These skills are grouped under such categories as readiness, word recognition, and word meaning. Each of these is broken into categories and subcategories, so that learning to read involves extensive practice of long inventories of isolated skills and sub-skills.

The reading instruction emphasis is on letters, sounds, parts of words, and words. Students spend time doing worksheets and exercises to learn vowels, consonants, prefixes and suffixes. Adherents of a bottom-up explanation of the reading process believe that readers must use letter-sound clues and decipher each word in order to read. Reading competency is measured in terms of mastering skills. It is believed that this constellation of individual skills will come together to produce competent readers.

Most teachers operating from a skill-development view of reading instruction use basal readers and materials that accompany them to teach these skills. According to Tompkins (1997), basal readers are judged based on students' achievement on standardized tests. The teachers also feel secure using the step-by-step instruction provided by the teacher's manuals. The stories used in basal readers are developed around the hierarchy of skills and contain a tightly controlled vocabulary. Many stories are excerpts from children's literature which have been rewritten for simpler and more decodable reading.

2.1.2 Top-down models of the reading process

In contrast to bottom-up models, top-down models view reading as a process which moves from the top, the higher-level mental stages, down to the text itself. In fact, in these models, the reading is driven by the reader's mind at work on the text. The reader uses general knowledge of the world or of particular text components to guess about what might come next in the text. Smith (1973) made an argument against the idea of decoding theory. He defines reading as 'a psycholinguistic process by which the reader (a language user) reconstructs, as best as he can, a message which has been encoded by a writer as a graphic display' (Smith, 1973: 22). He emphasises two important contributions of this psycholinguistic view of reading. First there is a limit to the amount of information that we are able to receive, process, and remember. The reader, therefore, does not use all the information on the page but rather must select the most productive language cues in determining the message of the writer. Reading is necessarily a rapid process, which could not proceed word by word. Second, reading is only accidentally visual (p. 48). More information is contributed by the reader than by the print on the text. That is, readers

understand what they read because they are able to take the stimulus beyond its graphic presentation.

Smith states that there are three sets of cues in the reading process: graphophonemic, syntactic, and semantic (Smith, 1973: 25). The starting points are graphic sequences, and readers may utilise the correspondences between the graphic and phonological systems. The reader uses pattern markers such as function words and inflectional suffixes to recognise and predict structure. Smith (1973) emphasises the role of meaning and of the reader's need to predict when reading: 'Reading is less a matter of extracting sound from print than of bringing meaning to print' (Smith, 1973: 2). He cites four characteristics of reading: 1) Reading is purposeful: people read for specific reasons or with specific goals. 2) Reading is selective. 3) Reading is based on comprehension: the reader brings along certain prior knowledge to a text and adds to it. 4) Reading is anticipatory: the interaction of this prior knowledge, the expectation of comprehension and the purpose of reading leads readers to anticipate the text content (Smith, 1973: 20-24).

All of these views emphasise that reading is meaning-seeking, tentative, selective and constructive. They all emphasise the importance of inference and prediction in reading. Readers use the least amount of available text information necessary in relation to their existing linguistic and conceptual schemata to get to meaning (Goodman, 1985:827).

Goodman and Niles (1974:15) also define reading as an interaction between reader and written language, through which the reader attempts to reconstruct a message from the writer. 'Reading is a receptive language process. It is a psycholinguistic process in that it starts with a linguistic surface representation encoded by a writer and ends with meaning, which the reader constructs. There is thus an essential interaction between language and thought in reading. The writer encoded thought as language and the reader decodes language to thought' (Goodman, 1992: 12). This model agrees that readers use their

knowledge of syntax and semantics to reduce their dependence on the print and phonics of the text and specifies four processes in reading: predicting, sampling, confirming and correcting. First, readers make predictions about the grammatical structure in a text, using their knowledge of the language and supplying semantic concepts to get meaning from the structure. Then, they sample the print to confirm their predictions. They neither see nor need to see every letter or word. After sampling, they confirm the guesses or correct themselves if what they see does not make sense (Goodman, 1985: 833-834). Goodman views a proficient reader as both efficient and effective. A proficient reader is effective in constructing a meaning that he can assimilate and is efficient in using the least amount of effort to achieve effectiveness. Clearly, Goodman and Smith give the reader a central role in understanding the text.

Based on the psycholinguistic models of Goodman and Smith, Coady (1979) has developed a model of efficient ESL reading. According to Coady, efficient reading depends on the successful interaction among three factors: higher level conceptual abilities, background knowledge, and process strategies (Coady, 1979: 6-7). Conceptual abilities refer to intellectual capacities such as the ability to analyse, synthesise and infer. Background knowledge includes content knowledge and social cultural knowledge. Process strategies refer to constructing the meaning of the text through sampling based on the knowledge of grapheme-morphophoneme information, syntactic information, lexical meaning, contextual meaning and cognitive strategies (Coady, 1979: 7-8).

The most important thing about psycholinguistic theory is that it redirects reading instruction (Cox and Zarrillo, 1993). Rather than focusing on the teacher's behaviours during reading lessons, psycholinguists place the emphasis on learners. The learners must read in order to learn to read. The materials they read must have meaning: poetry, rhymes, songs, and most importantly storybooks.

Ideas from cognitive psychology and psycholinguistic theory underpin the 'whole language' view of reading instruction. Goodman (1985, 1992), Smith (1992, 1994), and other advocates of the whole language philosophy, such as Newman (1985) and Watson (1992), suggest that students be taught to read and write in a more integrated, holistic fashion. The whole language philosophy is based on the assumption that reading is a process of unlocking meaning, not one of decoding symbols into sounds. Language should be emphasized as a 'whole', rather than how it is put together. Reading should begin with meaning and a close interrelationship of language components, rather than with word recognition and accumulations of discrete skills. According to Smith (1994), phonics teaching amounts to the memorisation of nonsense. It breaks naturally spoken language into abstract bits. The result of phonics instruction is that students are often able to sound out words, but do not necessarily understand them (Goodman, 1992). Goodman (1985) states that teachers should put aside basal readers and isolated phonics instruction and encourage students to read literature for information, for enjoyment, and to cope with the world around them. Reading instruction should be informal, natural, and controlled by the needs and motives of the learners.

2.1.3 Interactive models of the reading process

However, neither the bottom-up nor the top-down approach is now thought to be an adequate characterisation of the reading process. A more adequate model is known as the interactive model, in which every component in the reading process can interact with any other components. Processing, in fact, is now thought to be parallel rather than serial (Grabe, 1991: 384). Stanovich (1980) has developed an interactive compensatory model in which the degree of interaction among components depends upon knowledge deficits in individual components, where interaction occurs to compensate for deficits. Thus, for

example, readers with poor word recognition skills may use top-down knowledge to compensate.

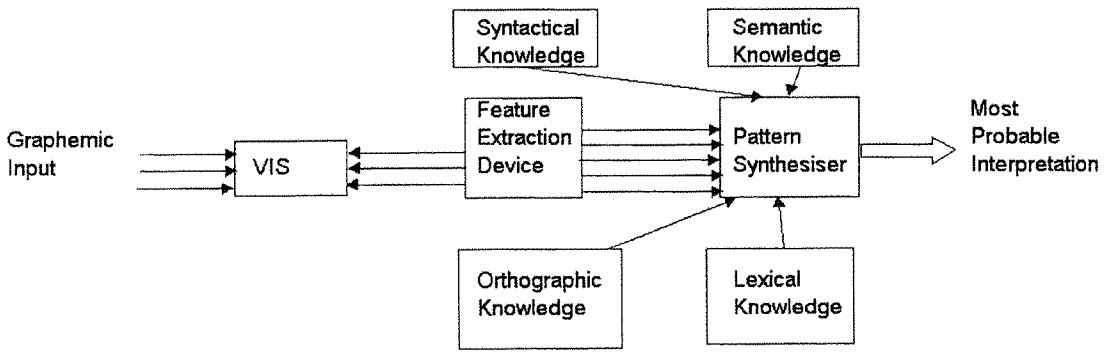
Van Dijk and Kintsch (1983) and Taylor (1983) offer more developed menus of reading as an interactive process. They state that reading involves the use of different levels of internal information as well as various types of information, all interacting simultaneously to allow optional interpretation. The reader relies on perceptual processing, phonemic processing, and internal recall of many types (syntactic knowledge, lexical knowledge, story grammars, descriptive scripts, schematic arrangement and connecting of related sets of information, intentions of the text and of the reader, affective mechanisms, etc).

Such interactive models incorporate both top-down and bottom-up reading processes. As readers read texts, they construct meaning based on both word processing and higher level processing. Rumelhart, one of the first to argue against the linear processing of bottom-up models, suggests that:

'Reading is the process of understanding written language. It begins with a flutter of patterns on the retina and ends (when successful) with a definite idea about the author's intended message. Thus, reading is at once a 'perceptual' and a 'cognitive' process' (Rumelhart, 1985: 722).

Citing several empirical studies, Rumelhart demonstrates the combined influence of syntactic, semantic, lexical and orthographic information on the reader's perception of print. Rumelhart's model emphasises the possibility of many different types and directions of reading processing, depending on text, context and available information sources. This is presented in Figure 2.2.

Figure 2.2: A representation of an interactive model of reading (Rumelhart, 1985: 722)



According to Rumelhart, the reader looks at the words and spellings that are registered in a visual information store (vis). The feature extraction device pulls out the critical features of these words and moves them to the pattern synthesiser. The pattern synthesiser is where all the reader's previous knowledge about language is located: spelling patterns, syntax, vocabulary, and semantics. 'Thus all of the various sources of knowledge, both sensory and non-sensory, come together at one place and the reading process is the product of the simultaneous joint application of all the knowledge sources' (Rumelhart, 1977: 588).

According to the interactive model, as readers read text, they construct meaning based on word processing and higher level processing. Thus the boosting of metacognition and development of reading strategies are important instructional goals to aid the readers in developing conscious control of the reading process (Ruddell and Speaker, 1985). The structure of the reader environment is vital to this end. Instructional emphasis should be placed on careful selection of activities with attention to strategies leading to effective text processing. The learner must know what to expect and how to successfully apply declarative and procedural knowledge in the construction of the text representation. The teacher should use a wide variety of instructional activities which demonstrate strategies

for efficient reading and assist the learner in incorporating these strategies into declarative and procedural knowledge.

The learner should be actively involved in the processing of text. This involvement should include setting goals and expectations for content, time and product. Attention must be given to the development of cognitive strategies to assist in the elaboration of information and metacognitive strategies for evaluating the fit between goal and text representation. The learner must develop the awareness that both language and world knowledge are necessary for the understanding of text and that peers, teacher and other texts can be used as information sources when difficulty is encountered. The boosting of affect, and the development of cognitive and metacognitive strategies are important instructional goals which foster a learner who pays greater attention, has greater perseverance and interacts with text, teacher and peers (Ruddell and Speaker, 1985).

2.1.4 Schema theory

Research on reading has looked at the way readers themselves affect the reading process and product, and has investigated a number of different variables. The influence of interactive, reader-driven models theory has thrown a spotlight on schema theory as a significant field of reading research. Rumelhart (1980:34) explained schema theory as follows:

'A schema theory is basically a theory about knowledge. It is a theory about how knowledge is represented and about how that representation facilitates the use of the knowledge in particular ways. According to schema theories, all knowledge is packaged into units. These units are the schemata. Embedded in these packages of knowledge is, in addition to the knowledge itself, information about how this knowledge is to be used.'

In reading research, schema theory has had two effects focusing attention on a) the constructive nature of comprehension and b) the crucial role of the reader's prior knowledge in that construction.

According to Anderson & Pearson (1984:255) schemata are readers' existing concepts about the world, knowledge already stored in memory. They constitute the framework into which the reader must fit what she or he understands from the text. If new textual information does not make sense in terms of a reader's schemata, the material is comprehended in a different way or ignored, or the schemata are modified to match the new facts.

'Schemata truly are the building blocks of cognition. They are the fundamental elements upon which all information processing depends. Schemata are employed in the process of interpreting sensory data (both linguistic and non-linguistic), in retrieving information from memory, in organising actions, in determining goals and sub-goals, in allocating reasons, and generally, in guiding the flow of processing in the system' Anderson & Pearson (1984:255).

Carrell (1983) distinguishes different types of schemata into formal schemata and content schemata. By the former, she means knowledge of language and linguistic conventions, including knowledge of how texts are organised, and what the main features of particular genres are. By the latter, she means essentially, knowledge of the world, including the subject matter of the text.

Reading researchers have long been interested in exploring content schemata. A study by Rumelhart (1980) showed clearly that readers need knowledge about the content of the passage to be able to understand it. The background-knowledge effect is very strong. It has been shown that even across passages on the same general theme, which had identical structure and syntax and very similar vocabulary, the more familiar version was better recalled (Bransford ,1979). Content schemata include knowledge of the world which is contained in a text. This is essential to comprehension as shown in the classic example'The policeman held up his hand and the car stopped' (Rumelhart, 1985: 267). It is not difficult to understand this sentence, because readers automatically employ world knowledge schemata to comprehend it.

Rumelhart (1980) listed major features of schemata as follows:

1. Schemata have variables.
2. Schemata can embed, one within another.
3. Schemata represent knowledge at all level of abstraction.
4. Schemata represent knowledge rather than definition.
5. Schemata are active processes.
6. Schemata are recognition devices where processing is aimed at the evaluation of their goodness of fit to the data being processed.

Rumelhart (1980:40-41)

Classroom practices that facilitate the restructuring of readers' ideas generally call for:

a)creating a situation that requires the students to invoke their preconceptions; b) encouraging students to state their preconception clearly; c) encouraging confrontation, bringing out in discussion the difference between the different points of view; d) creating a conflict between exposed preconceptions and some situations that the preconceptions cannot explain; and e) supporting the students' search for resolution. (McNeil, 1984:79-81)

The reading models reviewed above vary according to their emphasis which may either be placed on text-based variables or reader-based variables. The knowledge that a reader brings to a text, both language knowledge (formal schemata) and world knowledge or background knowledge (content schemata), play an important role in the comprehension process. Top-down approaches emphasise the importance of these schemata and the readers' contribution, over the text. However, interactive models also take adequate account of both formal and content schemata, while integrating bottom-up information.

These models have been developed as theories of first language reading. However, second language reading specialists often refer to these models when attempting to explain how second language readers read. The first and second language reading processes are both similar and different. With reference to these models, Barnett (1989: 34-35) suggests some basic differences between first and second language readers. First, unlike first language readers, second or foreign language readers may not have a fully developed phonological system when they begin to read. Second, while beginning first language

readers are normally young children, foreign language learners are often adolescent or adult learners already literate in one language. Most foreign and second language readers have relatively highly developed first language reading skills. Third, both linguistic knowledge such as vocabulary and syntactic knowledge, and rhetorical schemata play an important role in comprehending. But for the L2 reader both linguistic and rhetorical schemata are also still developing.

When considering L2 reading, therefore, the interactive model still seems to be the most viable one, recognising the complexity of the reading process and taking into account both reader and text characteristics and variables. Although we have no complete explanation of how second language readers comprehend, we know a great deal. The reader who is an active participant in written communication, who seeks meaning purposefully and reconstructs text as they read, has become a part of second language reading theory. An emphasis on using strategies for comprehending has become central to second language reading pedagogy (Barnett,1989:33). The key differences between first and second language reading are further considered in the next section.

2.2 Is reading in a foreign language a language problem or a reading problem?

Frequently, students reading in a second foreign language seem to read with less understanding and read considerably more slowly than they reportedly read in their first language. Results of research also support this view. Macnamara (1970) found that the Irish-English bilingual students he studied were reading in their weaker language (in this case, Irish) at a slower rate and with lower comprehension than in their first language. Besides taking considerably longer to read in their second language, students who

understood the words and structures of the texts under study (their understanding of the words and structures was tested separately) were still unable to understand what they read in the second language as well as in their first language. In a further study reported in the same paper, this time with French- English bilinguals, Macnamara found certain differences between reading in the native language and reading in a second language, ' in the rate at which individual words are interpreted, in the rate at which syntactic structures are interpreted, and in ability to anticipate the sequences of words' (p.114). There would appear to be some conflict between the results of the two studies. On the one hand, subjects have some difficulties understanding L2 text despite knowing L2 words and structures, and on the other hand, the interpretation of words and syntactic structures - that is grammar and vocabulary - seems to be the main factor in poorer L2 reading performance. The problem seems to be whether reading in a foreign language is 'simply' a problem of knowing the words and the grammar of the language, or whether there are other causes of the difficulties learners experience. Clarifying this question is necessary, when planning an interventing to improve learners' L2 reading ability.

2.2.1 L2 proficiency determines L2 reading ability

Alderson, Bastien and Madrazo (1977) provide evidence which suggests that a student's knowledge of the foreign language is more important to comprehension than is reading ability in the first language. Mexican university students were tested for their English proficiency and their reading performance in both English and Spanish. To control for knowledge of subject matter, and to reduce the effect of the text variable, students were given texts in their area of study, business administration, in English and translated into Spanish. The correlation between reading performance in English and reading in Spanish was significant but only moderately (rho=0.56). A higher correlation was found between

English language proficiency and reading comprehension in English (rho = 0.67). The study concluded that the best predictor of reading ability in a foreign language was not reading ability in the mother tongue, but rather proficiency in the foreign language.

A study by Aron (1978) also suggests that there is little relation between reading ability in the first language and that in the foreign language. Aron compared Spanish speaking EFL students' reading ability on two reading tests. Proficiency in English as a foreign language was not measured. Both reading tests contained questions aimed at testing three skill areas: recalling details, understanding a main idea, and making inferences. Low correlations were found between performance in the two languages, suggesting a lack of relationship between abilities in the first language and abilities in the foreign language.

Chihara, Oller, Weaver, and Chavez (1977) compared native speakers of English and Japanese learners of EFL on their ability to handle sequential prose and scrambled prose. They found that the difference between scores for scrambled and sequential prose increased as subjects became more proficient in English. This is interpreted by the authors to mean that as learners become more proficient in the foreign language they are more able to utilise context constraints.

Cooper (1986) examined the problem of non-native readers of English at tertiary level, where all subject textbooks are written in English. Two types of readers were considered. The first type had experienced a large part of their previous education through the medium of English. They were called practised readers. The second type had experienced their previous education through the medium of their first language (Malay), and studied English as a foreign language. They were called unpractised readers. A comprehension test and a test of linguistic competence were administered to both groups. The results show that scores for linguistic competence correlated highly with scores for general comprehension. They also show that unpractised readers were severely

disadvantaged by their poor knowledge of vocabulary and semantic relationships between words. Unpractised readers displayed weaknesses in all other main areas, especially in syntactic features.

Yorio (1971) also supports this point of view. He claims that the reading problems of foreign language learners are due to imperfect knowledge of the language, and to native language interference in the reading process. In Yorio's view, reading involves four factors: knowledge of the language, ability to predict or guess in order to make correct choices, ability to remember previous cues, and ability to make the necessary associations between the different cues that have been selected. According to Yorio, the process is made more complex for the foreign learners because of several elements. The reader's knowledge of the foreign language is not like that of the native speaker in that: the guessing or predicting ability necessary to pick up the correct cues is hindered by imperfect knowledge of the language; the wrong choice of cues or the uncertainty of choices makes associations more difficult; due to unfamiliarity with the material and lack of training, the memory span in a foreign language in the early stages of its acquisition is usually shorter than in the native language. Recollection of previous cues then is more difficult in a foreign language than in the mother tongue; and at all levels, and at all times, there is interference from the native language (p.108).

Cziko (1978) identified three types of contextual constraint: syntactic, semantic, and discourse (p.473). Cziko compared the abilities to use such constraints of native speakers of French and of learners of French at various levels of proficiency. He found that although even beginners and intermediate learners were able to make use of syntactic constraints when reading French, only the advanced foreign language readers and the native speakers were able to make use of semantic constraints. In addition, intermediate students were not aided in their performance on a cloze task by the 'additional discourse

constraints present in normal prose' (p.483). Cziko suggests that a relatively high level of competence in a language is a prerequisite to the ability to use discourse constraints as a source of information in reading (p.484); he was not able to find differences between advanced foreign language readers and native readers in ability to use discourse or other constraints. In addition, it seemed that students of a foreign language at a low level of competence were not able to use their good first-language reading strategies, one of which would involve the ability to utilise contextual constraints.

In a later study, Cziko (1980) employed oral reading analysis to indicate that processing strategies change and evolve with increases in proficiency. The subjects were English speaking students with intermediate and advanced competence in French as a second language and native speakers of French. The findings were:

1. Intermediate students made a significantly higher proportion of deletion and insertion errors than did the advanced and native speaker students.
2. Advanced learners made a significantly higher proportion of substitution errors that graphically resembled the text than did the native speakers.
3. The intermediate students made a significantly higher proportion of errors that did not conform to the syntactic or discourse constraints of the text than did the advanced and native students.

When reading in English, the good readers were superior to the poor readers in that they were able to produce more acceptable cloze responses. Yet when confronted with difficult blanks, the good readers appeared to be little better than the poor readers in producing high quality guesses (p.113). Cziko contends that second or foreign language reading ability is related to readers'target language proficiency.

Probably the relevant research most commonly quoted is Clarke's 1980 study which generated the so-called short circuit hypothesis. Analysing 21 ESL students'

miscues and their answers on a rational deletion cloze test, Clark finds some justification for the view that the reading process is universal but also evidence of a language competence ceiling hampering the good first language readers' attempts to use good reading strategies in second language: 'limited control over the language short circuits the good reader's system, causing him/her to revert to poor reader strategies when confronted with a difficult or confusing task in the second language'(p.206).

More recently, Bernhardt and Kamil (1995) have surveyed a number of studies and claim that first-language literacy is a strong predictor of L2 reading ability (upwards of 20% of variance was account for). But L2 linguistic knowledge is a consistently more powerful predictor, accounting for more than 30% of the variance. They conclude that the second language reading problem should be reformulated, not as an either/or question, but as a question of the interaction between the two knowledge sources.

The clear conclusion of the studies above is that second language is the most important factor in second language reading, at least up to a linguistic threshold, which must be crossed before first-language reading ability can be transfered to the second language reading context (Clarke,1980).

However, there is evidence from several research studies which support the hypothesis that poor foreign language reading is a reading problem, rather than solely a language problem, and this is presented in the next section.

2.2.2 Poor foreign language reading is a reading problem

Hudson (1982) believes that induced schemata (vocabulary or pictures relating to the text topic) can override language proficiency as a factor in comprehension. Hudson states that although good readers' performances in Clarke's and Cziko's studies were less successful when facing L2 reading tasks than L1 reading tasks, good readers still performed

significantly better than poor readers. Therefore, learners' L1 reading ability also has a significant impact on their reading. Poor L2 reading ability can be due to a lack of good L1 reading skills or a failure to transfer them.

Carrell (1991) was also motivated by the debate of Clarke (1980) and Cziko (1980) on L2 reading and hence conducted a study using two groups of subjects consisting of 45 ESL native speakers of Spanish (group 1) and 75 native speakers of English studying Spanish as a foreign language (group 2). Both groups were at varied proficiency levels in their second or foreign language. These two groups of subjects read texts in both English and Spanish.

The results of Carrell's study show that both L1 reading ability and L2 proficiency have significant effects on performance in L2 reading. However, Carrell states that what was interesting in this study was 'the relative importance of each of these factors from each of the two groups studied' (p.167). For the group of ESL Spanish speakers, L1 reading ability (Spanish) had greater impact than L2 proficiency (English) on L2 reading ability. The result, however, was different for the group of native speakers of English with Spanish as their foreign language. Foreign language proficiency (Spanish) affected second language reading ability more than did L1 reading ability (English).

The results of this study have several implications (Carrell, 1991). First, both L1 reading ability and L2 proficiency affect L2 reading. However, which of these two factors is more important could be related to other issues such as the target language setting (second language vs. foreign language), the directionality of language learning (English to Spanish vs. Spanish to English), and the target language proficiency levels.

As we have seen, Barnett (1989:34-36) pointed out two obvious differences between first language readers and second language readers. First, unlike first language readers, most second language readers do not have a fully developed phonological and

syntactical system of the target language when they begin to read it. Second, while beginning first language readers are normally young children, second language readers most often are adolescent or adult learners already literate in one language. Many second language readers generally have relatively highly developed first language vocabulary, syntactic knowledge, topical and rhetorical schemata, and varying first language reading strategies. The former difference causes problems for second language readers when reading target language texts, while the latter difference can be an advantage to second language readers. This view is shared by Coady (1979), who asserts that foreign language reading is a reading problem and not a language problem: 'We have only recently come to realise that many students have very poor reading habits to transfer from their first language, and then, in many cases, we must teach reading skills, which should have been in first language instruction' (Coady, 1979:12).

Barnett quotes evidence that even advanced foreign and second language readers use first language strategies when reading another language (Benedetto, 1984; Hauptman, 1979; Sarig, 1987). In her case study of 5 Hispanic advanced ESL learners, Benedetto claims that advanced linguistic development does not necessarily imply parallel development of higher-order reading strategies; in fact, linguistic factors are subordinate to the cognitive domain. Hauptman (1979) concludes that his 47 English-speaking French students use similar strategies in first and second language reading: the ability or inability to use global cues, the willingness or reluctance to take chances, and ease or difficulty in processing semantic information (summarised by Barnett, 1989). So researchers interested in the view that L2 reading is a reading problem have come to focus their attention on the transfer and use of reading strategies by L2 readers.

Sarig (1987) studied advanced learners of ESL: ten Hebrew speaking high school seniors who had formerly studied English for an average of eight years. Included in this

sample were subjects with low intermediate and high English proficiency levels, according to teachers' evaluations and an English test. Viewing reading as a problem- solving process, Sarig assigned two problem- solving tasks: main idea analysis and synthesis of overall message. After being trained to understand the tasks and to provide think- aloud and introspection data, the subjects read and reacted to texts in Hebrew and English. Analysing the data for reading strategies, Sarig discovered great similarity between first and second language reading. In particular, a high correlation existed between the type of move used in each language to perform each of the three stages in the tasks: 1) identification of main propositions; 2) identification of the one main proposition underlying the main text; 3) synthesis of the overall message. Sarig also categorised these moves according to how many readers used them and how frequently. This showed clearly the highly individual nature of reading; most readers used a unique combination of moves. Thus, readers used unique strategies in both L1 and L2. Sarig questioned the traditional concepts of good readers and poor readers; readers might use many good strategies but fail to comprehend sometimes because of only a few wrong moves. Overall, she found that L1 reading strategies appeared to transfer to second and foreign language reading.

In his descriptive study, Block (1986) had six ESL students (three native speakers of Spanish, three native speakers of Chinese) and three native speakers of American English, who reported what they understood and thought about while reading two English passages from a college textbook. From results of cloze tests in English and in their first language, the ESL students proved to have a level of reading proficiency similar to that of the American students. Block came to conclusions similar to those of Sarig, that strategy use was a stable phenomenon which was not tied to any specific language (p. 485), and that readers should be able to transfer their successful first language reading strategies.

Jimenez, Garcia, and Pearson (1996) also studied the effects of language and culture on reading strategies. The researchers examined the strategic reading processes of 8 bilingual Latina/o children who were identified as successful English readers. For comparative purposes, two smaller samples were included: 3 monolingual Anglo students who were successful English readers and 3 bilingual Latina/o students who were less successful English readers. The focus was on understanding the unique approach one reader used to create and monitor meaning across languages. All the students read the passages. For each of the passages, an accompanying prior knowledge task was developed. This task included an introductory statement which briefly described the passage topic and its genre. Four or five key vocabulary terms chosen from each passage were also included in the definition. Students were asked to predict as much as possible about what might happen. Data were gathered using both prompted and unprompted think-aloud, interview, a measure of prior knowledge and passage recall. Preliminary analysis resulted in the identification of 22 distinct strategies organised into three broad groups - text initiated, reader initiated, and interactive. Three strategies considered unique to the successful Latina/o readers were:

a) they actively transferred information across languages

b) they translated from one language to another

c) they openly accessed cognate vocabulary when they read.

The less successful Latina/o readers used fewer strategies, and were often less effective in resolving comprehension difficulties and less able to interpret the text. The data from the successful Anglo readers showed that they rarely used explicit strategies to monitor their comprehension. This was because they rarely encountered unknown words and they could access a well-developed network of relevant prior knowledge (p.91). The data showed that the Latina/o students who were successful English readers possessed

a qualitatively unique complex of strategic reading knowledge. The researchers suggested that teachers might benefit from an awareness of transfer which appeared in this case to compensate for lack of language proficiency.

It is clear from the above survey that there is a continuing argument whether problems in second language reading are caused by reading problems or target language problems. Both sides of the argument are supported by substantial research studies which influence reading instruction in second language. However, we agree with Bernhard and Kamil (1995) who concluded that the second language reading problem should be reformulated, not as an either/or question but as a question of the interaction between the two knowledge sources. Moreover there are clear indications in the literature that while L2 proficiency may be the biggest influence on the L2 reading skill of early learners, once a certain L2 proficiency level is reached, L1 skills become more important.

This study aimed at finding an alternative English reading approach to solve the English reading problems of Thai students as mentioned in Chapter I. The subjects in this study are first year undergraduate students who have learned English for 9-12 years. That is, they are adult learners who have already acquired substantial English knowledge and highly developed first language reading skills. Results from the research reviewed in this section on L1 transfer (Carrell,1991; Sarig,1987; Jimenez, et al.,1996) make the researcher believe that such learners might benefit from activating their awareness of reading strategies, that is, their matacognitive knowledge, which appears to have potential to compensate for limitations of language proficiency for learners at this level.

Furthermore, a great number of researchers in ESL/EFL reading have turned their attention to the area of comprehension monitoring, which previously achieved popularity in first language reading. These researchers, some of whom had a previous interest in schema theory, have called for more attention to comprehension monitoring strategies

(Block, 1986; Hosenfeld, 1977). As Brown, Armbruster and Baker (1986) have stated, 'metacognition plays a vital role in reading' (p. 49). It is, in particular, this area of metacognitive knowledge, which is examined in this study in order to develop more effective reading instruction for Thai undergraduate students.

2.3 Metacognition

Metacognition began to receive much attention from researchers around the1970s. Costa (1984) defines metacognition as:

'our ability to know what we know and what we don't know. It occurs in the cerebral cortex and is thought by some neurologists to be uniquely human. Metacognition is also our ability to plan a strategy for producing what information is needed, to be conscious of our own steps and strategies during the act of problem solving, and to reflect on and evaluate the productivity of our own thinking' (p. 57).

Wenden (1998) adds that in the FL/ SL literature, metacognitive knowledge is also referred to as learner beliefs, learner representations, and learners' naïve psychology of learning (p.516-517). According to Flavell (1979), metacognitive knowledge consists of three variables: person, tasks, and strategy, presented in Table 2.1.

Table 2.1: A taxonomy of metacognitive knowledge in language learning (Flavell, 1979)

<table>
<tr><td colspan="2">Person knowledge</td></tr>
<tr><td>Universal attributes of learners
Ability
Age
Sex
Intelligence
Motivation
Personality
Learning style</td><td>Sociocultural factors
Educational background (prior education, other language)

Familiar factors
Intraindividual factors
Self-assessment (proficiency, learning strengths, problems, weakness)</td></tr>
<tr><td colspan="2">Task knowledge</td></tr>
</table>

Purpose and goal of learning a FL Inherent difficulty of languages Nature of language learning Kind of learning Degree of difficulty Time needed to learn Nature of different skills Writing Reading Speaking Listening	Learning in different settings In the native country In the classroom Task responsibilities Roles (teacher/student) Language of instruction Working in groups, pairs, alone Error treatment Activities Materials and media
Strategic knowledge	
Metacognitive strategies Cognitive strategies Learning grammar Learning vocabulary	Reading and comprehension Listening and comprehension Speaking and pronunciation Writing

Person knowledge is general knowledge learners have acquired about human factors that facilitate or inhibit learning. Personal variables that are known to influence second language acquisition are factors such as age, language ability, sex, motivation, and learning styles. In addition, person knowledge includes specific knowledge learners have acquired about how the above factors apply in their experience (Wenden, 1998:158). Task knowledge has three facets. It refers to what learners know about the purpose of a task, how to develop the task, and how it will serve their language learning purposes. Strategic knowledge refers to general knowledge about what strategies are, why they are useful, and specific knowledge about when and how to use them.

From the definition and classification above, it can be seen that metacognitive knowledge refers to all types of information which learners acquire about their learning, while metacognitive strategies, which are mentioned in many studies of reading strategies including this study, are skills through which readers manage, direct, regulate, and guide their reading, i.e. planning, monitoring, and evaluation.

According to Flavell (1979), metacognitive knowledge plays an important role in many cognitive activities related to language use. It is activated deliberately when the nature of the learning task requires conscious thinking and accuracy, when the task is new, or when learning has not been correct or complete. However, it may appear automatically, evoked by retrieval cues in the task situation (Wenden,1998:520). By describing how metacognitive knowledge functions in language learning, several research studies, which are presented in the next section, have investigated learning strategies of successful language learners. These research studies have provided theoretical understanding of strategy use in the completion of specific learning tasks.

Reading is one of the areas in which research on metacognition has been focused. Baker and Brown (1986) explain the notion of metacognition by printing out that there are two clusters of activities, which are included in the definition given by Flavell: 'knowledge about cognition and regulation of cognition' (p. 353). The first cluster, knowledge about cognition, is knowledge which one possesses about one's own cognitive resources. This knowledge also encompasses the compatibility between the learner and the learning situation. The second cluster, self-regulatory mechanisms, is assumed to be employed by an efficient learner when problems occur while reading. These self-regulatory mechanisms include 'checking the outcome of any attempt to solve the problem, planning one's next move, monitoring the effectiveness of any attempted action, and testing, revising, and evaluating one's strategies for learning' (Baker & Brown, 1986: 354).

Brown et al. (1986) refer to knowledge involved in metacognition in reading as consisting of four major variables: text, tasks, strategies, and learner characteristics. Text refers to the features of reading materials that influence comprehension and memory such as difficulty, clarity and structure. Tasks refer to the requirements of various tasks and

purposes of reading that learners commonly encounter in school. Strategies are the activities learners engage in to understand and remember information from the text. Learner characteristics such as ability, familiarity with the material, motivation, and other personal attributes are states that influence learning. According to Brown et al. (1986), these four variables are inter-related. Therefore, the knowledge and awareness which the reader has of these variables are important in determining the degree of comprehension while reading.

Metacognition in the context of reading also involves the *control* readers have of their own actions while reading for different purposes. Successful readers monitor their reading and the state of their learning; they plan strategies, adjust effort appropriately, and evaluate the success of their ongoing efforts to understand (Brown, Armbruster & Baker, 1986: 49).

Metacognitive control, in which the reader consciously directs the reasoning process, is a particularly important aspect of strategic reading. When readers are conscious of the reasoning involved, they can access and apply that reasoning to similar reading in future situations. However, comprehension instruction does not always provide students with enough explicit information to enable them to assume metacognitive control (Carrell et al., 1989: 648).

General strategy research suggests that less competent learners are able to improve their skills through training in strategies or activating their metacognitive knowledge (Chamot, 1987; Thomson and Rubin, 1996; Nunan, 1997). The same is true of reading strategies. Less competent readers are able to improve through activating metacognitive knowledge (Carrell, 1985; Raymond, 1993; Dale et al., 1996). These claims are discusssed below in sections 2.4 and 2.5.

2.4 Language learning strategies

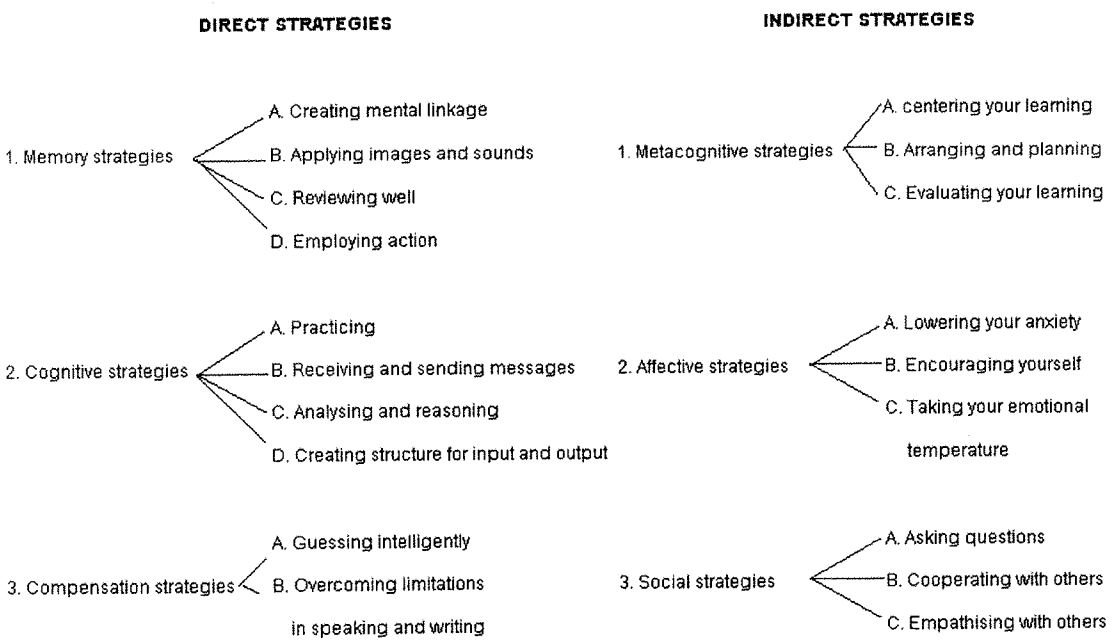
Recent approaches to the teaching of reading have emphasised the importance of students acquiring strategies for coping with text. As we have seen in the previous section, ESL reading has long been interested in reading strategies: how they contribute to better reading, how they can be incorporated into instruction. The empirical study of L2 learning strategies has developed since the mid 1970s. Studies of L2 reading strategies, and reading strategies instruction, are best seen as a subset of L2 learning strategy research. This section will review general research and theory on L2 strategies and strategy instruction, before L2 reading strategy research is explored in section 2.5.

2.4.1 Definitions of the terms

The term 'strategy' has been given to several processes. Strategies, as noted by Wenden (1987 a: 13) can refer to techniques, tactics, stratagems, conscious plans, basic skills, and intellectual skills that someone consciously selects in trying to achieve his or her objectives. Regarding the term 'learning strategies', Nunan (1990: 168) suggests that it is about the mental operations which learners adopt to learn and use the target language. Rubin (1978: 23) defines the term 'learning strategies' as any set of operations, stages or plans applied by the learners to gain information, to keep information and to use information, i.e., to learn and to control their learning procedure. Cohen (1998) defines language learning strategies as: 'those processes which are consciously selected by learners and which may result in action taken to enhance the learning or use of a second or foreign language, through the storage, recall and application of information about that language' (p.4). Oxford (1990: 115) expresses a more theory-driven view in a comprehensive overview, stating that a strategy is a combination of learning, thinking and

problem solving skills which are 'employed by the learner to aid the acquisition, storage, retrieval and use of information to make learning easier, faster, more enjoyable, more self-directed, more effective and more transferable to new situations' (p.8). What Oxford apparently tried to do was to subsume within her classification virtually every strategy that had previously been cited in the literature of learning strategies in order to guide teachers seeking to teach language learning strategies to their students. The overview combines both background research and practical suggestions for strategy development. She classifies language learning strategies into 2 classes, 6 major varieties and 19 sub-categories as shown in Figure 2.3.

Figure 2.3: Diagram of Oxford's learning strategy system (Oxford, 1990: 9)



Oxford's extended classification scheme served another purpose, which was to provide the foundation for generating items for a questionnaire designed to assess uses of learning strategies in second language acquisition. The Strategy Inventory for Language Learning (SILL), a survey instrument used cross-culturally to measure strategy use, was first designed in 1985 and revised for 2 versions, English Speakers Learning a New

Language (80 items) and Speakers of other Languages Learning English (50 items). The SILL has been extensively tested by Oxford, her associates and graduate students in both versions. The eight factors included in SILL were as follows:

1. General study habits- previewing lesson, using time well
2. Functional practice-seeking L2 speakers, attending L2 events
3. Seeking and communicating meaning- using cues for meaning
4. Studying or practising independently
5. Use of mnemonic devices- finding cognates, using imagery
6. Reliance on L1-translation
7. Formal practice-applying rules, grammar practice
8. Use of metacognitive strategies- self-encouragement, self-planning

Oxford and other strategy researchers have used SILL to analyse strategy uses among different populations, as is described later in this chapter.

2.4.2 Research on language learning strategies

The study of learning strategies in connection with second language acquisition has been prompted by the observation that different learners seem to approach the learning task in different ways, and that some of these ways appear to lead to more successful language learning. It has also been noted that the paths to success are various and that some routes will never lead to success. There is also the hope that if the strategies of more successful learners can be described and identified, it may be possible to train less successful learners in their use.

The study of learning strategies has developed since the mid-seventies and is related to the shift of interest from teaching methods to learner characteristics, and the development of cognitive perspectives on second language acquisition as mentioned in

section 2.3. A major contribution of research on language learning strategies has been to identify the strategies used by good language learners and to determine how these strategies can be conveyed to others. The research on language learning strategies reviewed in this chapter falls into two main categories; first to clarify and classify language learning strategies used by good and poor language learners and second to review selected studies on strategies teaching.

2.4.2.1 Research on language learning strategies

In 1975, Rubin published pioneering observations of the strategies used by successful language learners. She offers the following definition: 'By strategies, I mean the techniques or devices which a learner may use to acquire knowledge' (1975:43). She listed various features, which included psychological characteristics, communication, cognitive and social strategies.

> ' The good language learner:
> is a willing and accurate guesser,
> has a strong drive to communicative,
> is often not inhibited,
> is prepared to attend to form, practices,
> monitors his own and the speech of others,
> attends to meaning.' (1975: 46-48)

She also suggested that learner strategies would vary with the task, the learning stage, the age of the learner, the context, individual styles and cultural differences in cognitive styles.

A paper published by Stern in the same year (1975) lists ten strategies, which are based on a theoretical comparison between good and poor learners. The strategies listed are:

1. A positive learning style fitting in with the learner's preferred techniques
2. An active approach to learning
3. A tolerant and outgoing approach to the target language

4. Technical know-how about how to tackle a language
5. Regarding the language as a systems hypothesising about and updating the system
6. Constant search for meaning
7. Willingness to practise
8. Using the language for real communication
9. Self-monitoring and critical sensitivity to language use
10. Learning to think in the second language

Although Stern lists and writes about strategies, he offers no definition of a strategy, other than to say we need to discover 'what good language learners do that poor learners do not do' and 'how the good language learner proceeds' (1975: 304). Stern's broad categories were derived from teaching experience as well as from the analysis of the major tasks and problems facing the second language learners, but not from empirical study. However, these categories acted as the framework for, and were confirmed in, the study 'The Good Language Learner' carried out by Naiman et al (1978). This research focused on personality traits, cognitive styles and strategies, using Stern's list as a frame of reference. As a result of this study, four major strategies were broadly identifiable. The strategies were reported from interviews with 34 successful language learners. Most of the subjects had learned between three to five foreign languages and thus could be considered highly successful language learners. Good language learners:

- actively involve themselves in the language learning process
- develop an awareness of language as a means of communication
- accept and cope with the affective demands of L2
- extend and revise the L2 system by informing and monitoring

(1978: 13)

Under these major strategies were several minor strategies, not all of which were considered essential to all successful learners. In addition to the list of strategies, Naiman

et al provide a long list of 'specific techniques' connected to particular language learning activities. These are what are generally understood to be learning strategies in more recent research.

In a later work, Rubin (1981) identifies some of the major cognitive processes that probably contribute to language learning and provides a list of some of the specific strategies which exemplify those cognitive processes. She distinguishes between processes which may contribute directly and indirectly to learning. The data were obtained through observation of classroom lessons and tutorials, as well as of students engaged in reconstructing a story, and from interview and written self-report (diaries). She notes 66 specific strategies organised into a taxonomy.

In 1981, Bialystok published a report of her investigation into the conscious strategies used by second language learners and related the use of particular strategies to achievement on various tasks. She proposes the division of strategies into formal and functional:

Practice: arranged by the learner beyond classroom requirements

Formal practice: specific exercise of the language code to master rule system

Functional practice: increased opportunity for communication

Monitoring: essentially a formal (production) strategy, its implementation has effects on language structuring

Semantic Inferencing:

A functional (comprehension) strategy using available information to derive linguistic hypotheses, primarily from meaning

Both monitoring and inferencing may be used in conjunction for production tasks. She concluded that functional practice appeared to be critical to achievement on all tasks (Bialystok, 1981: 33).

The language learning strategies described by Bialystok are a feature of her model of second language learning. She defines them as: 'optional methods for exploiting available information to increase the proficiency of second language learning' (1978: 76) and adds that their use is 'at the discretion of the individual language learner'. The strategies operate between the three levels of her model: Input, Knowledge, including 'other knowledge', explicit and implicit linguistic knowledge, and Output.

Wenden (1986) described the importance of various types of metacognitive knowledge, indicated by learners about their own learning during the course of semi-structured interviews. These were:

1. Outcome of strategies (evaluating: judgements about the outcome of using a strategy and its usefulness for learning.)
2. Language proficiency (diagnosing: statements about what they knew or did not know about the quality of their performance and comments about progress.)
3. Personal factors (self-analysing: reactions to a particular learning activity as well as views they held about themselves as language learners, referring to learning style, aptitude and personality.)
4. Beliefs about how best to approach language learning (theorising: explicitly stated beliefs as well as those implicit in explanations of why learners had found a particular learning context or activity effective.)

5. The language (consisting of more and less complex observations about grammar, phonology, vocabulary, rules of discourse, relationships between vocabulary, social setting and communicative task.)

Politzer (1983) carried out a study linking self–report of strategy use to the development of linguistic and communicative competence. He compared responses obtained in a three-part questionnaire, relating to classroom behaviours, individual study and social interaction outside the classroom, to results of pre- and post- course proficiency tests. The questionnaire was based on existing strategies as well as reflecting the hypotheses of the researchers. The subjects were of Asian and Hispanic origin. The differences manifested by the two groups in strategy preference were compared to progress achieved. He concluded that good strategies may not be universally valid and behaviours may be culturally specific. This result also suggested that good behaviours may be differently appropriate for various types of skills and that a strategy may be good or bad depending on the level of proficiency or frequency of use (Politzer, 1983: 62).

Huang and van Naerssen (1987) investigated the learning strategies of a group of Chinese foreign language learners. The 60 subjects were graduating EFL students from a Chinese language institute, chosen randomly from a group of 120. All the students completed a three-part questionnaire about their language learning activities and a test of oral communicative ability and were placed in three groups according to their scores on the test. The ten highest scoring and the ten lowest scoring students on the test were also interviewed in depth. The researchers wanted to discover if the more successful learners relied on different language learning strategies from the less successful learners.

It was discovered that functional practice showed a statistically significant difference between the high and the low groups, and the students who were more successful reported using strategies more frequently. The researchers pointed out however,

'that a correlation between two factors does not automatically imply a direct cause and effect relationship' (Huang and van Naerssen, 1987: 293). They acknowledge that there may be other factors that have a strong effect on success or that higher performance might enable the use of more strategies.

O'Malley et al. (1985a) carried out a major research project on learning strategies used by 70 beginning and intermediate high school ESL students, which has been highly influential on later strategy research. Their purposes were to identify the strategies used by these students in typical language learning tasks, to determine whether the strategies could be classified within existing learning strategy frameworks and to determine whether the strategies used interacted with task or language activity and the proficiency level of the students.

The data reported were collected through interviews with learners, who were interviewed in groups about their learning strategies. There were also interviews with teachers and observation of classroom lessons, but these were thought to have been insufficiently productive and the data from these sources were not used in the analysis. O'Malley et al. use the following broad definition of learning strategy as: 'any set of operations or steps used by a learner that will facilitate the acquisition, storage, retrieval or use of information' (1985a: 22). They grouped the strategies reported into metacognitive (the regulatory processes by which learners plan, monitor and evaluate their learning) and cognitive strategies. They found that the pattern of strategy application was similar for both groups of learners. The strategies most frequently used by both groups were repetition, notetaking, and asking questions for clarification and co-operation.

The major contribution of O' Malley et al. to the development of learning strategy taxonomies has been the inclusion of metacognitive activities under learning strategies. They discovered a high level of metalinguistic awareness among many of the subjects and

were led to comment: 'Students without metacognitive approaches are essentially learners without direction and ability to review their progress, accomplishments and future learning directions' (1985a: 24).

Research using the Strategy Inventory for Language Learning (SILL) by Oxford (1985) with 1,200 university students led to the conclusion that females used learning strategies significantly more often than males and used a wider range of strategies. In addition, students with higher self-rated motivation to learn the language had significantly higher scores. Finally, students with at least five years of study in the language used functional practice strategies significantly more frequently than students with four or fewer years.

Green and Oxford (1995) looked at patterns of variation in strategy use by students at different levels of proficiency. The subjects were 374 students at three different course levels at the University of Puerto Rico. Using the SILL, they found a significant relationship between strategy use and language learning success, in particular for women learners. Those strategies used more often by successful students emphasised active, naturalistic practice. Green and Oxford concluded by suggesting two implications of their study for the classroom: first, that strategies involving active use of the target language appear to play a crucial role in second language learning and secondly, that teachers need to recognise that particular strategies may be more suited to some learners than to others.

Finally, the longitudinal development of learning strategies has been studied by Chesterfield and Chesterfield (1985). They studied the learning strategies of 14 young Mexican-American children in a bilingual classroom. Data collection was by means of participant observation, field notes, and subsequent coding of the strategies revealed by the children. Eight children were observed during their first year of school, and the researchers analysed: a) variation within the group at any one time and b) variation in each of the children separately over time.

They reported considerable systematicity in the strategies employed by the subjects. The strategies which first appear are mainly receptive and self-contained, e.g. use of repetition, memorisation and formulaic expressions. Subsequently strategies emerge which permit interaction and verbal attention, such as appeals for assistance, requests for clarification and role play. Later strategies which reflect metacognitive ability are awareness and a capacity to look at language as an object of study, elaboration and monitoring. This may also imply that easier strategies are acquired by early learners, and the more difficult ones come later. Chesterfield and Chesterfield also attached importance to the frequency of strategy use. Their findings could relate to those of O'Malley et al (1985a) which showed that the most frequently used strategies were repetition, note-taking, and questioning for clarification. Chesterfield and Chesterfield argue that strategies should be regarded as developmental, from mainly receptive and self-contained strategies, to later more interactive strategies and to metacognitive strategies. Grenfell and Harris (1999) also see an important developmental gradient in learning strategies: 'Just as some parts of language are easier to learn than others. For example, use of dictionaries to provide a translation of a word is relatively low level and unsophisticated when compared to the complex usage of inference and deduction to ascertain meaning'(p.46). These findings clearly have potential implications for strategy instruction, and may be related to the notions of higher level/complex and lower level/simple strategies that we explore later.

2.4.2.2 Research on strategies teaching

The field of strategy training has received mixed reactions from professionals in the field. A further area investigated by O'Malley et al, linked to the study described above, was the trainability of strategies. The results of this study were inconclusive, as the level of significant difference in progress on various tasks for the trained group was very low. Only a small number of strategies were selected for training and the intervention period

was very brief. However, positive results were found for the speaking task. Another interesting finding was that Hispanic students benefited from learning strategies training but the Asian students preferred their own established rote strategies (O'Malley et al., 1985b).

An interventionist study involving training in listening strategies included this component as part of a listening diary homework programme for Japanese junior college students of oral English (Fujiwara, 1990). Of the 45 students in the two second-year oral English classes that participated in the listening diary programme, 36 (80%) felt that their listening had improved, and 16 felt that the listening diary homework was the most helpful component. Through the diary project, students reported that they:

1. learned new listening strategies and adopted for their own continued use those that they found most helpful;
2. became aware of what and how to learn;
3. improved their ability to evaluate their strengths and weaknesses as listeners in the foreign language;
4. began to set learning goals for themselves and;
5. developed a (more) positive attitude toward learning through listening.

Another strategy training research study was an experiment involving 24 college students of intermediate-level (third year) Russian in the experimental group and 12 in the control group (Thomson and Rubin, 1996). The experimental group was given 15 hours of strategy training in listening comprehension, using 45 videotaped segments. The control group also received the same videotaped stimuli but their strategy training just focused on speaking and writing, not on listening. The findings showed a significant difference in favour of the experimental group on a test of video comprehension, which was developed by the researchers and which included items representing different TV genres. However,

as most findings were non-significant, the researchers concluded that the treatment was not decisive or long enough.

With regard to interventionist studies involving speaking strategies, one such study was conducted with a sample of 122 first-year and fourth-year students in the Department of English at an Egyptian university, half receiving an experimental treatment and half in the control group (Dadour and Robbins, 1996). The treatment consisted of 15 weekly three-hour sessions, which provided the learners with instruction on using strategies to improve their speaking skills. Each session had a warm up, teachers' presentation and explanation with examples of new strategies, activities for practising the new strategies and for discussing them, group homework assignments, and students' presentations and discussions of the homework. The course gave direct instruction in the speaking skills that the students needed to master and the learning strategies that they were required to practise in order to improve their skills, and provided communicative activities as well. The course stressed the idea of giving students more responsibility for their own learning.

Research instruments used to collect data were: an EFL teacher's speaking skills inventory developed for the study, the CLEAR Oral proficiency Exam, and the SILL. Covariate analysis found the experimental group students at both the first- and fourth-year levels to outperform the control groups in speaking. Specific differences were found in fluency, vocabulary, and grammar, but not in pronunciation. The experimental group was also found to use more strategies of all kinds (memory, cognitive, compensatory, metacognitive, affective, and social) than the control group. The conclusion was that a well-structured strategy instruction course that allowed creativity on the part of both teachers and students could have a positive effect on oral communication and on the use of strategies of all kinds.

A second language speaking study was conducted with 60 undergraduates in a compulsory English for Arts Students (EAS) course at a Hong Kong university (Nunan, 1997). There was low motivation to learn English because the students' focus was on Putonghua, which was to be the official language once the Territory went back to China. Strategy training was deemed valuable because there was limited time to study English. Subjects were assigned to 4 classes, 2 experimental and 2 control groups. The experimental groups received key learning and study skills strategies incorporated into their language teaching programme. All subjects were administered a pre-course questionnaire to measure their motivation, their knowledge of 15 key strategies, their use of these strategies, and their perception of the value of the strategies. During the course, subgroups of students participated in focused interviews regarding their perceptions and feelings about studying English and especially about this course (EAS). Then the motivation and strategy questionnaire were re-administered on a post-test basis.

The study found that motivation improved over the duration of the semester, significantly more for experimental group than control group students (56% versus 26%). Knowledge of strategies was also found to improve for the experimental group. In addition, the experimental group increased in perceived utility of strategies. Yet reported frequency of development of these 15 key strategies was low and the difference between the experimental and the control groups on this factor was minimal. There were areas in which the experimental group reported using strategies more than the control group: selective listening (because of changed listening demands-different dialects of English), predicting, confirming, cooperating, applying, and classifying. Nunan was surprised that the experimental group was not ahead in reflecting, but he speculated that differences would only show up over time. Finally, students' reported strategy preferences shifted from memorizing, summarizing, and cooperating at the beginning of the semester to

inductive learning and selective learning by the end of the course. The conclusion was drawn that training had a significant effect on student motivation, and had some impact on use of selected strategies.

The following are two sets of criticisms leveled at training in communication strategies. The first was by Kellerman (1991), who maintained that learners need not be taught compensation strategies for dealing with gaps in L2 vocabulary knowledge because they already have these strategies in the first language. Kellerman would explain an apparent inability to use a strategy effectively as resulting from a lack of L2 language proficiency or from the inhibitory atmosphere in the classroom, rather than from a lack of control over the strategy.

The second, more elaborate critique was rendered by Rees-Miller (1993). She made a strong case that learner training had not been adequately assessed empirically. The studies that Rees-Miller cited lent some support to the conclusion that such training was not so effective. Her challenge to researchers was that they find evidence that using a strategy is better than not using it, and that they determine the factors that make learner training conducive to success. She suggested that the stage the learners are at in the learning process, their language proficiency, their educational background, their beliefs about language learning and the beliefs of their teachers, their varying cognitive styles, and any cultural differences that exist across learners all complicate the implementation of learner training. She posited that those and other factors may result in differential success. She also voiced concern about the duration of the effects if there were any, and she recommended longitudinal research to determine the relative effects of these variables. Her conclusion was that the teacher needs to proceed with caution in the use of strategy training in the classroom until more research was conducted.

The results of these efforts at training in the use of strategies are mixed, but point to the overall conclusion that in the right conditions, performance based strategies can be effectively trained. O'Malley et al. (1985a,b) suggested that it is possible to train for strategies on integrative tasks in a natural classroom environment and that strategy training should be integrated with regular instruction. O'Malley and Chamot further suggest that: 'strategy training should be direct in addition to being embedded. In other words students should be apprised of the goal of strategy instruction and should be made aware of the strategies they are being taught' (1990: 184). They also support the view that perhaps the simpler strategies are available to all and training can influence their frequency and appropriateness of use, whereas the more complex strategies may not be available to everyone and their use may have to be explicitly taught to some students. Strategy research suggests that less competent learners are able to improve their skills through training in strategies or activating their metacognitive knowledge (Chamot, 1987; Thompson and Rubin, 1996; Nunan, 1997). The same is true of reading strategies: Less competent readers are able to improve through activating metacognitive knowledge (Carrell, 1985; Raymond, 1993; Dole et al., 1996). These studies will be discussed in Section 2.5 below.

2.5 Reading strategies

Reading strategies can be defined as an action or series of actions employed in order to construct meaning (Garner, 1987: 70). According to Barnett (1989: 66) the term reading strategy refers to the mental operations involved when readers purposefully approach a text to make sense of what they read. That is to say, when readers encounter obstacles to their comprehension, they need to use strategies to overcome their difficulties. Reading

comprehension in the view of cognitive theory is an active constructive process that applies both top down and bottom-up processes. Readers who use world knowledge to develop their comprehension of a text are using top-down processing. They are drawing upon information already in the memory or upon an analysis of meaning- based features of the text to comprehend a passage. On the other hand, individuals who analyse each individual word for its meaning or grammatical characteristics and then accumulate these elements to form meaning are using bottom-up processing (O' Malley and Chamot, 1990:36-37). As stated in a study by Hosenfeld (1981), good readers use both top-down and bottom-up processing, while poor readers may operate only at the word level. Good readers may plan and alternate between top-down and bottom-up processing, depending on the task demands (p.47). Research on reading strategies relevant to this project can be categorised into two groups: studies of awareness and strategy use, and investigations into the effects of strategy instruction. These are reviewed separately in sections 2.5.1 and 2.5.2.

2.5.1 Research on metacognitive awareness and effectiveness of strategies use

Reading research involving metacognition and awareness is examined in this section. Such studies have had a considerable impact on understanding reading strategies and the implications for reading teaching. These studies also expand the categorisation of reading strategies. What remains problematic is that there is still a lack of clear categories and agreed definition of reading strategies. The studies selected for the review are listed in Table 2.2.

Table 2.2: Research on metacognitive awareness and effectiveness of strategies use

Researchers	Subjects	Independent Variables	Dependent Variables	Method	Findings
Hosenfeld (1977)	40 students of French, Spanish and German	high and low scores on reading test	choices of reading strategies	self-report as they read texts in English	Good readers: - keep the meaning in mind - read in word group - skip words they don't view as important
Hosenfeld (1984)	2 high school learners	Learning strategies		Think-aloud	Both inductive and deductive techniques are effective.
Padron and Waxman (1988)	82 Hispanic ESL students in the third, fourth, and fifth grade		1. scores on Stanford Diagnostic Reading Test 2. scores on reading strategy questionnaire	A comprehension exam was given twice, at a four month interval, to determine the relationship between gains in reading abilities and strategies on self report questionnaire.	Perception of cognitive strategies can predict test scores.
Barnett (1988)	216 university students who were enrolled in a French as a foreign language course	1. strategy use	1. background-knowledge scores 2. comprehension scores 3. strategy use scores 4. perceived use scores	Students read familiar and unfamiliar passages and made a recall protocol. Then, students answered a seventeen-item questionnaire in English about the type of reading strategies.	1. As strategies use increases student perception of strategy use increases. 2. The reader's perception of strategy use interacts significantly with comprehension.
Wade, Trathen, and Schraw (1990)	67 US under-graduate students		1. number of studies tactics they use 2. recall test scores	The subjects were asked to study a passage individually, then, they were asked to report the strategies use and worked on a recall test.	1. Categories of six types of strategy users: - the good strategy user - the information organizer - the flexible readers - the text noter - the mental integrator

					- the memorizer 2. No significant difference between the six types of learners in the amount of information recall.
Klazien (1991)	48 US high school students who were half good comprehenders and half poor comprehenders	original passages revised version passages with different difficulty.	1. number of process strategies 2. Cloze task	Subjects were asked to read three expository passages, and worked on the cloze test, then, reported their strategies.	The two groups used the same type and same numbers of strategies on the easy passage, but as the passage difficulty increased, good comprehenders used more types of strategies and used strategies more often than the poor comprehenders did.

It can be seen from several studies that second language students can observe and verbalise their reading strategies. Hosenfeld (1977) focused her research upon the reading strategies used by more and less successful readers. The specific techniques used were think-aloud, both introspective, and retrospective. In this early study (1977), Hosenfeld asked forty adolescent foreign language students of French, Spanish, and German to think aloud as they read silently. The subjects were divided into high and low scoring groups on a test of reading proficiency. From the self- reported data she discovered distinct differences in the strategies used by successful and unsuccessful readers. For instance, successful readers tended to: keep the meaning of the passage in mind, read in broad phrases, skip inessential words, guess the meaning of unknown words from context. By contrast, the unsuccessful readers tended to lose the meaning of sentences as soon as they decoded them, read word by word or in short phrases, rarely skip words, turn to a glossary for the meaning of new words and have a poor self- concept as a reader (Hosenfeld, 1977:

233). Further analysis of the think-aloud protocols indicated that as well as using the strategies mentioned above, successful readers tended to:

- identify the grammatical category of words
- demonstrate sensitivity to a different word order in the foreign language
- examine illustrations
- read the title and make inferences from it
- use orthographic information (e.g., capitalisation)
- refer to side glosses
- use the glossary only as a last resort
- look up words correctly
- continue if unsuccessful at decoding a word or phrase
- recognise cognates
- use their knowledge of the world.

In a later study (1984), Hosenfeld conducted case studies of two ninth-grade foreign language readers, using think-aloud and an introspective/retrospective procedure to uncover their problem-solving strategies. This qualitative approach showed precisely how they used strategies before and after receiving training. The study also showed that less successful readers could acquire strategies from successful readers (Hosenfeld, 1984: 234-236). Hosenfeld concluded that students clearly need help in learning to read in a foreign language (p.243), and proposed some teaching implications. For example, a teacher can engage students in a tutorial exchange when they come to the teacher's desk, or while moving from desk to desk as students work on a homework assignment. A teacher might 1) assign the first paragraph of a story for silent reading; 2) ask several student volunteers to identify words which are new to them and to describe their strategies

with these words; 3) discuss identified strategies with the entire class (Hosenfeld, 1984: 244).

Padron and Waxman (1988) investigated the relationship between students' metacognitive strategy awareness and their performance on measures of reading comprehension. The subjects were 82 Hispanic ESL students. Dependent variables were scores on a Standard Diagnostic Reading Test and scores on a self- report reading strategy questionnaire. The reading comprehension test was given twice, at a four month interval, to determine the relationship between gains in reading abilities and use of strategies as reported by questionnaire. This reading strategy questionnaire contained fourteen strategies, half presumed to be negatively related to achievement and half positively related to achievement. Negative strategies included e.g., writing down every word, or skipping the parts you don't understand in the story. Examples of positive strategies were summarising in writing, underlining important parts of the story. Students indicated how much they used each strategy (always, sometimes, never). The findings suggested that perception of cognitive strategies can predict test scores. However, students had lower achievement gain when they reported using both kinds of strategies.

To expand the relatively small database on reading strategies, Barnett (1988) designed a study to analyse the impact on foreign language reading comprehension of three strategies generally considered effective: 1) reading at the level of discourse rather than at the level of words; 2) following key words such as nouns, subjects, pronouns, and adjectives; 3) the ability to use context and morphology to guess the meaning of unfamiliar or unknown words. Two general hypotheses were formulated: 1) readers who use certain problem- solving strategies will understand more of what they read than those who do not use these reading strategies; 2) readers who perceive that they use strategies generally considered effective will understand more of what they read than those who do

not think they use such strategies. The subjects were 216 university students who were enrolled in a French as a foreign language programme. The instruments included: 1) questions designed to elicit background knowledge relevant to the texts, 2) a text to gauge reading comprehension, 3) two different texts to gauge reading strategy use, and 4) a questionnaire to discover which strategies subjects thought they used when reading French. The subjects completed eight multiple-choice background knowledge questions in their native language (English) before reading the text. After reading the text they returned their copies of the text and wrote in English what they remembered of it (a recall protocol). Subjects then answered a seventeen-item questionnaire in English about the types of reading strategies they thought best described the way they read (perceived-strategy questionnaire). Think-aloud data about their strategy use were elicited from eight subjects randomly selected on the basis of their performance. The results tended to support the hypothesis that readers who perceive that they use strategies generally considered effective actually do comprehend better than their peers who use less productive strategies. Moreover, analysis of the quantitative data on background knowledge revealed that reader schemata have a strong impact on second language reading comprehension. However, the think- aloud data reveal that some readers misperceive how they use reading strategies. Barnett concludes that students need to learn how to adapt strategy use to each text. Students should learn to analyse and evaluate their actual strategy use. Teachers can help students learn from each other, expand their abilities to use strategies and cultivate effective reader skills.

The study carried out by Wade, Trathen and Schraw (1990) was also aimed to expand understanding of overall reading strategies used by readers. The subjects were 67 undergraduate students who volunteered for the study. Prior to the experiment, background information about each subject was collected: age, sex, grade point average

and college major. No significant difference was found on GPA, vocabulary ability and background knowledge in the group. The subjects were asked to study a passage individually, then they were asked to report retrospectively on their study methods, and finally they were given a recall test.

Information from the students' verbal report provided data to characterise the six types of readers:

1) The good strategies users – These students had a high tendency to use a diversity of all tactics.
2) The information organisers - These students were similar to the good strategies users in that they used a large number of text-noting tactics and mental learning tactics; however they rarely mentioned using reading tactics.
3) The flexible readers - The students in this group used relatively few text-noting and mental learning tactics. They placed emphasis on reading tactics.
4) The text noters - The students in this group were very consistent in their use of text-noting tactic. They seldom reported using mental tactics or reading tactics.
5) The mental integrators - These students used the greatest diversity of mental learning tactics which they relied on far more than on text-noting or reading tactics.
6) The memorisers -These students relied on a single text-noting tactic. They always underlined, highlighted or took notes.

Although the test scores showed no significant difference between the six types of students, the trend was for the good strategies users to recall more information. From the study the researchers found that different strategies existed. However, the researchers commented at this point that 'we caution teachers not to classify students by this taxonomy nor to attempt to change students' strategies to conform to any of those in the

taxonomy. Thus rather than requiring students to use any particular study tactic teachers should encourage students to consider the kind of learning strategies, the reason for using them and how to employ them effectively' (p. 164).

In 1991, Klazien reported a study on L1 reading strategies used by good and poor comprehenders. This study was designed to examine how the interaction of reader ability, text difficulty and strategy knowledge affected reading strategy use among good and poor comprehenders in high school. The subjects were 48 US high school students of average ability, half of whom were good comprehenders (above 75% on the California Reading Comprehension Test) and half poor comprehenders (below 50% on the same test). The good comprehenders read the original passage, while the poor comprehenders read a version revised so that the passage would be the same relative difficulty for both groups. In each passage students were asked to fill blanks left by randomly deleting 12 context-dependent content words. Subjects then were asked to explain their reasoning processes for these cloze responses. The subjects' explanations were analysed to identify their comprehension strategies. All subjects reported heavily using key vocabulary, rereading, making inferences, and using previous experience for all the passages. Total strategies use declined for poor comprehenders as texts became more difficult. Good comprehenders also used more strategies on the easiest passage as well as on the more difficult passages. The researcher explained the difference in ability to regulate strategy use as a metacognitive framework. Subjects who see themselves as not being capable may give up, thinking that they could not succeed at a reading task. Their self-esteem may have affected their approach to the task. For example, one poor comprehender in the study explained his response on the frustration level passage as: 'I did this because I know it is really important to you, but usually, if something is this hard, I don't even try' (p.80). The researcher suggested that strategies should be taught in the context of real reading

situations and students need to be given practice on the strategies so that they can use them independently. He pointed out the importance of encouraging students to manage their own cognitive resources as they read. So teaching the poor comprehenders how, when and why to apply the strategies might enable them to become more proficient readers.

2.5.2 Research on the effects of strategy instruction on students' reading comprehension

Studies on the effects of reading strategies instruction vary according to their designs, the strategies investigated, types of materials, and learners. However overall, the results are very supportive and suggest that strategies instruction can be useful for both first and second language reading. Studies showing these positive results are summarised and shown in Table 2.3.

Table 2.3: Research on the effects of strategy instruction on students' reading comprehension

Researchers	Subjects	Independent Variables	Dependent Variables	Method	Findings
Carrell (1985)	35 ESL students of Chinese, Arabic, Malaysian, Korean, Japanese and Turkish background	Training on the use of the five groups of signal words (TLS)	recall scores	The subjects were divided into control and experimental groups. The experimental group was taught to identify and use the five groups of signal words; collection, description, causation, problem solving and comparison. The control group received no training.	Training in TLS helped to increase the amount of information recall.

Raymond (1993)	43 Anglo students who studied French as a second language	Training in TLS	recall scores	The experimental group was taught for 5 hours on practising TLS. The control group received a traditional approach (question, answer).	The experimental group recalled significantly more ideas from one text, but less in the other text.
Dole, Brown and Trathen (1996)	67 fifth and sixth grade US students	- strategy instruction - story content instruction - basal control instruction	comprehension test scores	The three groups were taught on different types of instruction.	Readers who received strategy instruction made superior gains in comprehension performance over their peer groups.

Carrell (1985) investigated whether English as second language students who had been taught a so-called Top Level Structure strategy (TLS) read better than those who were not trained. High- intermediate ESL students of Chinese, Arabic, Malaysian, Korean, Japanese, Spanish, and Turkish origin were the subjects. The experimental group (n = 14) was taught to identify and use the five groups of signal words: collection, description, causation, problem solving and comparison. Subjects in the control group (n = 11) read identical texts but received no training in the recognition and the use of TLS. The regular classroom teachers were used. For both the pre- and post-test, subjects read a text and wrote immediately free recall in English, and identified the TLS by answering an open-ended question about it. A delayed recall for the experimental group was also included. Recalls were scored for the presence or absence of idea units from the original texts. Each protocol was also analysed to determine whether it used the TLS of the original texts. The open-ended questions were scored as to whether the reader had correctly identified the TLS used by the author. A one way ANOVA showed no significant differences between the experimental group and the control group in the number of idea units recalled on the pre-test. However, on the post-test, the mean for the experimental group was statistically

significantly larger than for the control group. Thus training in TLS helped to increase the amount of information recalled for the experimental group, and the effects of training persisted in the second post-test. The experimental group also had a significantly higher in the proportion of those who identified and used the TLS of the texts.

Raymond (1993) also made a comparison study on the teaching of reading strategies. Like Carrell, Raymond applied TLS strategies to the teaching of French as a second language. The study was designed to answer whether French as a second language reading is facilitated by teaching TLS. The subjects were 43 Anglo students of a high-intermediate proficiency level in French at the University of Ottawa. All subjects took a second language reading test one week before the experiment began. This was used to verify the reading ability of the students and to assure that they had equivalent reading proficiency level. They were randomly divided into experimental and control groups. The experimental group received 5 hours of systematic training, one hour for each TLS: description, sequence, causation, problem-solution and comparison. The control group received a traditional study procedure (question, answer) for the same amount of time, and a post-test was administered one month after the end of the training period. After training, the experimental group recalled significantly more idea units than the control group from one text, but significantly fewer from another text. The researcher claimed these inconsistent results might be due to the lack of background knowledge of the subjects, and to a conflict between the new procedure and the learners' prior strategies. The researcher made a comment that strategic training in second language reading was a highly complex and difficult undertaking. Success depends not only on mastery of individual strategies, but interaction of strategies with text content, reader interest and background knowledge and reader perception of text.

Finally, Dole, Brown and Trathen (1996) made a study of the effects of strategy instruction on the L1 reading comprehension performance of at-risk students. The researchers carried out the study in two phases. The first was a comparative study of two approaches to reading instruction, and the second phase concerned the students' response to strategy instruction.

In the first phase of the study, 67 fifth graders from a designated at-risk school were randomly assigned to one of three treatments - strategy instruction, story content instruction, and basal control instruction. The instructional sessions occurred over 5 weeks, and students read a total of 24 passages. Strategy instruction was based on an interactive model of the reading process. The instruction introduced strategies including how to make predictions, how to identify main characters, how to identify the story's central problem, and how to identify a solution. The total instructional time for the strategy treatment was 10-15 minutes in length within the total 50-minute period.

Results of the study indicated that at-risk readers who received strategy instruction made superior gains in comprehension performance over their peers who received story content or basal reading instruction. However, the superior performance of the strategy group showed when students read texts on their own in class, without the teacher's instructional support. There was no significant difference in the performance of the three groups on formal comprehension tests. This indicated that all three forms of instruction were equally effective in helping students understand texts. The researchers explained that the strategy treatment focused on developing independent text readers, and this made the difference when students had to read on their own. This pointed out the value of teaching students to become independent readers who can use certain strategies on their own without the teacher's support.

In the second phase of the study, two students from the strategy group were selected to examine their qualitative, individual responses to strategy instruction. Taken together, both phases of the study showed the benefit of strategy instruction for at- risk students. But findings from the second phase also showed how students' motivation could influence their use of the strategies they received.

As we have seen, research studies on reading strategies fall into two groups: strategy use by readers and the effects of strategy instruction. The former examines types of readers and strategies used by the good and the poor readers. However, there is still a lack of agreement regarding categories and clear definitions on reading strategies among these studies. Different researchers use different terms to refer to the reading process, though there remains a clear relationship with categories developed for learning strategies. The learning strategies study by O'Malley et al. (1985) contributed a major development of definition and categorisation of strategies, and therefore is the model which has most influenced this study.

The research in the latter group reported the effects of strategy instruction on both first and second language readers. The researcher aimed at investigating such effects on Thai students. The research designed by Raymond (1993) and Dole et al. (1996) in particular has influenced the design of this study, which will be explained in detail in Chapter III.

2.6 Frameworks of strategies instruction

A major contribution of research on language learning strategies has been to identify the strategies used by good language learners and to determine how these strategies can be conveyed to others. Results from empirical research show a positive

effect of strategies instruction on second language learners (Palincsar and Brown, 1986; Cohen, 1998; Nunan, 1997). Chamot et al. (1999) explain the critical elements of effective strategies instruction, which include students' and teachers' beliefs, classroom context and instructional approach. Strategies instruction is learner-centred, thus, students must believe 'what causes their success or failure is the use of effective strategies not lack or innate ability alone' (p. 35). The teacher, too, must believe that effective strategies use can determine student success. At the same time, the classroom environment must support students to take control of their own learning. Thus a very important aspect of strategies instruction is how it should be implemented. A number of suggestions can be found in the literature and are reviewed below.

Chamot et al. (1999) present useful guidelines for teachers to select initial strategies to teach:

- start with the simplest strategies (such as visualizing) and progress to more complex ones (such as summarizing)
- start with strategies that the students already use
- start with strategies that have the widest applications
- determine which strategies the students need most
- make sure that the strategies are well-matched to the instructional objectives
- start with the strategies that the teachers find effective.

They are also strongly in favour of cooperative student activities as a mean of 'scaffolding' strategy instruction. In their view, activities such as practising in pairs, brainstorming, jigsaw and team games, are excellent ways to scaffold instruction as 'it provides instructional support while increasing students' responsibility for learning' (p. 41).

Grenfell and Harris (1999) also present clear steps to be followed in teaching reading strategies: 1) consciousness or awareness raising 2) modeling 3) general practice 4) action planning 5) focused practice 6) evaluation. The first step is aimed to encourage learners to be aware of the learning process, then, in the second step teachers encourage learners to share the strategies that work for them in discussing some of the strategies, starting from top-down processing to a bottom-up approach as follows:

- recognizing the type of text (e.g.a poem for children) and therefore having some expectations of what it might be about;
- going for gist – skipping non-essential words;
- using the titles and the pictures for clues (it is likely that not all the learners will have noticed the pictures behind the little girl);
- identifying 'chunk boundaries' – how a text breaks down and which parts of it to work on at any one time;
- using common sense and knowledge of the world (earth is not blue);
- looking for cognates;
- saying the text out loud;
- using the pattern of sentences to make sensible guesses
- breaking down an unknown word/phrase and associating parts of it with familiar words;
- using punctuation for clues: questions marks, capital letters, etc.;
- identifying the grammatical category of words.

(p. 74-76)

In the general practice step (step 3), explicit strategies instruction is presented alongside a model of using them. Step 4 is aimed to encourage learners to draw up their own individual plan and to select strategies to use in step 5. An important aim of step 5 is that learners should reach a stage when they have successfully internalized the strategies. In the last step, learners evaluate their own strategy acquisition and recommence the cycle. This may include expanding the range of reading of different types of text.

Wade and Reynolds (1989) present 3 steps in teaching reading strategies: 1) task awareness 2) strategy awareness and 3) performance awareness. Task awareness involves both text and task analysis, while strategy awareness involves decisions about what study methods would be most appropriate for a particular text, and the last stage includes

students evaluating their strategies use. Wade and Reynolds (1989) provide some suggested instructional activities to develop metacognitive awareness such as different types of questions, brainstorming, and peer work.

Similarly, Cohen (1998:89-95) offers 7 steps for the design of strategy training based on suggestions for strategy training by Oxford (1990). Cohen's steps are:

1) Determining the learners' need and the resources available for training
2) Selecting the strategies
3) Considering the benefits of integrated strategy training
4) Considering motivational issues
5) Preparing the materials and activities
6) Conducting explicit strategy training
7) Evaluating and revising the strategy training

There is still a debate whether strategies instruction should be integrated with classroom instruction in language or content subjects or should focus only on learning strategies. Arguments in favour of separate training programmes advance the notion that strategies are generalisable to many contexts and students will learn strategies better if they can focus all their attention on their developing strategies (Jones et al., 1987 cited by O'Malley&Chamot,1990:152). Those in favour of integrated strategy instruction programmes, on the other hand, argue that learning in context is more effective than learning separate skills (Wenden,1991). Another issue is whether strategy instruction should be direct or embedded. In direct instruction, students are informed of the value and purpose of the strategies, whereas in embedded instruction, students are presented with activities and materials to elicit the use of strategies but they are not informed of the reasons underlying the particular approach. Many researchers, however, recommend that

instruction in learning strategies be direct rather than embedded (O'Malley & Chamot, 1999; Cohen, 1998; Grenfell & Harris, 1999).

Finally, co-operative activities are also important to strategies instruction. Oxford (1990) presents a number of classroom activities which are 'strategy-friendly' such as brainstorming, group work, pair work, jigsaw reading, strategy search games. The purpose of embedded games is to make learners become familiar with strategies. Strategy search games are aimed to determine how strategies relate to a set of learning tasks, and jigsaw reading helps learners use guessing strategies, monitoring, inferencing and other reasoning strategies. Brainstorming is a very useful activity to motivate students' interest as well as to elicit their strategies. Small group work and discussion help learners increase their self control, awareness of strategies and help them to learn from each other. In addition, ' Activities must be interesting, valid, and meaningful and they should deal not just with intellectual aspects of language learning but with the affective side as well' (Oxford,1990:209).

2.7 Conclusions

Reading is a complex process, and foreign language reading has additional levels of complexity. This chapter reviewed related literature, and a selection of related research studies to give the theoretical background of this study. The aim of this study is to investigate the effects of explicit strategy instruction on reading ability of Thai students. The literature includes two main aspects: the second language reading, and learning strategy. Although they may be important in considering the success of Thai students reading in English, literature and research on EAP and vocabulary studies have been omitted from this study.

There are two main different points of view regarding the factors which affect L2 reading ability. The first view (Clarke, 1980; Cziko, 1978, 1980; Cooper, 1986; Alderson et al., 1977; Aron, 1978) suggests that target language reading ability seems to be mainly the result of proficiency in that language and in vocabulary in particular. The second view contends that L1 reading ability, and L1 higher conceptual abilities have great effects on L2 reading comprehension (Carrell, 1991; Coady, 1979; Cummins, 1980). This group believes that higher level strategies developed in a first language can be transferred to second language reading. From such a belief developed a pedagogical approach that concentrated on teaching students reading strategies in their first language as well as in the second language.

In the field of strategies training also, researchers fall into 2 groups. One argues that strategies instruction is ineffective and learners need not be taught compensation strategies (Kellerman, 1991; Rees-Miller, 1993). The other group asserts that learning strategies are teachable and have positive effects on language learning (Chamot and Rubin, 1994; Thomson and Rubin, 1996; Carrell, 1985; Raymond, 1993; Dole, Brown and Trathen, 1996; Nunan, 1997; Cohen et al., 1998). Taken together, the work on general learning strategies and on reading strategies is sufficiently encouraging to support a focus on strategy instruction if we accept that there are difficulties in foreign language reading even for advanced language learners, and that these foreign language readers need to be helped to improve. This research is designed to find firmer evidence and a better solution for teaching foreign language reading to a relatively advanced group, i.e. Thai undergraduate students. Therefore, the objectives of this study are to explore the reading strategies employed by Thai students while reading English texts and to discover the impact of strategies teaching on these students' reading proficiency. In the next chapter the methodologies of the study and its research tools will be explained.

Chapter III

Research Design and Development of Instruments

As explained in Chapters I and II, this study aimed at investigating the effects of strategy instruction on the reading comprehension of Thai students. It was designed as an experimental study to compare the effectiveness of two approaches to the teaching of reading. Qualitative methods were also applied to investigate reading strategies used by the subjects in more depth.

This chapter presents the research design and methodology and is divided into four main parts. The first part explains the overall design, including the selection of participants and instructional procedures. The second part explains the research instruments in more detail. This part presents the construction of the reading comprehension test and its pilot study, the design of the questionnaire on reading strategies followed by a short account of the associated pilot study, and the think-aloud procedure and how it was piloted. The third part gives a description of the data analysis procedures. Finally, a short conclusion draws together the lessons of the pilot studies for the main study.

The research questions addressed in this study are as follows:

1. Is there any reading ability improvement after applying the two approaches: the traditional reading teaching approach and strategy instruction?
2. Is there any significant difference in the level of reading ability of the students resulting from the two approaches?
3. What reading strategies do the Thai students apply in order to understand English texts?
4. Do readers transfer learned strategies to their extensive reading processes?

5. Is there any significant difference in strategy use between students taught using the traditional and experimental approaches?
6. Is there any relationship between reported patterns of strategy use and students' scores on reading comprehension tests?

3.1 Research design and research procedure

3.1.1 Research design

The main objective of this study is to find a more effective way of teaching reading comprehension to Thai students. Thus the researcher is concerned with effecting improvements in students' performance as a consequence of changing teaching models, which leads to the adoption of an experimental design for this study.

Cohen and Manion (1996:8) state that the essential feature of an experimental research study is that investigators deliberately control and manipulate the conditions which determine the events in which they are interested. Designing an experimental study is not an easy task since the aim of the experimental design is to answer precise questions. An experimental design, therefore, needs a lot of preparation for research tools which include: a precise set of questions, an explicit set of variables, explicit tasks which can be measured, sufficient participants to enable statistical inferences to be made, control and counterbalance to eliminate rival interpretations of data, and a means of ensuring the relevance of the results to the questions (McDonough and McDonough, 1997: 158-159). When a researcher wants to compare the effectiveness of two approaches to English reading instruction and has the power to manipulate the learning context to design an appropriate experiment, there is sense in doing so. Important models for this study were the other experimental studies conducted by Carrell, 1985; Raymond, 1993; and Dole et

al., 1996, which compared the effectiveness of two kinds of reading strategy training. In these studies, the independent variables were English teaching models and the dependent variables were gain scores on a reading comprehension test and scores on a strategy use questionnaire before and after the course. Process variables were also investigated in this study through a think-aloud study and a diary study, giving a fuller picture of strategy use among the two groups of students.

This study was designed as a true experimental study. Apart from the six basic features of an experimental study mentioned earlier, according to Hatch and Farhady (1982:22), a true experimental design has three characteristics: 1) a control group or groups is present 2) the students are randomly selected and assigned to the groups 3) a pre-test is administered to capture the initial differences between two groups. They also state that these three characteristics allow researchers to achieve high internal validity and also some external validity. This experimental study was designed using two matched groups. The subjects were divided into two groups based on their English scores on the university entrance examination. The students were paired according to these scores. Each pair was divided by simple sampling: one was placed in the experimental group, the other in the control group. Both control and experimental groups contained roughly even numbers of male and female students. The overall procedure of the study is presented in the diagram below.

	Pre-test	Questionnaire	Variables	Post -test	Q2
Control group	O1	Q1	X 1	O2	Q2
Experimental group	O1	Q1	X 2	O2	Q2

O1 = Pre-test

O2 = Post-test

X1 = Teaching through the traditional reading teaching method

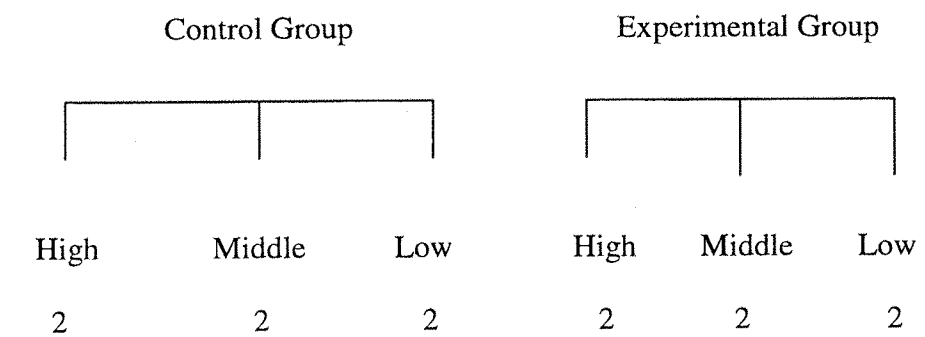
X2 = Instruction activating reading strategies

Q1 = Pre-questionnaire

Q2 = Post-questionnaire

All subjects were given the same pre-test of reading comprehension and completed the same pre-instruction questionnaire on reading strategies. The subjects in the control group were taught by the researcher using traditional reading instruction every Tuesday for three periods of 60 minutes a week, while the experimental group were also taught by the researcher using an experimental approach designed to activate reading strategies, for the same duration on Fridays. The study took place over twelve weeks. After the twelfth session all subjects were given a reading comprehension post-test and they were asked to complete the reading strategies questionnaire again.

According to their pre-test scores the subjects were also further classified into high, medium and low reading ability sub-groups.



Twelve students were then randomly selected from the high, medium and low reading ability sub-groups of both the control group and the experimental group. These twelve subjects worked individually with the researcher using a think-aloud process once a week for two hours each time. They also kept diaries of their reading activities every day, which were collected every week for 10 weeks.

3.1.2 Population

The subjects of this study are all first year students in the Applied Physics Department, Faculty of Applied Science, King Mongkut's Institute of Technology, North Bangkok (KMITNB), Thailand. The 74 participants comprise 28 females and 46 males aged between 16 and 19 years. According to the university entrance system in Thailand, it can be said that they are average Thai undergraduate students, who have already been studying English for about 9-12 years. They have little chance to practise English regularly outside class and most of them find it difficult. Of the four skills, they responded through the questionnaire (ie.the first part of the strategy questionnaire) that reading was the most important skill for them, as they have to use this skill for their other studies. As a requirement of the bachelors degree, the students have to submit projects and for these they have to read a lot of scientific and technical texts, which are in English. They believe that their difficulties in reading are the result of difficulties in vocabulary, grammatical structure and text organisation, i.e. they believe they have language problems even though they have studied English for quite a long time.

Two treatment groups were established as described above. The mean pre-test scores for the control group and the experimental group were 16.87 and17.08 respectively. A t-test performed on these means confirmed that they were not statistically different, suggesting that there was no difference between the two groups in terms of reading ability in English before the course.

3.1.3 Validity of the research

As had been said, the fundamental purpose of using a true experimental design is to achieve high internal and high external validity, supporting the credibility and generalisability of the research.

3.1.3.1 Internal validity

The true experimental design generally has high internal validity since more than one group is involved and the groups are formed by random assignment (McDonough and McDonough,1997:54). There are many factors which can influence internal validity, such as history, maturation, testing, instrumentation, selection and experimental mortality.

To control the history factor, the subjects in this study are all Thai students who were in the first year programme of the same department, Applied Physics, Faculty of Applied Science. The subjects have similar backgrounds as explained in the population section. The control group and the experimental group were formed by matched sampling. By using random assignment the researcher could take care of the selection procedure. Since the subjects were first year students aged between 16 to19 and the duration of the study was 12 weeks there was no problem with maturation. To minimise test and instrumentation effects, the reading comprehension test and reading strategy questionnaire were designed, piloted, and revised so as to maximise reliability and validity. The same test was used as both pre-test and post-test. Since the gap between the two test administrations was 11 weeks and the students did not know the correct answers, it was assumed that any test familiarity effect was minimal. Experimental mortality could be controlled since English is a compulsory subject. Thus, it can be said that the study was well controlled and has high internal validity, which leads to high credibility for the interpretation of the eventual findings.

3.1.3.2 External validity

Internal validity is of prime importance when designing any experimental study. But an experiment would have little utility if the results cannot be generalised to other similar situations, so external validity is also important. It is obvious that a true experimental study is relatively free from internal validity threats. Moreover, McDonough and McDonough (1997) stated that the feature of generalisability or external validity is a prize attribute of good experimentation: 'the fact that this method can attack issues isolated from other effects and contamination from contextual details enables conclusions about those issues to be made in the form of general statement' (p.165). However, the procedure cannot fully control some factors which may affect external validity. To minimise possible Hawthorne effects, for example the researcher tried to control the independent variables by following pre-determined teaching principles, as shown in the next section. Also, both groups were taught by the researcher for the same duration, with the same materials and teaching aids. The subjects were all students in a single university department, but according to the university's entrance exam scores, the subjects were of average level within the whole cohort. The researcher is a teacher in the institute; therefore, this can be seen as a direct model for teacher-led research and the location approximated to a natural setting.

3.1.4 Structure of the two instructional approaches

Teaching approaches are the independent variables of this study. Key elements of the two approaches to English reading instruction are shown below:

	Traditional basal Approach	Activating reading strategies
Theoretical framework	Bottom up model of reading and schema theory.	Interactive model on the transfer of reading strategies.
Assumption about the reading process	Reading is the construction of meaning from letters, words, phrases and sentences.	Reading is the construction of meaning from texts, through reading strategies and background knowledge.
Instructional focus	Maximise comprehension of a given text.	Transfer of learned strategies to independently read text
Expectation of the teacher	Develop students' reading ability through bottom up model and schema theory.	Develop students' reading ability by activating metacognitive awareness and promote transfer.
Teacher activities	Provide students with vocabulary related to the texts and important concepts and schemata relevant to the texts.	Provide students with activities to activate the use of reading strategies.
Students' tasks	Practise reading comprehension, through the	Discussion, using strategy processes while reading,

steps of vocabulary and text understanding, answering questions, completing worksheets, reading and working on exercises.	completing worksheets, answering questions and evaluating.

3.1.5 Description of the two reading teaching approaches

3.1.5.1 Traditional English reading instruction

Traditional English reading instruction in Thailand is based on a combination of bottom up reading theory and schema theory. According to bottom up theory, reading is viewed as a decoding process; the reader attempts to reconstruct the writer's intended meaning by recognising the letters and words as meaningful units (Barnett, 1989:18-19). Therefore, the role of vocabulary in reading is important. However, Thai teachers also give an importance to activating students' background knowledge. As stated by Bransford (1979:141) 'the presentation of information that helps people activate appropriate knowledge can have powerful effects on their abilities to comprehend, to remember and to solve problems'.

Showing influence from both models, the traditional English reading instruction is intended to maximise students'comprehension of texts. The teaching is divided into three stages, a pre-reading, while-reading and post-reading stage. The class starts with the activation of students' background knowledge about the topic of a to-be-read text. This might be through activities such as class discussion, questioning games, reference to pictures or other teaching aids, or silent time.

Following these principles, in the present study, the teacher introduced the topic of the day, then encouraged students to activate their prior knowledge about the topic by thinking silently or through any of the activities mentioned above. The aim of this stage was to make students ready for the lesson, and to stimulate their interest in the topic as well as activate their background knowledge.

After that the teacher presented important passages, specific information, and concepts from the text to be read. This presentation included a basic outline of the central problem of the text but not how this was resolved. The aim of this stage was to provide the students with the overall structure of the text.

Following this stage was vocabulary and grammatical explanation. A vocabulary list for the to- be- read text was distributed to the students, and the teacher explained the meaning of the vocabulary within the context of the to-be-read text. The selected grammatical structure was explained. The overall aim of this stage was to provide the students with declarative knowledge about the grammatical structure and the vocabulary.

In the while-reading stage, students read individually and silently most of time. When they had finished reading, students did comprehension practice exercises on their own.

At the post-reading stage, the teacher explained the text again in detail. The students could ask if they had any problems about the text. The teacher then checked the students' understanding by asking questions. The class ended up with a discussion and summary related to the problem of the text and its resolution. An example lesson plan for this method is in Appendix A (Control group).

3.1.5.2 Strategy Instruction

Strategy instruction is based on a cognitive theory of language learning. According to this theory, learning strategies are behaviours and thoughts that a learner engages in during learning that are intended to influence the learner's encoding process (Weinstein and Mayer, 1986:315). In this model the readers are not passive receivers of the information from the text. They bring with them an abundance of knowledge that facilitates their interpreting information from the text. Comprehension occurs when readers integrate their existing knowledge with new information derived from the text (Anderson & Pearson, 1984:256). When strategy instruction is applied to reading, its aim is to develop students' conscious awareness of reading strategies that they could apply to texts when they read on their own. In this case, students were taught how to use their knowledge of reading strategies. This included how to set a purpose for reading, how to make predictions, how to find the main idea within a text, how to identify the main problem of the text and how to identify a resolution. This procedural knowledge was combined with conditional knowledge about why such strategies are helpful and how to use them flexibly, i.e. activate their metacognitive awareness.

We have accepted Wenden's (1987) argument that practising strategies on authentic language tasks facilitates the transfer of strategies to other tasks. Consequently, in this study strategies instruction is integrated in English reading teaching to promote students' metacognitive awareness. As recommended by O'Malley and Chamot (1990), Cohen, (1998) and Grenfell and Harris (1999) strategies are taught directly and explicitly to the experimental group. From the various frameworks of strategies instruction reviewed in Chapter II, we have drawn upon the work of Wade and Reynolds (1989) in combination with the guidelines stated by Cohen (1998). So the steps involved in writing lesson plans for the experimental group include:

1) Determine the strategies that learners already use
2) Study all the reading materials, determine their content and linguistic objectives
3) Identify strategies to be taught
4) Determine the strategies that are well-matched in instructional objectives, content objectives and teaching materials
5) Determine the co-operative activities that match the lessons

As for the control group, the experimental class was divided into three stages, pre-reading, while-reading, and post-reading. However, the objectives and the procedure were different.

- The pre-reading stage: developing task awareness

The main objective of this step is to help students become aware of what information in a text is most relevant to their reading purpose. Brainstorming was seen as an effective activity to develop their reading task awareness. After having students read the text, they brainstormed the ideas or information they found important, then recorded their response on the board, and were asked to explain their reasons for selecting each item. After brainstorming, the teacher helped the students to develop their judgement criteria, by asking them what type of information they should pay more attention to, and why. Then on the board the teacher wrote various headings: types of information - main idea, major details, minor details, examples. The outcome of this activity should be a listing of important criteria that students should keep in mind as they read. The activity could be practised in small groups or class discussion, and could be repeated until the students were able to identify the information.

- The while-reading stage: strategy awareness

Once students have analysed the reading text they must become aware of the active use of strategies, through naturalistic practice. This involves making them aware of both the kinds of strategies they can use and the different reasons why these are useful. Therefore, again brainstorming was used to develop students' awareness of reading strategies. A strategy definition sheet and record of reading strategy use (see Appendix A (Experimental group)) were handed out, on which students could check the strategies they used while reading. Developing strategy awareness is said to be an essential component in effective strategy instruction (Oxford and Leaver, 1996:230-231). This will help the students to develop their awareness of different types of strategies, including how, when and why they would be most effective.

- Post-reading stage

The post-reading stage included class discussion about the organisation of the text, including discussion of the main problem and its solution. The class ended up with students evaluating their own work, then peer evaluation. It is important for teachers and learners to recognise that some strategies may be more suitable to some learners than others. Many findings indicated that males and females at different levels of proficiency are likely to use different kinds of strategies (Naiman, Frohlich & Todesco, 1978; Rubin, 1975; O'Malley & Chamot, 1990; Green and Oxford, 1995). Students can carry out a small group activity to compare the results of their assessment of strategy use and discuss why they prefer the strategies they used. Students may find that they are using a variety of reading strategies, but the most important issue is not that they use any particular methods but rather that they use them effectively.

3.2 Research Instruments

This study used a combination of both quantitative and qualitative techniques. Thus several research instruments were employed. The next sections describe the research instruments in detail.

3.2.1 The construction of the reading comprehension test and the pilot study

Testing is a vital instrument in experimental studies. Results of tests can be used in describing processes of language learning, evaluating courses, reporting the progress of learners and comparing the effectiveness of teaching approaches. Davies (1990:2) offers the role of language testing as: 1) an operationalising of theoretical constructs; 2) a means of establishing goals and standards for teaching courses and syllabuses; 3) a methodology for carrying out empirical research in applied linguistics, whether that research is language testing research, investigations in language acquisition, judgements, intelligibility studies, comprehension and use, or comparative experiments in language teaching methodologies and materials. In this study a test of reading comprehension served as a tool to examine the level of students' reading ability and to compare the effectiveness of two teaching approaches. The reading comprehension test designed for this study comprises three reading passages and thirty multiple-choice questions. These questions aim to measure students' ability to read passages in English for details, to draw inferences and implications and make interpretations. Each reading passage is 250-500 words long. This test was designed as an intermediate proficiency test, as appropriate to the students' level in English.

To construct the test, the researcher followed the four stages proposed by Davies (1990:12-13), which were a planning stage, pre-pilot stage, pilot stage and final validation stage. In the planning stage, the researcher planned the content and general layout of the test, and decided on the type of test item to be used, the length and the method of scoring. This stage included production of a set of test specifications. Following the view of Davies (1990:2) that tests should reflect language theory, in this study reading is seen as an interactive process taking place between the reader and the text, in which both background knowledge and language knowledge contribute to text comprehension. Accordingly, the reading comprehension test was based on the specifications shown in Table 3.1 (Cohen, 1994: 225-233). (For the test itself, see Appendix C.)

Table 3.1: Reading comprehension test specifications

Students' behavioural objectives	**Number of items**
1. Guess the meaning of vocabulary items by using internal and external context clues.	3
2. Show awareness of the use of cues in texts. Refer or give references of words	8
3. Extract specific details from the text	7
4. Report the main idea of individual paragraphs	5
5. Infer conclusions and predict continuations	2
6. Interpret complex ideas, events and relationships	3
7. Perception of author's idea	2

Multiple-choice questions are a common device for testing students' text comprehension. They allow testers to control the range of possible answers to comprehension questions, and to some extent to control the students' thinking processes. However, writing multiple-choice items is not straight forward. By virtue of the distractors, they may present students with possibilities they may not otherwise have thought of. Furthermore, students can learn how to answer multiple-choice questions by eliminating improbable distractors (Alderson et al., 1995:50). Taking these points into consideration, the researcher studied the testing textbook by Alderson et al. (1995) and carefully wrote plausible but incorrect options that she hoped would attract the weaker readers but not the better readers. The first draft of the test was pre-piloted with four Thai students. Then the content validity and construct validity were checked by asking three experienced English teachers to respond to the test items. For a full assessment of the reliability and validity of the test it was piloted in Thailand in May and then in June 1999. The pilot test was administered to 80 first year Applied Science students of KMITNB. Item analysis was conducted to find the overall difficulty, discrimination and reliability levels of the test. The test was again revised and those items that did not perform well were rejected or modified.

Item analysis is a means of estimating how much information each single item in a test contributes to the information provided by the test as a whole. It enables the researcher to find out how easy or difficult each item is (index of difficulty) and how well it distinguishes the better students from the poorer ones (index of discrimination). Item discrimination is the ability of an item to distinguish between good and poor students. To investigate the index of difficulty and the index of discrimination, the data from the pilot study were analysed by using a testing programme by Sukamolson (1998). Apart from the difficulty and discrimination levels, test reliability was also assessed using the Kuder-

Richardson 20 formula (Sukamolsan,1998: 49) in order to ascertain that the test was consistent in its measurement. The general results of the third pilot test were: overall index of difficulty 0.45, overall index of discrimination 0.44, and the reliability index (KR20) 0.77 which is judged adequate reliability (Sukamolsan, 1998:55). (Full details of the item analysis are given in Appendix D.)

3.2.2 The think-aloud procedure and the associated pilot study

3.2.2.1 Literature review

There are several methods which can be used in investigating the use of language learning strategies such as interview, questionnaire, observation, verbal report, and diaries. One extensively used method to investigate learning strategies is verbal report. This research technique is claimed to be an effective approach in the study of cognitive processes as stated by Cohen (1997:34): 'We would suggest that verbal report measures provide a more viable - perhaps the most viable means of obtaining empirical evidence as to strategies use than other means'. This statement is supported by Pressley and Afflerbach (1995:1), who discussed it as 'A maturing methodology with much interesting work already accomplished'. In general, verbal reports include data that reflect:

- self-report: learners' descriptions of what they do, characterised by generalised statements about learning behaviour -e.g., 'I tend to be a speed listener.'
- self-observation: the inspection of specific, not generalised, language behaviour, either introspection, i.e. within 20 seconds of the mental event, or retrospectively - e.g., 'What I just did was to skim through the incoming oral text as I listened.'; picking out key words and phrases' and self-revelation or think-aloud; stream of consciousness disclosure of thought processes while the information is being attended to- 'What does they refer to here?' (Cohen, 1998:34).

Examples of learning strategies studies where verbal reports are employed are numerous and several have been described in Chapter 2 (Naiman et al., 1978; Cohen and Aphek, 1981; Hosenfeld, 1984; O'Malley et al., 1985a; Wenden, 1986; Block, 1986; Kern, 1994). In such studies, think-aloud was employed as a means of describing strategies in second language learning. Olson et al. (1984) refer to Ericsson and Simon (1980), who give suggestions regarding the use of think-aloud. First, information about the immediate awareness of readers should be the focus of the think-aloud task, not explanations of their behaviours. Second, what readers are thinking about at the time they are reading, not what they remember thinking about earlier, should be reported. Third, readers should be encouraged to talk about aspects of their immediate experience which they can talk about, taking into account that some processes are not accessible to introspection nor easy to verbalise.

As a result of their work using think-aloud technique, Randall et al.(1986) contend that protocols received from this technique are powerful as they can be used by researchers or by teachers as diagnostic tools for their students to receive useful information about the interactive nature of the reading process. For example, some students may employ a useful strategy inappropriately in a way that hinders the main focus of the text. 'Using the protocols procedure the teacher can observe how students gain insights into their habits as they go through the protocol process'(p.241). Think-aloud technique gives an opportunity to teachers who otherwise may not be aware of reasons why their students arrive at wrong conclusions in reading comprehension as stated by Rankin (1988): ' By knowing what strategies second language readers actually use when reading (as opposed to what they think they do), we will not only improve our understanding of reading as a communicative act but also our understanding of how it might best be taught'(p.122).

In this study, think-aloud was employed to gain insight into the reading process of the subjects. Think-aloud is considered to be a direct way of investigating cognitive processes, and has previously been used with problem solving tasks (Newell & Simon, 1972) . Although many cognitive processes related to comprehension occur outside of awareness, a successful reader is likely to be aware of at least some key cognitive activities that occur while reading (Hosenfeld, 1977; Padron and Waxman, 1988). Olson et al (1984) believe that think-aloud is an effective tool to use in order to gain information about comprehension processes. According to Olson et al. (1984) 'These data should reveal the kinds of strategies used by readers in accomplishing these tasks, the kind of knowledge sources employed, and the kind of representations constructed' (p.257). Similarly, Aflerbach and Johnston (1984) support the use of think-aloud tasks in reading research because 'they provide veridical descriptions of cognitive processes which otherwise could only be investigated indirectly,....they allow access to the reasoning processes underlying higher level cognitive activity, and they are sometimes the only available avenue for analysis of mental processes' (p.308). The think-aloud tasks vary according to the researcher's purpose. If the goal is to gain unanalysed information about readers' thinking processes, then readers should be told to 'let the thoughts flow verbally without trying to control, direct, or observe them...thus think-aloud data are, by their very nature, unanalysed and without abstraction'(Cohen & Hosenfeld, 1981:286).

Like any other technique, think-aloud has limitations and drawbacks of which researchers should be aware. Paris et al.(1988) point out some problems with the technique: many underlying cognitive processes may not be accessible at a conscious level to verbalise; the readers' choice of words may be inaccurate; and other factors such as age, anxiety, or self-disclosure may affect protocols. Another limitation of think-aloud is that it may be more applicable to readers who are readily able to master the technique, to

introspect and articulate their reading behaviour (Carrell, 1989). Therefore there is a need to train subjects to be familiar with the task.

Another criticism comes from the possibly intrusive effect. For example, Cohen (1998) refers to Man (1982): 'in reading research, attention is drawn to the possibility that immediate retrospection may distort the process of reading if the readers read more closely than normal, read sentence by sentence, or concentrate on the additional cognitive and metacognitive task' (p.37).

Some researchers who are sceptical about verbal report data have some criticisms focusing on their unreliability. Ericsson and Simon (1980) critiqued that probing may force the subjects to produce a verbal response that is not closely related to the actual thought process. Think-aloud protocols may be systematically contaminated by an indulgence in shared assumptions (Dobrin, 1986). In fact, protocols have been depicted as an edited replay of the respondents' perceptions.

Since second language reading involves both lower level and higher level processes (Carrell et al., 1988; Rumelhart, 1977), not every technique is able to capture all processes efficiently. Olson et al. (1984) note that lower level processes such as syntactic and semantic analysis of sentences may be better analysed by other procedures. However, according to Olson et al., the think-aloud technique 'is best used to study the higher level processes in reading: the inference, predictions, schemata elaboration and other complex cognition that occur as part of skilled reading'(p.225). Cohen (1998) concluded on the value of this technique: 'research has demonstrated that verbal reports, elicited with care and interpreted with full understanding of the circumstances under which they were obtained, are, in fact, a valuable and a thoroughly reliable source of information about cognitive processes' (p.38). It seems that verbal reports, although not perfect, provide more complete access than can be obtained through observation or other sources.

3.2.2.2 The think-aloud pilot study

In order to make sure that the think-aloud technique was appropriate for this study, and to try to minimise problems in using it, a pilot study of the think-aloud process was needed. Since the researcher had never used this technique before it was necessary for her to learn how to run the activities and how to analyse the data. Furthermore, it was expected that if successful, the pilot study would shed some light on how Thai students monitored their comprehension when reading an English text and what strategies they used, so that the results of the pilot think-aloud study could be used as contributory material for designing the reading strategy questionnaire.

The pilot study was conducted in September 1998 in Thailand, using four undergraduate students. All subjects read the same materials to uphold the reliability of the pilot study. They performed think-alouds eight times during fifteen days (7-21 September 1998). All sessions were audiotaped and transcribed. In order to familiarise the subjects with the think-aloud procedure on the first occasion the researcher explained all the procedures in Thai, gave a demonstration using a trial passage, and then asked the subjects to read selected English texts. As they did so they were asked to think-aloud reporting the reading strategies they were using. So the reading texts serve as a tool to elicit reading strategies. The reliability and validity of the think-aloud procedure depends a lot on the selection of reading texts. Hence, the texts were selected according to the criteria suggested by Singer & Donlan (1989:145) as follows:

- The researcher selected independent whole texts (complete articles) rather than text excerpts.

- The researcher selected materials that presented new information, on topics appropriate to the students' ages, educational level and interest. (See Appendix G for the think-aloud texts)

Fifteen texts of 200 – 400 words were selected from periodicals in science and technology for the pilot think-aloud procedure. The selected texts were given to four other science students prior to the pilot study, and their comments were taken into consideration. The texts which were considered too easy, too difficult or irrelevant were excluded, and others revised. The revised texts were then given to four students to read, using the think-aloud procedure. Most subjects were articulate in reporting their thoughts. The researcher did some probes such as 'What are you thinking right now?' when the subjects were silent for a period of time to make them aware of their thinking process. She also asked clarification questions when it was unclear to her what the subject was talking about. However, these interventions did not occur frequently. All sessions were audiotaped, and analysed. The protocols provided useful access into how the readers were using their strategies. This was helpful both for selection of the real think-aloud texts, and also for the construction of the reading strategy questionnaire.

After the interviews and think-alouds were conducted, the data was then transcribed, categorised, analysed, and interpreted. Since think-aloud data has a low degree of structuring, it is necessary to develop analytical categories step by step. According to Strauss and Corbin (1990:56-59) coding serves to summarise, synthesise and sort out the emergent themes in interviews, observations and other sources. The researcher carefully read the studies by Hosenfeld (1977) and O'Malley and Chamot (1990) and decided to use their definitions and taxonomy of learning strategies as a basis for the reading strategy list to be used in this study, with a specific code for each strategy. Then, the researcher carefully read and coded the transcripts.

3.2.2.3 Lessons from the think-aloud pilot

Cohen (1998:91) has pointed out that whereas verbal reports are incomplete because many important psychological process are completely unconscious, the collecting of verbal report data is still very beneficial in that they provide direct evidence about processes that are otherwise invisible. Thus, the researcher decided to choose this technique in investigating reading strategies. The following are important points that the researcher learned from this pilot study.

First, there was a problem with isolating cognitive processes. As mentioned by Pressley and Afflerbach (1995:19), one problem of think-aloud is that socio-psychological variables interfere with cognitive variables. Since reading, especially in a foreign language, is a very complicated process the subjects complained that they could not comprehend the passage as the same time as 'talking' with the researcher. So they were allowed to use immediate retrospective verbal report after they had read the passage. With these retrospective reports the researcher found some other problems such as the subjects forgetting what they were thinking about during reading, and coming up with new ideas while retrospecting. Hence, the researcher decided to use the suggestions by Greene and Higgins (1994) for improving the reliability and validity of think-aloud, a) by minimising the time between process and report, and b) making clear the purpose of the study.

Second, warm-up or training time was needed. Though the idea of think-aloud is to ask the subject to verbalise 'everything that passes through his head' (Ericsson and Simon, 1980:36), this was not easy in the real task. The subjects must be given warm-up or training time, otherwise they could not report their thinking, but still most of the time they only reported their understanding of the passages. So as a training activity the researcher applied the problem-solving strategies suggested by Greene and Higgins

(1994). The subjects were asked to complete a jigsaw puzzle, and while doing that task they were asked to think-aloud how to solve the problem. This worked quite well, though some subjects needed to be asked questions like 'Can you tell me the strategies you are using?' or ' What are you thinking about?' when they were quiet for a long time. As the subjects became more skilful with the think-aloud technique, they could report more fluently.

Third, to increase reliability, interrater agreement was needed. The researcher asked two fellow research students to analyse one think-aloud transcript by giving them the reading strategy list with the definitions for each strategy, and asking them to identify the strategies they found in the transcript.

The results of the think-aloud pilot study have proved that this verbal report is an efficient technique to gain access to mental activity. Taking into consideration the nature of the technique, the researcher believes that when think-aloud is used in a cautious manner, for example, after training subjects to fully understand the task, while avoiding probing as much as possible, it will produce valuable information on readers' cognitive processes while they read English texts. From the points mentioned above, the researcher has learned how to use this technique and felt more confident in using think-aloud in the real study.

Overall the pilot study gave valuable information to the researcher as to how to conduct the main study properly and how to avoid mistakes. The procedures described above for the pilot study proved satisfactory and thus were used largely unchanged in the main study. The only important development was the conduct of a more substantial reliability trial on codings conducted for the main study, which led to some further minor changes to the reading strategies coding scheme (See section 3.2.3 below).

3.2.2.4 Categorisation of strategies

The variety of reading strategies proposed and of the individual terms used by different researchers results in a lack of any established, clear taxonomy of reading strategies. For example, as reviewed in 2.5.1, Hosenfeld (1977, 1984) offered catalogues of types of second language readers. She listed a number of effective reading strategies and ways to encourage students to use these strategies. Block (1986) categorised the strategies in her study into two levels: general comprehension strategies (10 strategies), and local strategies (5 strategies), while Bialystok (1981) divided reading strategies in her study into practice, monitoring, and semantic inferencing. Casanave (1988) divided strategies into two categories: routine monitoring, and repair strategies. The former consist of predicting, and checking understanding, and the latter consist of evaluating what the problem is, deciding how to solve it, implementing it and checking the results. Pereira (1991) classified her eight moves into four major strategies: classifying, evaluating, reasoning, and monitoring understanding.

Studies of reading strategies are a subset of language learning strategy research. In this study, hoping for a more generalisable set of concepts and greater agreement on the taxonomy of reading strategies, the researcher adopted the well developed taxonomy of language learning strategies from O'Malley and Chamot (1990) as a foundation for the taxonomy of reading strategies identified in this study. According to van Dijk and Kintsch (1983), a strategy is 'the idea of an agent about the best way to act in order to reach a goal' (p. 64-65). In this study, all reading behaviours or actions initiated by the subjects in order to comprehend the text were called reading strategies.

In developing the taxonomy of reading strategies, a quantitative criterion was not used. That is, regardless of the frequency with which the strategy occurred, it was incorporated into the classification. Once the initial taxonomy of strategies had been

compiled, a definition of each strategy was developed based on the taxonomy from O'Malley and Chamot (1990), and an example was drawn from the data in the protocols.

Because the taxonomy of strategies by O'Malley and Chamot (1990) was developed for general language learning strategies, it needs adaptation to cover all 44 reading strategies identified in this study. The researcher tried to relate them as clearly as possible to the main groups and sub-groups of O'Malley and Chamot's taxonomy by focusing on the functional purpose presumed to underlie the employment of each strategy. For instance, 'plan', 'read the title' and 'read ahead' are grouped under preview or advance organization, the term used by O'Malley and Chamot. The function of this group of metacognitive reading strategies is judged to be to 'preview the main idea and concepts of the material to be learned, often by skimming the text for the organising principle' (p. 198). On the other hand, prediction strategies, which consist of 'predict based on title', 'predict based on the picture', 'predict based on the context' and 'predict based on diagram', are classified as cognitive strategies because the readers use these strategies when already engaged with the text, e.g.to predict what might come next or to complete a missing part (p. 199). Some examples of reading strategies, which are classified as affective strategies are 'use interest' and 'react to the text'. The subjects used these two strategies to interact with the text and to make themselves feel competent to do the learning task (p. 199).

The purpose of arranging the strategies into groups and sub-groups based on O'Malley and Chamot was to try to make them more conceptually coherent and generalisable to other studies, by looking at assumed reasons or purposes behind these strategies and grouping them accordingly. The final taxonomy of reading strategies developed in this study are presented in Chapter V.

3.2.3 Developing and piloting the reading strategy questionnaire

In order to explore strategy use of all subjects in the study, and find the relationship between reading comprehension scores and the numbers of strategies used by all members of the experimental and control groups, a questionnaire was developed to elicit quantitative data on use of reading. For this purpose the researcher studied the learning strategy research by Carrell (1989), Oxford (1990), Wenden (1991), and Padron and Waxman (1988). These researchers used questionnaires successfully to investigate language learning strategies; these examples influenced the researcher to adopt the technique, though modified using data on reading strategies drawn from the think-aloud pilot study. Cohen and Manion (1994: 96-97) suggest that clarity of writing and simplicity of design are essential for the use of questionnaires in research. A good questionnaire is one which is relatively easy to answer, easy to record and evaluate, user friendly, and unambiguous. Thus, the researcher designed this reading strategy questionnaire as a 45-item, Likert-type questionnaire on which students were to indicate the extent to which they use the described strategies by responding either (1) Always (2) Often (3) Sometimes (4) Seldom or (5) Never. A mean score approaching 1 indicates that the student reports using the strategies almost all of the time, whereas a score approaching 5 indicates that the student reports using the strategies almost none of the time. McDonough and McDonough (1997: 176) point out that the advantage of Likert type is that shades of opinion may be given numerical values: 'it might be significant if large members of respondents could only bring themselves to agree with a particular statement'. To develop the questionnaire, a list of reading strategy statements was compiled and then categorised according to O'Malley and Chamot (1990) and Wenden (1991) for the purpose of analysis. First an early version of the questionnaire was trialled on three native English speakers and eight Thai students in Southampton. They were asked to correct any mistakes or unclear

wording, give comments on the questionnaire and suggest any other reading strategies they used. Taking their comments into consideration, some questions were eliminated and others revised and edited to be used in the pilot study. The final reading strategy questionnaire comprises 39 reading strategy statements drawn from the pilot think-aloud study, and 6 further statements about factors which may make reading in English difficult. The 39 strategies can be classified following O'Malley and Chamot (1990:197) into three main categories:

1) Metacognitive strategies involving executive processes in planning for learning, monitoring one's comprehension and production, and evaluating how well one has achieved a learning objective.
2) Cognitive strategies in which the learners interact with the material to be learned by manipulating it mentally, such as making mental images or elaborating on acquired concepts or skills, or physically such as in grouping items or taking notes.
3) Social affective strategies in which the learners either interact with another person in order to assist learning, for example co-operation or asking questions for clarification, or using some kinds of affective control to assist a learning task.

3.2.3.1 Structure of the reading strategy questionnaire

Metacognitive strategies were represented by 14 statements as summarised below:

1) Six statements on planning, e.g.

   Before reading I decide what my purpose is.

2) One statement on directing attention

   I skip an unimportant part.

3) Two statements on selection, e.g.

I underline important parts of the story.

4) Three statements on self management, e.g.

I keep on reading if I don't understand something.

5) Two statements on self evaluation, e.g.

I check through the story to see if my understanding is correct.

Cognitive strategies were reflected in 18 statements:

1) One statement on note taking

I take notes.

2) Three statements on resourcing, e.g.,

I look for further information about the texts in other books.

3) One statement on translation

When reading an English text, I translate into Thai.

4) One statement on using imagery

I imagine or draw a picture of the texts in my mind.

5) One statement on summarising

I summarise the content of the text.

6) Three statements on grouping, e.g.

I use figures (1, 2, 3,..) to show the steps or process of the text.

7) One statement on questioning

I ask questions about the text.

8) Five statements on inferencing, e.g.

I guess the meaning of unknown words from the context.

9) One statement on world elaboration

I use my prior knowledge and experience to understand the text.

10) One statement on transferred strategy

I identify grammatical categories of words to help me understand the text.

Affective strategies were represented by five statements related to affective reactions to the text, e.g.,

I am interested in what I am reading.

Difficulties included 8 statements, e.g.,

I have difficulty in grasping the organisation of the text.

(See Appendix E for the complete questionnaire)

3.2.3.2 Pilot study of the questionnaire

In order to develop the reliability of the instrument, sixty pilot questionnaires were sent to Thailand on 12thFebruary1999, and fifty-five copies were returned on 2nd March 1999. The subjects of the pilot study were 55 undergraduate students in the Faculty of Applied Science, KMITNB. The data from the questionnaires were analysed. Using Microsoft EXCEL for the MAC Version 5.0 to input the data, SPSS Version 4.0.4 for the MAC (SPSS Inc., 1990) was used to compute descriptive statistics and perform reliability analysis. The results were then discussed with the supervisor and the questionnaire was revised once again to be used in the main study. The final version of the questionnaire together with data from the pilot study and statistics regarding reliability can be found in Appendix F. The results of the pilot study showed that a reading strategy questionnaire can be used to gain meaningful data especially where the number of questionnaires completed is relatively large.

3.3 Analysis of the data and statistical techniques

3.3.1 Quantitative analysis

To answer research questions 1 and 2, statistical analysis of the pre-test and post-test scores is required. As reported fully in Chapter IV, a t-test was used to compare the mean scores of each group on the pre-test and post-test to determine whether there was any reading ability improvement after teaching. A paired samples t-test was used for testing whether the mean scores of the two groups were significantly different from each other. To answer research questions 4, 5 and 6, strategy use scores were required. Strategy use scores were obtained through the strategy questionnaire. The data were analysed using Pearson's correlation coefficient to explore the relationship between the number of strategies reported and scores on the reading comprehension test. Also a paired sample t-test was used for testing the significant difference between the strategy use of the two groups. Microsoft EXCEL for the MAC Version 5.0 was used to input the data, and SPSS Version 4.0.4 for the MAC (SPSS Inc., 1990) was used to compute descriptive statistics and perform reliability analysis.

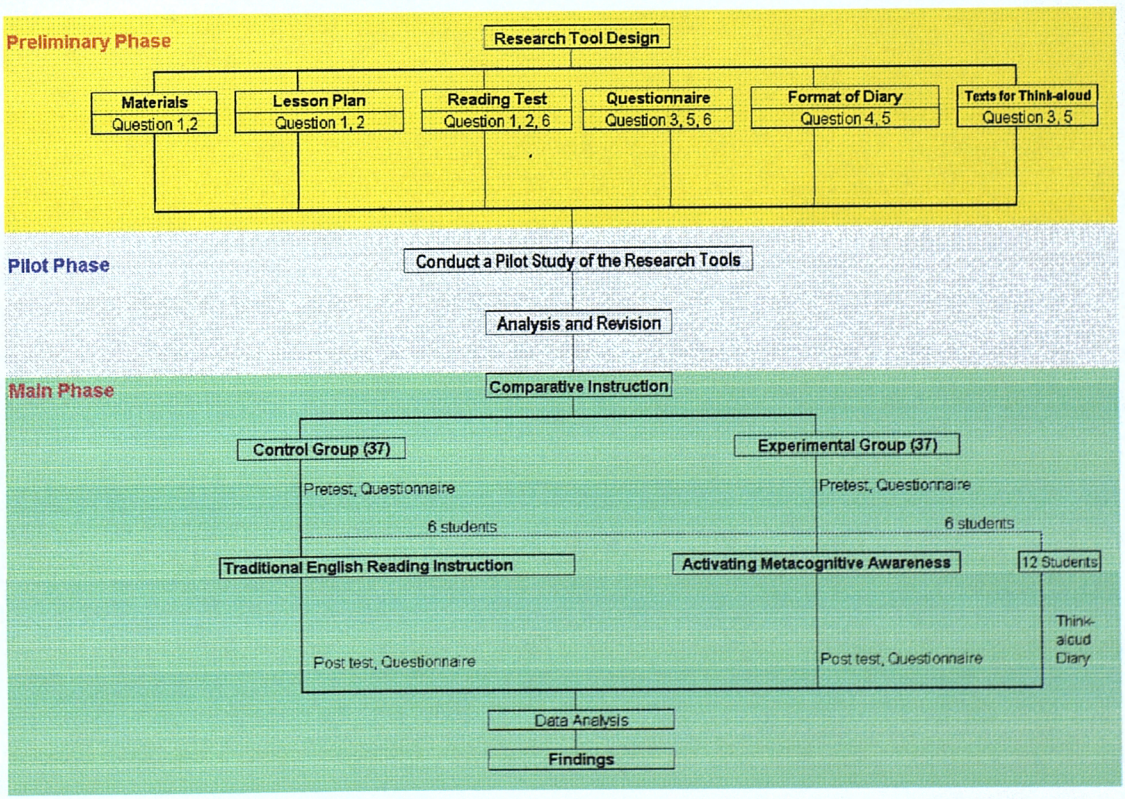
3.3.2 Qualitative analysis

The qualitative dimension of the study provides further evidence regarding both students' use of reading strategies and the transfer of learned strategies (research questions 3, 4 and 5). To gain data on reading strategies in use, as we have seen, interviews and think-aloud procedures were administered to twelve subjects selected from both experimental and control groups. These subjects also completed diaries reporting strategy use during their

out-of-class reading. The audiorecordings from the think-aloud tasks were transcribed and translated into English for the purpose of analysis. The process of analysis of the qualitative data, including the development of a suitable coding scheme and accompanying reliability study, is described fully in Chapter V. To explore the transfer of learned strategies, a diary technique was used. The diaries consist of an A4 sheet for each day to be filled in by the twelve subjects over a period of 10 weeks. The diaries include the headings 'out of class reading activities', 'duration', 'my problems', and 'my reading strategies'(See Appendix I). The data from the diaries was categorised and then analysed in order to answer research question 4.

In sum, designing a mixed research method, especially combining qualitative and quantitative techniques in experimentation, is very complicated. The research design, research tools, and methodology described in this chapter are summarised in Figure 3.1.

Figure 3.1 Research procedure



3.4 Conclusion

This chapter has detailed the methodology that was used in this study. The choice of an experimental design, enhanced by a qualitative investigation into the reading process, has been justified and the relationship of the design to the research questions to be answered has been shown. The chapter has described the participants in the study, the key variables, the methods used to collect the data, the preparation of the research instruments and statistical procedures used to analyse the data. A matched-pairs method was applied to divide the students into two groups, the control group and the experimental group. The control group was taught through a traditional English reading teaching approach while the experimental group was taught so as to activate their metacognitive awareness of reading. Suitable statistical tests were employed to test for any significant changes after the course of instruction and to identify significant differences between the two groups. Qualitative studies were also utilised to investigate an in-depth view of reading strategies used by selected subjects. For an experimental study, the reliability and validity of the research instruments is very important. To achieve this, a range of pilot studies and reliability checks were conducted. With careful preparation at every step, it can be said that the measuring instruments and the data collecting methods are appropriate for the study, and high internal validity can be claimed for the findings of this study.

Chapter IV

Findings of the Quantitative Data Analysis

The last chapter reported the research methodology, instruments and procedure. Chapters IV and V report the findings of the main study, which are divided into two main parts; the quantitative data and the qualitative data.This chapter is itself divided into two major parts, which present the results of the reading test and the findings of the strategy questionnaires. In the first part, an analysis of reading test scores is reported to answer research questions one and two. In the second part, findings from the reading strategy questionnaire are analysed and reported to answer research question three.

For the readers' convenience the research questions are restated:

1. Is there any reading ability improvement after applying the two approaches: the traditional reading teaching approach and strategy instruction?
2. Is there any significant difference in the level of reading ability of the students resulting from the two approaches?
3. What reading strategies do the Thai students apply in order to understand English texts?
4. Do readers transfer learned strategies to their extensive reading processes?
5. Is there any significant difference in strategy use between students taught using the traditional and experimental approaches?
6. Is there any relationship between reported patterns of strategy use and students'scores on reading comprehension tests?

4.1 Results of the reading test

The presentation of the findings is organised as follows:

4.1.1 A comparison of pre-test scores between the control group and the experimental group

4.1.2 The effect of teaching reading through the traditional method

4.1.3 The effect of teaching reading through strategy instruction

4.1.4 A comparison of the reading ability of the two groups after applying the two methods.

4.1.1 Comparison of pre-test scores between the control group (group A) and the experimental group (group B)

The subjects of this study were 74 first year students who were equally divided into the control group and the experimental group. In order to divide the students into two groups of similar ability in English, the students were paired according to their English scores on the university entrance exam, as described in chapter III. Each pair was divided by simple sampling: one placed in the experimental group, and the other in the control group. In order to confirm that the reading ability of these students in the two groups was not significantly different at the beginning of the study, the reading test devised for the study was administered as a pre-test. The pre-test scores of the two groups were analysed and presented in Table 4.1.

Table 4.1: A comparison between pre-test scores of the control and the experimental group

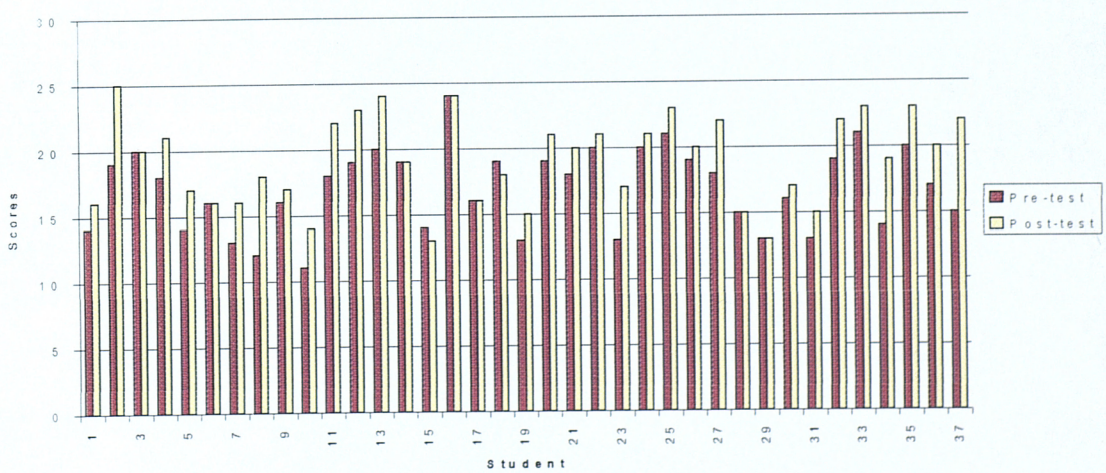
Group	N	Mean	Standard Deviation	t- value	Sig. (2-tailed)
Control (A)	37	16.8649	3.0474	-0.318	0.752
Experimental (B)	37	17.0811	2.8026		

The pre-test scores of the two groups were compared by using an independent sample t-test. The data in Table 4.1 indicate that the mean scores of the two groups were not significantly different. The mean scores of the control group and the experimental group were 16.86 and 17.08 respectively. The t-value was -0.318 with a two-tailed p value of 0.752, i.e., a non-significant value. So it can be concluded that there was no significant difference in the reading proficiency of the two groups of students at the start of the study.

4.1.2 Comparison of pre-test and post-test scores of the control group (group A)

After the pre-test, the control group was taught through the traditional method for ten weeks. To find out whether the students made any progress in reading ability during this period of traditional instruction, a post-test was conducted in the eleventh week to measure their achievement. The scores obtained by individual group A students on the pre- and post-tests are presented in Figure 4.1.

Figure 4.1: The pre-test and post-test scores of the control group



The pre-test and post-test scores of the control group were compared to see whether the students' reading ability improved after being taught through the traditional method. As we can see from Figure 4.1, most of the reading scores of the students in this group improved after being taught for 10 weeks. To find out whether this difference was statistically significant, the scores were compared by using a paired sample t-test and the results are presented in Table 4.2.

Table 4.2: A comparison of the pre-test and post-test scores of the control group

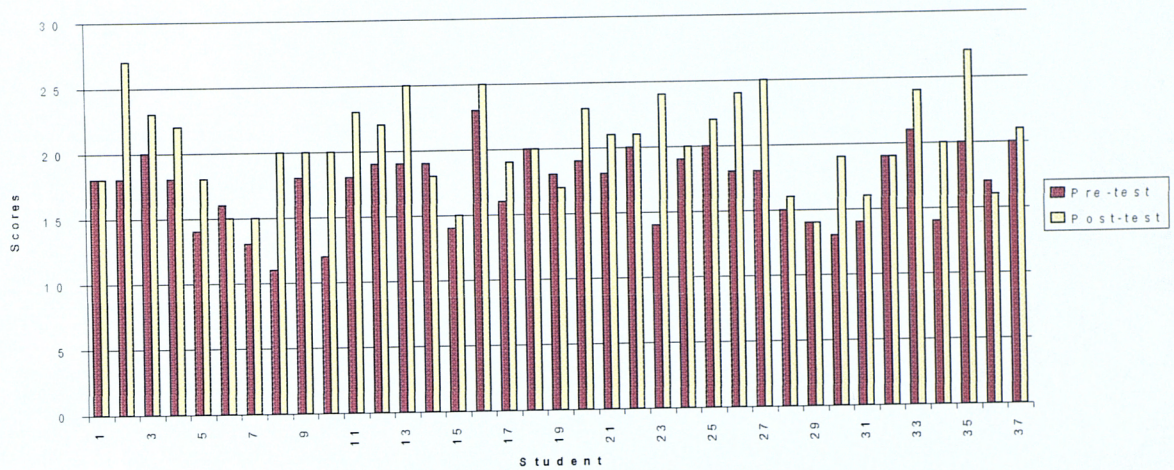
Test	N	Mean	Standard Deviation	t	Sig. (2-tailed)
Post-test	37	19.0541	3.4071	5.832	0.000
Pre-test	37	16.8649	3.0474		

The result of the t-test shows that there is a statistically significant difference between the control group scores on the pre-test and the post-test. The mean score on the pre-test was 16.86 and the mean score on the post-test was 19.05. The t-value was 5.83 (sig.0.00). This shows that the students in the control group made a significant gain in reading achievement after being taught through the traditional method for 10 weeks.

4.1.3 Comparison of pre-test and post-test scores of the experimental group (group B)

After the pre- test, the students in the experimental group (group B), were taught through strategy instruction for the same 10-week period. To find out whether the students in this group improved significantly in their reading ability, the same post-test was given to this group in the eleventh week. The scores of the pre-test and post-test for individuals in group B are presented in Figure 4.2.

Figure 4.2: The pre-test and post-test scores of the experimental group



From the bar graph, it can be seen that most of the students in Group B also gained higher scores in the post-test. In order to see whether there is a statistically significant difference between the pre-test and post-test scores for this group, results were again obtained by using a paired samples t-test, which is illustrated in Table 4.3.

Table 4.3: A comparison of the pre-test and post-test scores of the experimental group

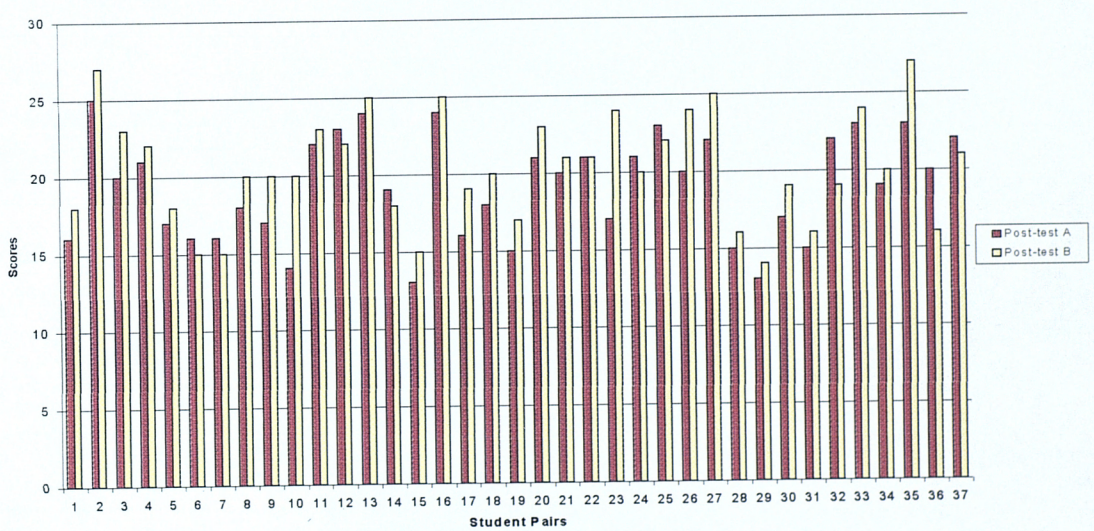
Test	N	Mean	Standard Deviation	t	Sig. (2-tailed)
Post-test	37	20.2432	3.5932	6.249	0.000
Pre-test	37	17.0811	2.8026		

The group B mean score on the pre-test was 17.08 and that on the post-test was 20.24. The t-test result indicates a highly significant difference between the pre-test and post-test scores (t-value = 6.25, sig. = 0.00). This means that Group B students also made good progress after they were taught to activate their metacognitive awareness .

4.1.4 Comparison of the reading ability of the two groups after applying the two methods

So far we have seen that both the experimental and control groups made significant gains in reading ability during the 10 weeks of the study, as measured by pre- and post-test scores. To answer research question two, whether there is any significant difference between the two groups after experiencing the two methods, the post-test scores of the two groups were compared and presented in Figure 4.3.

Figure 4.3: Post-test scores of the control and the experimental groups



The data in Figure 4.3 show that the post-test scores of the experimental members of the student pairs were often higher than those of their partners from the control group. To see whether there is a statistically significant difference between the two groups, the post-test scores were compared by a t-test, and the results are presented in Table 4.4.

Table 4.4: A comparison between the post-test scores of the control and the experimental group

Group	N	Mean	Standard Deviation	t	Sig. (2-tailed)
Control	37	19.0541	3.4071	-3.672	0.001
Experimental	37	20.2432	3.5932		

Table 4.4 shows that the mean post-test scores of the experimental and the control group were 20.24 and 19.05 respectively. The t-test indicates a statistically significant difference between the achievement of the experimental group and the control group (t value = -3.67, sig. = 0.001). While both groups improved their reading test scores in the course of the study, the experimental group showed a significantly higher gain in reading ability than the control group. This key finding indicates that the research data supports the main hypothesis of the research.

4.2 Results of the reading strategy questionnaire

The results of the reading tests already answer two research questions. They show a statistically significant difference in reading ability between the control group and the experimental group, which emerges after the teaching intervention. However, this study did not concentrate only on the product of strategy instruction, but also gave importance to the development of reading processes. Thus, the researcher wanted to see whether there was a relationship between students'reading scores and how they read, that is to say their use of reading strategies. To obtain data on the reading strategies of the students, a strategy questionnaire was developed as described in Chapter III.

The questionnaire is a 45 item, Likert type instrument, on which students indicate the extent to which they use the described strategies by responding either (1) always (2) often (3) sometimes (4) seldom or (5) never. A mean score of 1 would indicate that the students perceive themselves to be using a strategy all the time, whereas a mean score of 5 indicates that the entire students group perceive themselves to be using the strategy none of the time. The questionnaire is divided into two main parts, the reading strategies used by students and the problems they encounter when they read an English text (see also Appendix G). The questionnaire was administered to all the students twice, first before applying the teaching methods and second after ten weeks of applying the two different teaching approaches. The data from the questionnaire was analysed to answer research questions 5 and 6.

The presentation of the findings is organised as follows:

4.2.1 The range of strategies reported by all the subjects before applying the teaching approaches

4.2.2 Comparison between the two groups of reported strategy use before applying the teaching approaches

4.2.3 Comparison of the reported strategy use of the control group, pre-instruction and post-instruction

4.2.4 Comparison of the reported strategy use of the experimental group, pre-instruction and the post-instruction

4.2.5 Comparison between the two groups of reported strategy use after applying the two teaching approaches

4.2.6 The correlation between reported strategy use and reading proficiency

4.2.7 The range of reading strategies reported by all students, post-instruction.

4.2.1 The range of the strategies reported by all the subjects before applying the teaching approaches

All 74 students were asked to complete the reading strategy questionnaire prior to instruction, of which 64 were returned. The results of the first administration of the questionnaire are presented in Table 4.5.

Table 4.5: The range of reading strategies reported by all students before applying the teaching approaches

Item no.	Strategy	Mean rating	Standard Deviation
1	Read the title	1.54	0.69
2	Read every word	2.79	0.91
3	Use numbers to show steps	3.79	0.95
4	Give up and stop reading	3.3	0.99
5	Use interest	2.68	0.86
6	Translate into Thai	2.31	1.03
7	Make a summary	2.74	1.04
8	Set purpose before reading	2.84	1.11
9	Make prediction	2.69	0.95
10	Take notes	3.26	1.09
11	Find the text boring	2.79	0.96
12	Draw a diagram	4.05	1.13
13	Skip unimportant parts	2.62	0.88
14	Read ahead to find the whole idea	2.38	0.82
15	Look up words in the dictionary	1.61	0.8
16	Skip problematic parts	2.5	0.91
17	Keep on reading	2.72	0.87
18	Reread problematic parts	2.24	0.87
19	Use the illustration	2.79	1.08
20	Check their understanding through the text	2.67	1.01
21	Look for further information	3.83	0.98

22	Questioning	3.41	0.99
23	Underline important parts	2.49	1.05
24	Use prior knowledge	2.06	0.8
25	Use grammatical structure	2.89	0.89
26	Recognise main parts and supporting parts	3.03	0.93
27	Use context clue	2.19	0.90
28	Use an asterisk	2.94	1.32
29	Remember the main idea of the text	2.86	0.89
30	Pleased when the reading makes sense	2	0.79
31	Use word formation (root, prefix, etc.)	2.97	1.02
32	Confused by the text	2.67	0.97
33	Relate new information to previous material	2.8	0.80
34	Use imagination	2.63	1.12
35	Find the text easy	3.67	1.02
36	Use marker words (and, but, so, etc.)	2.91	0.98
37	Find the text difficult	2.13	0.93

Table 4.5 gives a general overview of the range of strategies reported by all the students at the beginning of the study. The table indicates that they were aware of strategies, but at moderate to low levels. The means reported for individual strategies range from 1.54 to 4.05 and the standard deviations from 0.69 to 1.32.

Table 4.6 presents the means and standard deviations for all 37 individual reading strategies in rank order. Some strategies were reported as very often used such as using the title (item no.1, mean 1.54), using a dictionary (item no.15, mean 1.61), using prior knowledge (item no.24, mean 2.00), and an affective strategy (item no.30, mean 2.00). The least popular reading strategies reported by the students were drawing a diagram (item no.12, mean 4.05), followed by looking for further information (item no.21, mean 3.83), using numbers to show steps (item no. 3, mean 3.79), and self questioning (item no.22, mean 3.41).

Table 4.6: Relative popularity of reported reading strategies

Rank order	Strategy	Mean score	Standard Deviation	Item no.
1	Read the title	1.54	0.69	1
2	Look up words in the dictionary	1.61	0.80	15
3	Pleased when the reading makes sense	2.00	0.79	30
4	Use prior knowledge	2.06	0.80	24
5	Find the text difficult	2.13	0.93	37
6	Use context clue	2.19	0.90	27
7	Reread problematic parts	2.24	0.87	18
8	Translate into Thai	2.31	1.03	6
9	Read ahead to find the whole idea	2.38	0.82	14
10	Underline important parts	2.49	1.05	23
11	Skip problematic parts	2.50	0.91	16
12	Skip unimportant parts	2.62	0.88	13
13	Use imagination	2.63	1.12	34
14=	Confused by the text	2.67	0.97	32
14=	Check their understanding through the text	2.67	1.01	20
16	Use interest	2.68	0.86	5
17	Make prediction	2.69	0.95	9
18	Keep on reading	2.72	0.87	17
19	Make a summary	2.74	1.04	7
20=	Read every word	2.79	0.91	2
20=	Find the text boring	2.79	0.96	11
20=	Use the illustration	2.79	1.08	19
23	Relate new information to the previous material	2.80	0.80	33
24	Set purpose before reading	2.84	1.11	8
25	Remember the main idea of the text	2.86	0.89	29
26	Use grammatical structure	2.89	0.89	25
27	Use marker words (and, but, so, etc.)	2.91	0.98	36
28	Use an asterisk	2.94	1.32	28
29	Use word formation (root, prefix, etc.)	2.97	1.02	31
30	Recognise main parts and supporting parts	3.03	0.93	26
31	Take notes	3.26	1.09	10
32	Give up and stop reading	3.30	0.99	4
33	Questioning	3.41	0.99	22
34	Find the text easy	3.67	1.02	35
35	Use numbers to show steps	3.79	0.95	3
36	Look for further information	3.83	0.98	21
37	Draw a diagram	4.05	1.13	12

In order to examine the pattern of results more closely, the data were then classified into 4 groups; metacognitive strategies, cognitive strategies, affective strategies, and reading difficulties.

4.2.1.1 Metacognitive Strategies

Metacognitive strategies can be further subdivided into three subgroups: strategies for managing and planning (items 1, 8, 9, 14); strategies for focusing and selecting learning (items 2, 4, 13, 16, 17, 18, 23, 26, 28, 29); and one strategy for evaluation (item 20). Students' reported use of these strategy subgroups is presented in following tables.

Table 4.7: Strategies for managing and planning

Rank order	Strategy	Item no	Mean rating	Standard Deviation
1	Read the title	1	1.54	0.69
24	Set purpose before reading	8	2.84	1.11
17	Make prediction	9	2.69	0.95
9	Read ahead to find the whole idea of the text	14	2.38	0.82

The results shown in Table 4.7 suggest that at this time (pre-instruction) the students were not able to manage and plan their reading process very well. Among the strategies in this group only one strategy, 'read the title', was reported as often used (mean = 1.54). The other managing strategies, received mean ratings reflecting occasional use (i.e., between 'often' and 'sometimes'). This shows that the students were fairly good at using a low level strategy (read the title), but used other high level managing strategies with moderate to low frequency.

Table 4.8: Strategies for focusing learning

Rank order	Strategy	Item no	Mean rating	Standard Deviation
20	Read every word	2	2.79	0.91
32	Give up and stop reading	4	3.30	0.99
12	Skip unimportant parts	13	2.62	0.88
11	Skip the problematic parts	16	2.50	0.91
18	Keep on reading the problematic parts	17	2.72	0.87
7	Reread the problematic parts	18	2.24	0.87
10	Underline important parts	23	2.49	1.05
30	Recognise main parts and supporting details	26	3.03	0.93
28	Use an asterisk	28	2.94	1.32
25	Keep the main idea in mind	29	2.86	0.89

Table 4.8 shows that though the students reported use of several strategies to concentrate their reading, none of these strategies was rated as often used by the group overall. With respect to self-management, the students most frequently reported the 'reread' strategy, but only 13 students reported that they 'always' reread the problematic parts. In general we can say that the students tend to reread the problematic part and continued reading if unsuccessful at decoding a word or phrases. The least popular strategy was 'give up and stop reading', though twenty-nine students did this 'sometimes' and nine students reported that they 'always' gave up reading.

Again they did not show high awareness of their selection strategies. They reported moderate use of 'skipping unimportant parts'. Only 4 students reported that they always 'keep the meaning of the main idea in mind' and 'underline important parts' while reading. Students rarely reported use of 'recognising main point and supporting details', arguably the most complex analytic strategy.

Finally, prior-instruction, the students in this study were not much aware of self-evaluation while reading. This was an uncommonly used strategy (mean 2.67, S.D. 1.01), which suggests that they rarely checked through the text to see if their understanding was correct.

4.2.1.2 Cognitive Strategies

Cognitive strategies involve interacting with the material to be learned, manipulating the material mentally or physically. They can be divided into:

- Strategies for knowledge transfer (items 24, 25)
- Resource strategies (items 19, 21)
- Strategies for structuring and processing messages (items 3, 6, 7, 10, 12, 34)
- Strategies for enquiry (items 22, 32)
- Strategies for coping with unfamiliar words (items 15, 27, 31, 36)
- One strategy for text elaboration (item 33)

Table 4.9: Strategies for knowledge transfer

Rank order	Strategy	Item no	Mean rating	Standard Deviation
4	Use prior knowledge	24	2.06	0.80
26	Use grammatical structure	25	2.89	0.89

Table 4.9 shows that students in this research seemed to be aware of using their prior knowledge and world knowledge to understand the text. However, they were less aware of transferring linguistic knowledge when reading.

Table 4.10: Resource strategies

Rank order	Strategy	Item no	Mean rating	Standard Deviation
20	Use the illustration	19	2.79	1.08
36	Look for further information in other books	21	3.83	0.98

From Table 4.10, it could be said that the students rarely used resource strategies to help them understand the text.

Table 4.11: Strategies for structuring and processing messages

Rank order	Strategy	Item no	Mean rating	Standard Deviation
35	Use a number to show steps of processes	3	3.79	0.95
8	Translate into Thai	6	2.31	1.03
19	Make a summary	7	2.74	1.04
31	Take notes	10	3.26	1.09
37	Draw a diagram	12	4.05	1.13
23	Use imagination	34	2.63	1.12

Before instruction, it can be seen from Table 4.11 that students rarely used strategies to organise the message. It was not surprising to see their favourite strategy from this group was translation, and that highlighting was their second favourite. They reported quite often that they underlined or marked important points in the text and they sometimes used imagination and related new information to previous. However, it can be said that before instruction, they sometimes organized their reading by using the remaining strategies in this group.

Table 4.12: Strategies for enquiring

Rank order	Strategy	Item no	Mean rating	Standard Deviation
33	Self questioning	22	3.41	0.99
14	Confused by the text	32	2.67	0.97

Table 4.12 shows that students were quite often confused when they read an English text, but rarely questioned themselves about the text.

Table 4.13: Strategies for coping with unfamiliar words

Rank order	Strategy	Item no	Mean rating	Standard Deviation
2	Use a dictionary	15	1.61	0.80
6	Use context clue	27	2.19	0.90
29	Use word formation	31	2.97	1.02
27	Use markers	36	2.91	0.98

As seen in Table 4.13, it was unsurprising that the most frequently cited strategy to cope with unfamiliar words was using a dictionary. Thirty-four students reported that they

'always' used a dictionary when reading an English text, and eighteen students 'often' used a dictionary to cope with a vocabulary problem. However, an inferencing strategy was also quite frequently cited by the students. They reported that they used word formation (prefixes, suffixes, roots) to understand unknown words with noticeably lower frequency.

As for strategy to elaborate the text, the students reported their use of this strategy quite low frequent (item, 33 mean 2.80). Before the course they were not able to relate information to the previous very well.

4.2.1.3 Affective Strategies

Table 4.14: Affective strategies

Rank order	Strategy	Item no	Mean rating	Standard Deviation
16	Use interest	5	2.68	0.86
20	Find the text boring	11	2.79	0.96
3	Pleased when the reading makes sense	30	2.00	0.79
5	Find the text difficult	37	2.13	0.93

As seen in Table 4.14, affective strategies involved emotional interaction with the text. The rather often cited strategy was using interest. They were also pleased when they found that they understood what they read. However, they often found the text difficult, which made them confused by what they read. Furthermore, they regularly reported that they found the text boring.

4.2.1.4 Reading Difficulties

Items 38-45 of the questionnaire explored students' reported difficulties when reading an English text. Mean ratings for the whole cohort (N = 64) are presented in Table 4.15 and Figure 4.4.

Figure 4.4: Mean scores for difficulties reported by all students before instruction

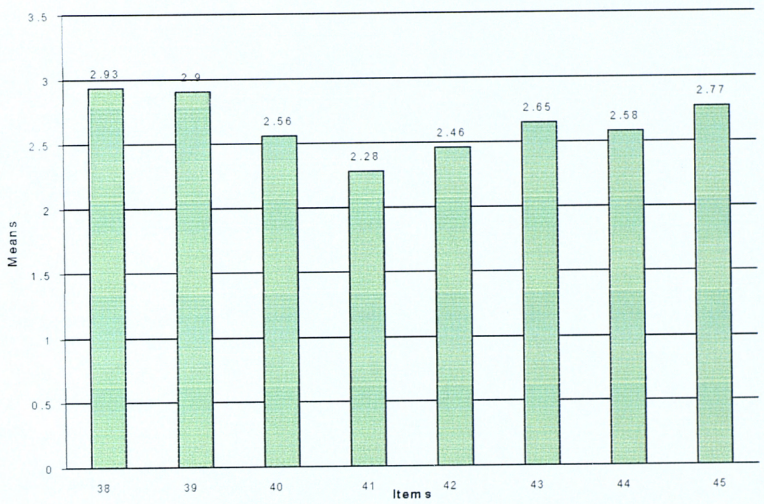


Table 4.15: Mean scores for difficulties

Difficulties	Item no	Mean	Standard Deviation
Get the whole idea of the text	38	2.93	0.99
Understand the text	39	2.90	1.00
Grammatical structure	40	2.56	0.80
Vocabulary	41	2.28	0.83
Get the overall meaning	42	2.46	0.91
Guess the meaning	43	2.65	0.76
Text organisation	44	2.58	0.87
Relate the ideas of the text	45	2.77	0.87

For items exploring what made reading English difficult, the students did not show much variation. They all reported that they had difficulties in reading an English text, and they rated vocabulary as the most difficult problem they faced, while relating the ideas of the text was the least difficult problem. However, the means for each difficulty were very similar, from 2.28 to 2.93. In general, even though the students reported their self-awareness of difficulties when reading an English text, it seems they were unable to analytically distinguish between different factors, which may cause difficulties.

4.2.2 Inter-group comparison of reported strategy use before applying the teaching approaches.

The previous section describes the reading strategies reported by all the students in this study, when the questionnaire was first administered, i.e., pre-instruction. The students then were divided into two groups for the application of the two teaching approaches. In order to confirm that their reported strategy use was not significantly different at the beginning of the study, the pre-instruction questionnaire data from the two groups were compared. Items on reading difficulties were excluded, leaving 33 reading strategy items as the basis for comparison. A mean score for each item was calculated for each of 32 students. Then an overall mean score for each group was calculated by the formula $\Sigma X/N$ (where X = item mean score). The overall mean scores for the two groups were compared by using an independent t-test. Results are presented in Table 4.16.

Table 4.16: Comparison of the pre-instruction strategy use reported by the two groups

Student Group	N (Items)	Overall Mean Score	Standard Deviation	t-value	Sig (2-tailed)
Control group N=32	33	2.7506	0 .5422	0.074	0 .941
Experimental group N = 32	33	2.7397	0 .6499		

The data in Table 4.16 indicate that prior to instruction the reported strategy use of the two groups was not significantly different. The t-value was -0.07, which is not statistically significant at the 0.05 level ($p = 0.94$). It could be concluded that at the beginning of the study the students in the two groups did not report different levels of strategy use.

4.2.3 Comparison of the reported strategy use of the control group, pre-instruction and post-instruction

After 10 weeks' teaching through a traditional approach, the students of the control group were asked to complete the reading strategy questionnaire again to see if there was any significant change in their reported patterns of strategy use. The data from their pre- and post questionnaires were analysed by a paired samples t-test again omitting 'difficulty' items. Results are presented in Table 4.17.

Table 4.17: Comparison of the pre and post strategy use reported by the control group

Control group N=32	N (Items)	Overall Mean Score	Standard Deviation	t-value	Sig (2-tailed)
Pre-instruction	33	2.7506	0 .5422	2.247	0 .032
Post-instruction	33	2.5864	0 .6253		

The results of the t-test show a statistically significant difference in reported strategy use at the 0.05 significance level ($t = 2.25$, $p = 0.03$). The lower mean score showed that the students in the control group reported higher level of strategy use after 10 weeks' instruction.

4.2.4 Comparison of the reported strategy use of the experimental group between the pre-instruction and the post-instruction

While the control group was taught through a traditional approach, the experimental group was taught for the same duration through the activating metacognitive strategies approach. After the10-week instruction period the students were also asked to complete the reading strategy questionnaire again to investigate any differences in their report of strategy use. The data were again analysed by a Paired Samples t-test, and results are presented in Table 4.18.

Table 4.18: Comparison of the pre and post strategy use reported by the experimental group

Experimental group (N=32)	N (Items)	Overall Mean Score	Standard Deviation	t-value	Sig (2-tailed)
Pre-instruction	33	2.7397	0.6499	5.253	0 .000
Post-instruction	33	2.2503	0.4489		

The results of the t-test show a highly statistically significant difference (t = 5.25, p = 0.00). It could be concluded that the students in the experimental group reported greatly increased levels of strategy use after 10 week's instruction.

4.2.5 Comparison between the two groups of reported strategy use after applying the two teaching approaches

So far we have seen that both the control and the experimental group reported significantly increased levels of strategy use after 10 weeks' instruction, regardless of instruction type. In order to check for differences between their reported levels of strategy use after instruction, the data from the post-instruction questionnaires of the two groups were compared using an independent samples t-test. Results are presented in Table 4.19.

Table 4.19: Between-groups comparison of post-instruction reported strategy use

Group	N (Items)	Overall Mean Score	Standard Deviation	t-value	Sig (2-tailed)
Control (N=32)	33	2.5864	0.6253	2.508	0 .015
Experiment (N=32)	33	2.2503	0.4489		

The overall post-instruction means of the two groups showed that the students in the experimental group reported significantly higher levels of reading strategy use than the students in the control group. The results of the t-test show a statistically significant difference at the 0.05 level ($t = 2.51$, $p = 0.02$). Thus even though both groups increased their use of strategies over the instruction period, the experimental group gained significantly more than the control group.

4.2.6 The correlations between reported strategy use and reading proficiency

We have seen that there was a statistically significant difference in the reported levels of strategy use between the two groups. Furthermore, the results of the reading test showed that the students in the experimental group made higher gains in reading scores than the control group. Thus, it is interesting to explore more closely the relationship between students' strategy use and their reading proficiency. Data from the post-instruction questionnaires completed by all 64 students were analysed to find individual overall means for their strategy use. The strategy means and the post-test scores for each student were then correlated using the Pearson correlation to determine the relationship between

the reported levels of strategy use and the reading scores. The results are presented in Table 4.20.

Table 4.20: Correlations between reported strategies and reading scores

N (Students)=64 N (Items)=33	Mean	Standard Deviation	Pearson Correlation	Sig (2-tailed)
Post-instruction strategy use	2.5183	0.3147	-0.690	0.000
Post-test score	19.7344	3.3724		

The results of the Pearson correlation show that the correlation between reported strategy use and reading proficiency were positive and highly significant ($r = -0.69$, $p = 0.00$). This strongly suggests that the level of reported strategy use can predict the result of reading proficiency measures. That is to say, reading proficiency increases as students report increased strategy use.

4.2.7 The range of reading strategies reported by all students, post-instruction

Section 4.2.1 describes the range of reading strategies reported by all students prior to instruction. As we saw from the above sections, after 10 weeks' instruction there was a statistically significant increase in the overall level of strategy use. This section investigates change in the relative popularity of reported strategies over the same period.

Figure 4.5: The mean ratings of individual reading strategies reported after applying the teaching approaches (lower mean ratings = higher frequency of use, & vice versa)

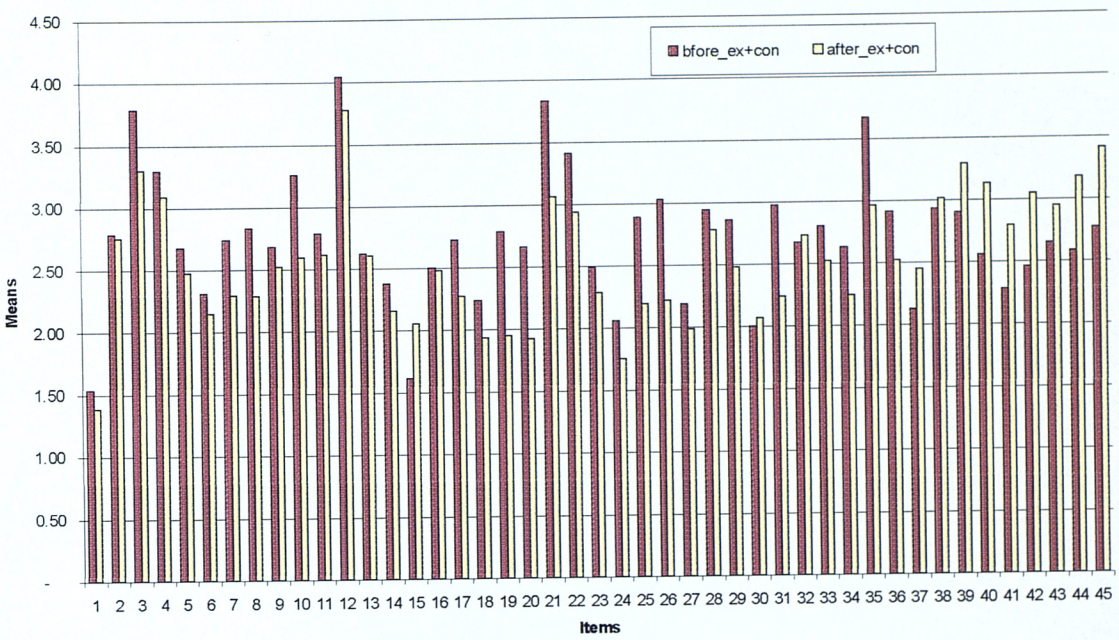


Figure 4.5 shows mean ratings for individual strategies by all students before and after instruction. In each case, lower mean ratings indicate higher levels of use, and vice versa. In general, reported strategy use increased slightly for almost every item, with means between 1.39-3.78. The most popular reported strategy post-instruction was still read the title (item 1, mean 1.39). It is interesting to see the change in the 5 most popular reported strategies. After instruction, these were: using prior knowledge (item 24, mean 1.75); checking their understanding through the text (item 20 mean 1.93); rereading problematic parts (item 18, mean 1.94); using illustrations (item 19, mean 1.95) and using context clues (item 27, mean 1.99). They also reported considerably more often, using grammatical structure to understand the text (item 25, mean 2.20).

The least popular reported strategies were still the same, i.e., draw a diagram (item 12, mean 3.78); use numbers to show steps (item 3, mean 3.30); and look for further information (item 21, mean 3.06).

For a few strategies, mean ratings rose post-instruction reflecting decreased levels of reported use. Thus, ratings for item 15 indicated that students relied less on using a dictionary, mean 2.06. Items 37-45 which reflected difficulties in reading also had increased ratings showing lower levels of difficulty (mean 2.79-3.41). This suggests that the students have more confidence in reading English texts. However, they were still unable to distinguish between their difficulties. Means and rank orders for strategies reported post-instruction are presented in Table 4.21.

Table 4.21: Comparison of relative popularity of strategies between pre- and post-instruction

Rank order		Strategy	Mean rating Pre-instruction	Mean rating Post-instruction	Item no.
Pre	Post				
1	1	Read the title	1.54	1.39	1
2	7	Look up words in the dictionary	1.61	2.06	15
3	8	Pleased when the reading makes sense	2.00	2.07	30
4	2	Use prior knowledge	2.06	1.75	24
5	19	Find the text difficult	2.13	2.45	37
6	6	Use context clue	2.19	1.99	27
7	4	Reread problematic parts	2.24	1.94	18
8	9	Translate into Thai	2.31	2.15	6
9	10	Read ahead to find the whole idea	2.38	2.16	14
10	16	Underline important parts	2.49	2.29	23
11	20	Skip problematic parts	2.50	2.48	16
12	27	Skip unimportant parts	2.62	2.61	13
13	15	Use imagination	2.63	2.25	34
14	29	Confused by the text	2.67	2.73	32
14	3	Check their understanding through the text	2.67	1.93	20
16	20	Use interest	2.68	2.48	5
17	21	Make prediction	2.69	2.52	9
18	11	Keep on reading	2.72	2.17	17
19	18	Make a summary	2.74	2.30	7
20	30	Read every word	2.79	2.76	2
20	28	Find the text boring	2.79	2.62	11
20	5	Use the illustration	2.79	1.95	19
23	21	Relate new information to the previous maternal	2.80	2.52	33

24	16	Set purpose before reading	2.84	2.29	8
25	20	Remember the main idea of the text	2.86	2.48	29
26	12	Use grammatical structure	2.89	2.20	25
27	25	Use marker words (and, but, so, etc.)	2.91	2.53	36
28	31	Use an asterisk	2.94	2.78	28
29	14	Use word formation (root, prefix, etc.)	2.97	2.24	31
30	13	Recognise main parts and supporting parts	3.03	2.22	26
31	26	Take note	3.26	2.60	10
32	35	Give up and stop reading	3.30	3.09	4
33	32	Questioning	3.41	2.94	22
34	33	Find the text easy	3.67	2.96	35
35	36	Use numbers to show steps	3.79	3.30	3
36	34	Look for further information	3.83	3.06	21
37	37	Draw a diagram	4.05	3.78	12

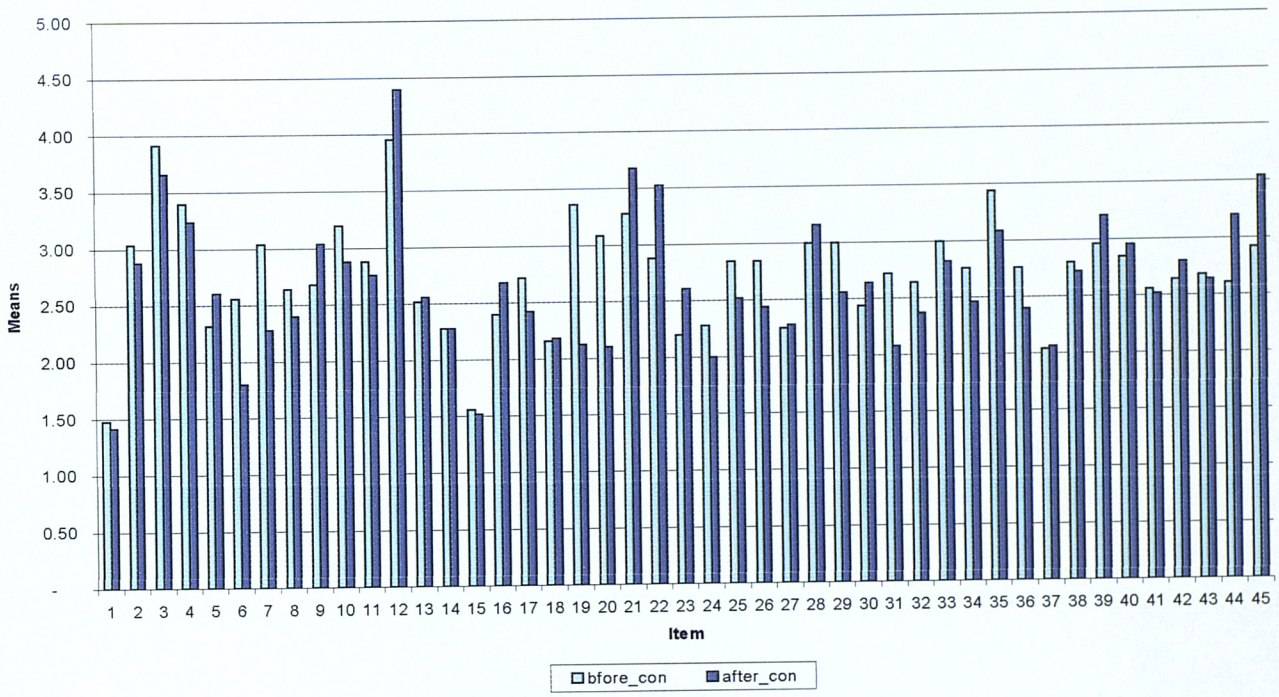
As shown in Table 4.21, the highest and lowest ranked strategies were still the same. There are some changes in the middle group, which can be divided into two main groups: strategies which became less popular and which became more popular. The former are items 2, 13, 32, and 37 and the latter include 19, 20, 25, 26, 31. All these items changed their rank position by at least 10 places.

Thus, after instruction the students tended to find the text relatively less difficult (item 37), reported less confusion when reading an English text (item 32), and were less inclined to read every word (item 2, mean 2.75).

The first striking rise in the rank order is use of illustration (item 19), which rose from rank order 20 to 5. Use of grammatical knowledge (item 25) rose from 26 to 12. There is also a dramatic relative increase in metacognitive strategies. The students reported much more often on checking their understanding (item 20) and on recognition of main parts and supporting details (item 26). At the word level, they tended to make more use of word formation strategy (item 31).

As we saw in section 4.2.3 there was a statistically significant difference in the reported strategies of the control group. Figure 4.6 presents a comparison of the reported strategies of this group, pre- and post-instruction.

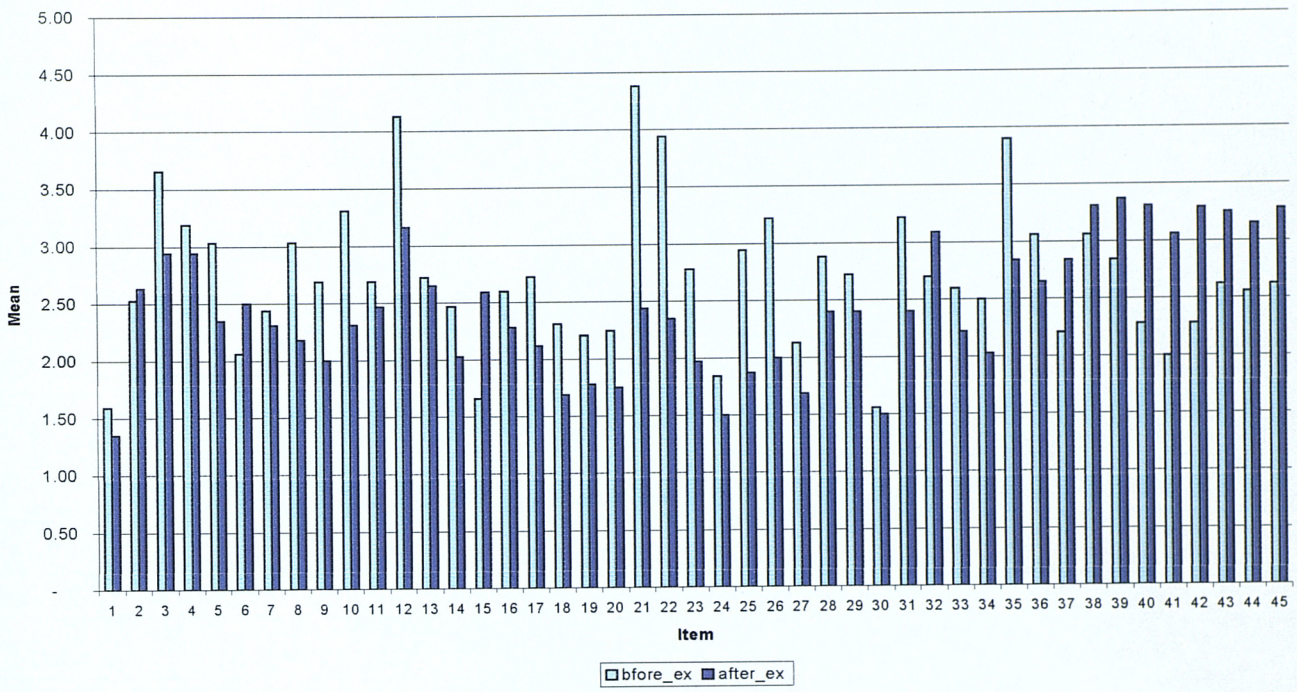
Figure 4.6: Comparison of the reported strategy use of the control group, pre-instruction and post-instruction



In general, students in the control group reported more frequent strategy use after 10 weeks' instruction. An increase in the use of certain strategies needs to be discussed. Using a dictionary remained their most popular strategy (item15, mean 1.52). However, they reported more often on translation (item 6, mean 1.8), making a summary (item 7, mean 2.28), using the illustration (item 19, mean 2.12) and checking their understanding through the text (item 20, mean 2.1). There was a decline in reports of looking for further information (item 21, mean 3.68), self-questioning (item 22, mean 3.52) and underlining important parts (item 23, mean 2.6). Their reports showed less difficulty in text organisation (item 44, mean 3.2) and relating the idea of the text (item 45, mean 3.6).

For the experimental group there was considerably more change in their reported strategy use than for the control group, as presented in Figure 4.7.

Figure 4.7: Comparison of the reported strategy use of the experimental group, pre-instruction and post-instruction



Post-instruction, students in the experimental group reported considerably higher levels of strategy use. Their favourite strategies were the same, i.e. read the title (item 1, mean 1.35), use prior knowledge (item 24, mean 1.5) and being pleased when their reading makes sense (item 30, mean 1.5). It is interesting to see a big increase for the strategies, looking for further information (item 21, mean 2.44) and self–questioning (item 22, mean 2.35). They also reported considerably more use of using grammatical structure (item 25, mean 1.87) and recognising main points and supporting details (item 26, mean 2.0). However, they reported less use of reading every word (item 2, mean 2.63), translation (item 6, mean 2.5) and using a dictionary (item 15, mean 2.59). There is also a decline in frequency for items 37-45 which showed that the students reported less difficulties when reading an English text. They also reported feeling less confused with what they read (item 32, mean 3.09) and finding the text easier (item35, mean 2.84).

4.3 Conclusion

The results of the main experimental study have shown that the answer to research question 1 and 2 is 'yes'. There is reading ability improvement after the course and the students who received strategy instruction (experimental group) made superior gains in reading proficiency over their peers who received traditional English reading instruction (control group). Furthermore, after the course, the students in the experimental group reported significantly more frequent strategy use than the control group (research question 5). The positive correlation between the reading scores and the strategy use told us that strategy use is related to reading proficiency (research question 6). The answers to the remaining research questions are presented in the next chapter.

Chapter V

Findings of the Qualitative Data Analysis

As mentioned in Chapter III, the research design pursued a mixed approach between quantitative and qualitative methodologies. The quantitative part of this study served to determine English reading achievement and to gather overall information on strategy use through the pre- and post-questionnaire. However, in order to investigate students' ongoing cognitive processes more closely and use of reading strategies more closely, think-aloud and diary techniques were utilized. An analysis of the qualitative data is used to answer research questions 3 and 4 and to provide greater depth and validation of the results of the quantitative study. This chapter reports the qualitative findings, beginning with the findings from the think-aloud study, followed by the findings from the diary study. The two research questions related to the qualitative findings are:

3. What reading strategies do the Thai students apply in order to understand English text?

4. Do readers transfer learned strategies to their extensive reading?

5.1 Think-aloud analysis

The last chapter presented the results of the reading strategy questionnaire completed by all students in the study. However, a questionnaire is not a tool to gain access to cognitive processes directly. In order to explore how the students monitor their reading strategies while reading English texts, think-aloud technique is a more efficient instrument as described in Chapter III. The think-aloud study aimed at:

1. Describing the reading strategies reported directly while reading English texts.

2. Comparing the use of reading strategies by students at different proficiency levels as determined by the reading test scores within and between the two groups.

This section reports the analysis of the think-aloud protocols and is divided into three main parts. Section 5.1.1 reports the procedure for the think-aloud study, including the selection of texts, the selection of subjects and the actual think-aloud study. Section 5.1.2 presents the analysis procedure, which comprises the development of a taxonomy of strategies used to code the think-aloud protocols, an examination of the reliability of the strategy coding, and the analysis of data. Section 5.1.3 reports the results of the think-aloud study, comprising: descriptions of reading strategies; a comparison of reading strategies used by different proficiency levels within the control group; a comparison of the strategies used by different proficiency levels of the experimental group; and a comparison of reading strategies used by the students at the same proficiency levels but between the two groups.

5.1.1 The procedure of the think-aloud study

5.1.1.1 The selection of the texts

Ten reading passages were selected from the magazines *New Scientist,* and *Scientific American.* In order to make sure that the passages serve as an appropriate tool for think-aloud, particular criteria such as readability level and interest level were considered as described in section 3.2.2. The ten passages are:

Title	Date
1) Elixir of Youth	6th September 1997
2) Best of Both Worlds	20 th September 1997

3) Muck into Medicine — 4th October 1997

4) Plantibodies — 5th November 1997

5) That's Us Stuffed Then — 6th December 1997

6) Sensor Sensibility — 6th March 1999

7) No More Needles — 15th May 1999

8) Cloth of Ages — 15th May 1999

9) Word Power — 15th May 1999

10) Get Stuck in — 15th May 1999

(See Appendix E for the full passages)

5.1.1.2 Subject selection

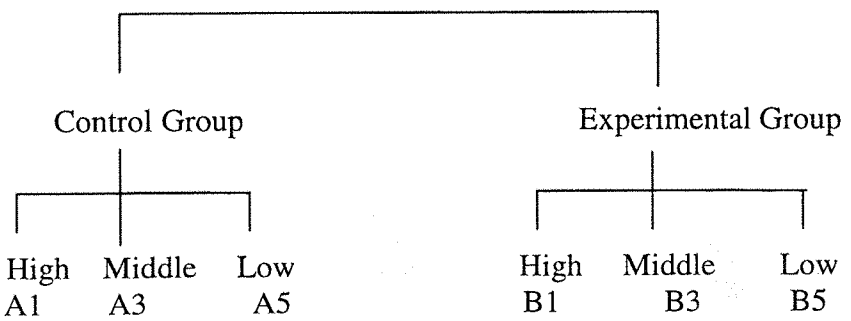
As described in Chapter III, the subjects were divided into two groups on the basis of the English entrance exam. Scores from the pre-test were used as a criterion to divide students into three levels of reading proficiency. Since the think-aloud schedule was time consuming, the researcher asked for 2 volunteers from each proficiency level of both the control and experimental groups. In class the researcher talked to each reading proficiency group, explained the nature of the think-aloud study briefly, and asked whether anyone was interested in participating. The researcher gave them time to think, and if they agreed to participate in the study, they would be given a consent form to sign. Twelve students participated in the think-aloud study as presented in Table 5.1.

Table 5.1: Subjects of think-aloud study

	High group	Score	Middle group	score	Low group	score
Control group	Miss A1	24	Mr. A3	16	Mr. A5	13
	Miss A2	23	Miss A4	17	Miss A6	12

Experimental group	Miss B1	25	Miss B3	16	Miss B5	13
	Mr. B2	23	Miss B4	18	Mr. B6	9

However, the think-aloud data finally analysed for this study were from only six students, presented below:



5.1.1.3 The actual think-aloud study

From the pilot study and from the methodological literature described in section 3.2.2, the researcher learned that subjects for think-aloud research need training. All subjects were asked to join in a practice think-aloud session. The researcher explained the nature of the study, the purposes and the procedures the subjects would need to follow. The researcher then asked the subjects to complete a jigsaw puzzle. While completing the jigsaw puzzle they were asked to say out loud what they were thinking, how they started and completed that task. Then, the researcher told them that what they had done was a think-aloud task. After that all the subjects were a given written description including guided questions on think-aloud.When the researcher had completed the explanation, she answered questions herself and then performed think-aloud while reading a sample article 'The Greenhouse Effect'.

After completion of the group orientation, individual practice sessions started. Each subject was asked to perform the think-aloud task using a sample article. After all

training sessions, dates of participation in the main study were scheduled for each participant. In the main study the subjects were given further texts to perform the think-aloud task. Their think-aloud verbalizations were audio-recorded for transcription and analysis.

5.1.2 Analysis procedure

The think-aloud verbalisations of the six students were then transcribed by the researcher. In order to facilitate an inter-rater reliability check the transcriptions were then translated into English. After the transcription and the translation were completed, analysis of the data was undertaken through definition and categorisation of the strategies.

5.1.2.1 Categorisation and definition of strategies

As mentioned already, the purposes of the think-aloud study was to investigate how Thai undergraduate students monitored their comprehension as they read English texts, what types of strategies they used and whether there were any important differences between them (research question 3).

The think-aloud protocols in this study revealed many strategies demonstrated by the subjects while reading to understand the texts. In all, in a gradual process of reading and re-reading, forty-four strategy types were defined and categorised. The main categorisation was based on the classification of strategies proposed by O'Malley and Chamot (1990: 46) and Oxford (1990). However, each strategy was finally defined and categorised with reference to the data protocols, rather than predetermined categories already mentioned in the literature. The clustering of strategies into 13 level categories was an attempt by the researcher to focus on similarity of functional purpose in the employment of the strategies. The researcher submitted the suggested categories and

strategy definitions to the supervisor for comment. After revision, the category list and definition presented in Table 5.2 was used as a tool to code the strategies identified in the protocols.

Table 5.2: Definition and categorisation of reading strategies

Category	Code	Reading Strategies	Definitions and examples
Metacognitive strategies			
Preview			The readers survey the text either by reading the title or reading ahead to get the overall ideas of the text.
	1)Plan	Planning	The readers monitor their purpose before reading the text. e.g., I set the purpose before reading.
	2) t	Read title	e.g., From the title, the picture I get is the main idea of the text.
	3) ra	Read ahead	e.g., When I read, I scan the whole paper.
Self management			The readers manage their reading styles to comprehend the text.
	4) con	Continue if unsuccessful at the coding a word or phrase	e.g., I don't get clear idea about this, so I proceed reading.
	5) ea	Return to an earlier part	e.g., At this point I decide to go back to the first paragraph.
	6) as	Alternative strategies	e.g., I already guess from the context but it does not work, so I'll open the dictionary.
	7) re	Rereading	e.g., I can understand now by rereading it.
	8) ad	Adjust speed	e.g., At this part I've to read very slowly.

Selective attention			The readers focus on special parts, i.e., they know which parts are important and which parts they should skip.
	9) u	Underline or highlight the important parts	e.g., First, I underline the important information.
	10) sk	Skip an unimportant part	e.g., They are not important, so I skip.
Self evaluation			The readers evaluate themselves or their understandings if they are correct or not.
	11) eva	Evaluate their guess	e.g., I guess already, but I don't think it's correct.
	12) rp	Realise their problems	e.g., Vocabulary is my problem.
	13) c	Correct one's own earlier hypothesis	e.g., Now I realise that it is about criticism not the mummies.
	14) af	Self affirmation	e.g., Yes, I think it's about.....
Monitoring			The readers consciously monitor and direct understanding while reading.
	15) ms	Consider whether what is being read makes sense	e.g., I just don't take it as it comes. I don't think it makes sense.
	16) keep	Keep the meaning of the passage in mind	e.g., This is the main idea of the text.
<u>Cognitive strategies</u>			
Knowledge Transfer	17) pr	Prior knowledge	The readers use prior knowledge or world knowledge to comprehend the text.

			e.g., I don't have any problem because I have studied this before.
	18) gt	Grammatical transfer	The readers use linguistic knowledge to facilitate reading comprehension. e.g., I try to analyse the sentence, what is the subject, what is the verb.
Resource			The readers use reference materials such as picture, graph, diagram, or text-book to comprehend the text.
	19) dict	Dictionary	e.g., I underline the unknown words and will look for their meanings in the dictionary.
	20) pic	Picture	e.g., First, I look at the picture to know what it is about.
	21) ch	Chart	e.g., This chart helps me to understand better.
	22) book	Other books	e.g., I'll look for more information in other books.
Structuring Information			The readers group or classify the text or the process when reading.
	23) note	Note taking	The readers take notes while reading. e.g., I wrote down important ideas.
	24) tl	Translation	The readers use first language as source to understand. e.g., I'll translate into Thai what the author wants to tell us.
	25) im	Imagination	The readers generate visual images to understand the text. e.g., I can get a big picture. I can understand.
	26) sum	Summarisation	The readers summarise the text while reading. e.g., I summarise the earlier paragraph to understand the next one.
	27) fig	Figure	e.g., I also write down the figures 1, 2,

			3… to show the steps of the process.
	28) di	Diagram	e.g., I draw the diagram of this paragraph.
Enquiry			The readers question themselves while reading to comprehend the text.
	29) q	Self questioning	e.g., I ask myself 'what is it?', 'what stops us from growing old?'.
	30) cf	Express confusion	e.g., What? I get confused with this part.
Guessing the meaning			The readers guess the meaning of unknown words or phrases by using word formation, context clues, markers or punctuation.
	31) wf	Word formation (prefix, suffix, root)	e.g., To understand 'polyaspartic' I have to chop the word.
	32) cc	Context clue	e.g., I don't know the exact meaning of this word, I just guess from reading the next sentence.
	33) m	Markers	e.g., This marker 'however' tells me that this is opposite to the former.
	34) p	Punctuation marks	e.g., This hyphen helps me to understand better.
Prediction			The readers predict what might come next while reading which base on the title, picture, context, or diagram.
	35) pt	Based on the title	e.g., From the title, I think the author will tell us about the ancient cloths.
	36) pp	Based on picture	e.g., From the picture I think this text is about the rocket.
	37) pcon	Based on context	e.g., I look at the whole passage and know what the author will tell us.
	38) pd	Based on	e.g., The diagram tells me that the text

		diagram	is about the speed.
Text elaboration			The readers use information in the text to link ideas or integrate new ideas with known information.
	39) pret	Interpret the text	e.g., After reading the last paragraph, I know it is an argument.
	40) cp	Connection between parts	The readers connect new information with previous context. e.g., I can join the information of this paragraph to another.
	41) com	Comparison between parts of text	e.g., I can understand when I compare this paragraph to the previous one.
Affective strategies			The readers use interest or react emotionally to the information in the text.
	42) in	Interest in	e.g., When I look at the title, I think it is interesting.
	43) rt	React to the text	e.g., I think it is boring.
	44) text	Text association	e.g., I want to know more about this story.

5.1.2.2 Reliability of the coding

After the taxonomy had been developed, the analysis of the think aloud data was undertaken. In order to check the reliability and consistency of the coding by the researcher, the supervisor acted as an inter-rater. The think-aloud protocols of one student (B1) were submitted to the supervisor to read and code. The purpose of the coding by a second rater was to demonstrate whether the strategies detected by the researcher were identifiable by an outsider.

The researcher asked the inter-rater to code the strategies on the think-aloud protocols according to the revised definition list. The inter-rater and the researcher coded the same protocols independently. After coding subgroups of protocols, the level of coding agreement was then calculated to check for reliability. Table 5.3 shows the agreement reached on 3 successive cycles of double coding.

Table 5.3: Coder agreement, think-aloud study

Protocol	Total identified strategies	Total agreed identification		Total agreed identification & coding	
		Number	%	number	%
Muck into Medicine (group 1)	46	30	65.2	27	58.7
Cloth of Ages (group 1)	63	40	63.5	33	52.2
Get Stuck in (group 1)	59	39	66.1	31	52.5
Word Power (group 1)	55	36	65.5	32	58.2
No More Needles (group 2)	25	18	72.0	16	64.0
That's us Stuffed Then (group 2)	34	26	76.4	21	61.7
Sensor Sensibility (group 2)	44	32	72.7	28	63.6
Elixir of Youth (group 2)	69	55	79.7	45	65.2
Best of Both Worlds (group 3)	56	49	81.5	39	69.6
Plantibodies (group 3)	51	44	86.2	39	76.4

The first column in Table 5.3 presents the total identified number of strategies either by the second rater or the researcher. The second column represents the total number of

agreed identifications and the third column represents the agreed identifications and codings.

The procedure of the reliability study included review and discussion of coding decisions and some revision of the strategy taxonomy. As can be seen from Table 5.4 the percentages of agreed identifications and coding of the first four protocols were quite low, between 52.2-58.7%. From the fourth protocol onwards the percentages of total agreed identification and coding rose above 60% and in the last two protocols it reached 70 and 76% respectively. These levels of agreement were deemed acceptable as in similar studies.

During the reliability study, the percentages of agreed identification and coding improved due to discussion after each time of coding. After the completion of the formal reliability study involving independent coding, codings were jointly reviewed and agreed. Thus the revised strategy coding reached the complete agreed identification and coding. (See Appendix H for an example of coding.)

5.1.3 Results of the think-aloud study

After the coding, both quantitative and qualitative analysis was undertaken. First, the researcher counted all identified strategies produced individually by six students for each of the ten think-aloud texts. In all, 2077strategies were identified, which were counted as 100%. All strategies which were reported by the subjects for each paragraph within the texts were tallied on strategy sheets. After all strategies were tallied, the researcher calculated the total number for each strategy reported by the six subjects. The data for each strategy were analysed to find the frequency distributions and percentages. The results of the think-aloud study are presented in 2 parts:

- Overall description of reading strategies employed by the six subjects while reading English texts

- A comparison of reading strategy use between the control group and the experimental group.

5.1.3.1 Overall description of reading strategies employed by the six subjects

The think-aloud verbal reports of the six students participating in this study revealed that they used a variety of reading strategies to understand English texts. Altogether, forty-four strategies were identified in this study, which were classified into 3 main categories and 14 sub-categories as already described in 5.1.2.1. Table 5.4 shows frequencies for these 44 strategies as used by the 6 subjects.

Table 5.4: Strategies and their frequencies

Strategies	**Codes**	**Frequency**						Total	Per cent
		High		Middle		Low			
		A	B	A	B	A	B		
Metacognitive Strategies									
Preview									
1) Planning	plan	6	0	2	3	0	1	12	0.58
2) Reading title	t	10	18	11	13	11	7	70	3.37
3) Reading ahead	ra	7	4	5	4	4	9	33	1.59
Self management									
4) Continue if unsuccessful at decoding a word or phrase	con	14	17	3	5	4	1	44	2.12
5) Return to an earlier part	ea	4	5	0	4	2	2	17	0.82
6) Alternative strategies	as	4	9	2	9	2	1	27	1.3
7) Rereading	re	17	27	26	17	9	14	110	5.3

8) Adjust speed	ad	6	0	0	4	0	0	10	0.48
Selective attention									
9) Underline important parts	u	12	23	5	21	7	17	85	4.09
10) Skip unimportant parts	sk	17	13	7	13	7	6	63	3.03
Self evaluation									
11) Evaluate their guess	eva	11	20	21	14	8	6	80	3.85
12) Realise the problems	rp	12	16	6	6	20	6	66	3.18
13) Correct one's own hypothesis	c	7	7	7	8	7	4	40	1.93
14) Self affirmation	af	3	6	14	5	4	7	39	1.88
Monitoring									
15) Consider what is being read makes sense	ms	9	18	7	9	4	4	51	2.46
16) Keep meaning of the passage in mind	keep	13	12	7	17	4	6	59	2.84
Sub Total		152	195	123	152	93	91	806	38.81
Cognitive Strategies									
Knowledge transfer									
17) Prior knowledge	pr	33	46	20	38	13	20	170	8.18
18) Grammatical transfer	gt	6	21	10	20	4	3	64	3.08
Resource									
19) Dictionary	dict	3	3	1	4	4	3	18	0.87
20) Picture	pic	4	13	11	8	6	6	48	2.31
21) Chart	ch	4	4	2	2	2	2	16	0.77
22) Other books	book	1	1	1	1	0	0	4	0.19
Structuring Information									

23) Note taking	note	4	1	1	3	1	1	11	0.53
24) Translation	tl	4	4	9	10	14	9	50	2.41
25) Imagery	im	8	5	4	6	7	1	31	1.49
26) Summarisation	sum	28	18	16	15	9	11	97	4.67
27) Figure	fig	3	0	0	3	0	0	6	0.29
28) Diagram	di	2	0	0	3	0	0	5	0.24
Enquiry									
29) Self questioning	q	16	48	40	23	12	19	158	7.61
30) Express confusion	cf	2	5	2	3	0	3	15	0.72
Guessing the meaning									
31) Word formation (prefix, suffix, root)	wf	7	6	5	7	6	4	35	1.69
32) Context clue	cc	38	39	18	35	14	20	164	7.9
33) Markers	m	2	2	0	4	0	0	8	0.39
34) Punctuation	p	0	3	0	0	0	0	3	0.14
Prediction									
35) Based on title	pt	10	9	9	7	5	5	45	2.17
36) Based on picture	pp	3	4	7	6	2	3	25	1.2
37) Based on context	pcon	4	9	7	4	3	4	31	1.49
38) Based on diagram	pd	0	0	0	0	0	0	0	0
Text elaboration									
39) Interpreting the text	pret	19	20	4	6	3	4	56	2.7
40) Connection between parts of text	cp	10	16	12	12	5	8	63	3.03
41) Comparison between parts of text	com	2	4	0	8	0	3	17	0.82
Sub Total		213	281	179	228	110	129	1140	54.89

Affective Strategies									
42) Interest	in	10	5	3	3	5	2	28	1.35
43) React to the text	rt	19	19	12	18	3	9	80	3.85
44) Text association	text	5	4	2	6	3	3	23	1.11
Sub Total		34	28	17	27	11	14	131	6.31
	Total	399	504	320	406	214	234	2077	100.00
	Percent	19.2	24.3	15.4	19.6	10.3	11.3	100	

As shown in Table 5.4, cognitive strategies were the most frequently employed strategies (54.89%), followed by metacognitive strategies (38.82%) and affective strategies (6.31%). Figure 5.1 presents the overall strategy use by the six students, and Table 5.5 presents the strategies in rank order for frequency of use. Examples for each strategy are given in following sections.

Figure 5.1: Frequencies: all think-aloud strategies

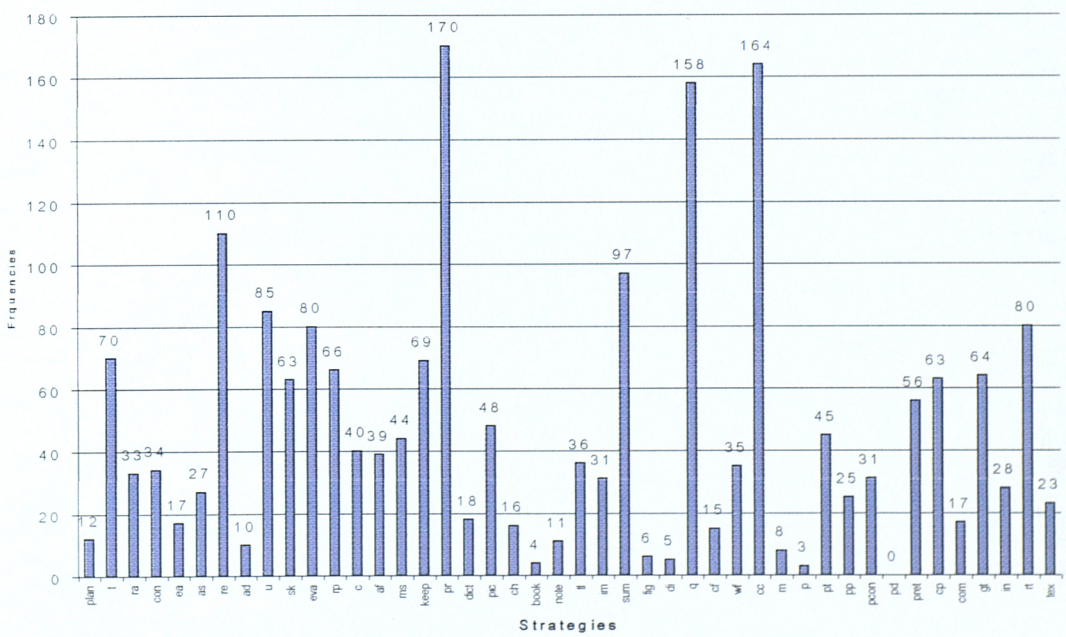


Table 5.5: Rank order of think-aloud strategies

Rank Order	Strategies	Abbreviation	Frequencies	Percentage
1	Prior knowledge	pr	170	8.18%
2	Context clues	cc	164	7.90%
3	Self questioning	q	158	7.61%
4	Rereading	re	110	5.30%
5	Summary	sum	97	4.67%
6	Underline	u	85	4.09%
7	Self evaluation	eva	80	3.85%
7	React to the text	rt	80	3.85%
9	Title	t	70	3.37%
10	Realise the problems	rp	66	3.18%
11	Grammatical transfer	gt	64	3.08%
12	Skipping	sk	63	3.03%
12	Connecting between parts	cp	63	3.03%
14	Keep the meaning in mind	keep	59	2.84%
15	Interpretation	pret	56	2.70%
16	Make sense	ms	51	2.46%
17	Translation	tl	50	2.41%
18	Picture	pic	48	2.31%
19	Prediction from title	pt	45	2.17%
20	Continue	con	44	2.12%
21	Correcting	c	40	1.93%
22	Affirmation	af	39	1.88%
23	Word formation	wf	35	1.69%
24	Reading ahead	ra	33	1.59%
25	Imagination	im	31	1.49%
26	Prediction from context	pcon	31	1.49%

27	Interest	in	28	1.35%
28	Alternative strategies	as	27	1.30%
29	Prediction from picture	pp	25	1.20%
30	Text association	tex	23	1.11%
31	Dictionary	dict	18	0.87%
32	Return to earlier parts	ea	17	0.82%
32	Comparison	com	17	0.82%
34	Chart	ch	16	0.77%
35	Expressing confusion	cf	15	0.72%
36	Planning	plan	12	0.58%
37	Note taking	note	11	0.53%
38	Adjust speed	ad	10	0.48%
39	Markers	m	8	0.39%
40	Figure	fig	6	0.29%
41	Diagram	di	5	0.24%
42	Book	book	4	0.19%
43	Punctuations	p	3	0.14%
44	Prediction from diagram	pd	0	0.00%
		Total	2077	100.00%

As shown in Figure 5.1 and Table 5.5, the most frequently employed strategies were prior knowledge (170, 8.81%), followed by context clues (164, 7.90%) and self questioning (158, 7.61%), which all belong to the 'cognitive strategies' group. Among the metacognitive strategies, self questioning, rereading (110, 5.30%) and self evaluation (80, 3.85%) were used with a moderate frequency. The strategies with very low frequency were grouping strategies (11, 0.53%) as well as use of markers (8, 0.39%) and punctuation (3, 0.14%). The use of all 44 strategies will be discussed in more detail below, considering the three main categories in turn.

5.1.3.1.1 Metacognitive strategies

As discussed in Chapter II, metacognitive strategies are used to oversee, regulate or self direct language learning (O'Malley & Chamot,1990). These strategies include planning, monitoring and checking. Flavell (1981:5) argued that metacognitive strategies are especially likely to occur in situations that stimulate a lot of careful, highly conscious thinking. Examples of metacognitive strategies include self-evaluation and consciously directing one's attention to the learning task (O' Malley & Chamot, 1990:55). In this study metacognitive strategies refer to the activities employed by the readers to plan, control, monitor and evaluate their comprehension. Subjects in this study did not report high levels of metacognitive strategy use, but still showed their awareness of a variety of metacognitive strategies when they read English texts.

Figure 5.2: Metacognitive Strategies

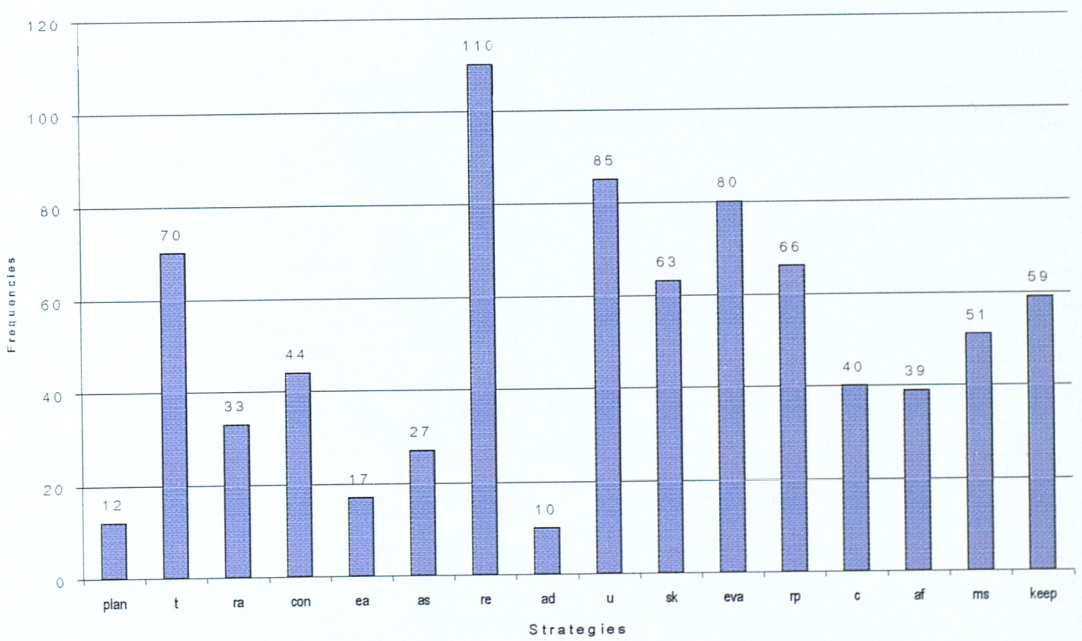


Figure 5.2 shows the frequency of metacognitive strategies used by the 6 students. Rereading was the most frequently reported strategy (110, 5.30%) followed by selecting

the important parts (85, 4.09%) and self evaluation (80, 3.85%). From their report we can say that the subjects were fairly able to plan, control and self evaluate while reading English texts. Further details for metacognitive strategies are presented according to the six subgroups; preview, self management, selection, self evaluation and monitoring.

Preview

According to O'Malley and Chamot (1990:47) planning is a key strategy for second language acquisition for it is involved in directing the course of language reception and production. In this study only 4 students reported that they set their purposes before reading and they did so at a very low frequency (12, 0.58%). One subject realised the importance of this strategy as she stated that she set the purpose before reading, so that she could know how to manage her reading style: *"It makes a lot of difference. I'll read through it quickly for leisure, but in detail if I have to tell others the story. For example, if we want to know how to use a communication radio, we have to install its antenna. We must know the exact process about the materials, how to install it, what kind of cable, etc. So we have to follow all the details and instructions" (Miss A1 : Sensor Sensibility).* However, every subject reported that they would roughly look for the main ideas both by previewing the titles (70, 3.3%) and by skimming or reading ahead (33, 1.59%) *" I started with the title and the picture but I get the clear main idea from the first paragraph" (Mr. A3: Word Power).*

Self management

The functional purpose of this category is that the readers demonstrate their comprehension strategies by adjusting their reading styles to understand the texts. In this study readers' use of self management strategies amounted overall to 10.02% of total strategy use. They would reread if they did not understand any part (110, 5.30%): *" I have read two or three times in some parts that are very difficult to understand, e.g. the first*

one with technical process. I have to reread many times. But it was difficult" (Miss A1: Elixir of Youth), or continue if unsuccessful at decoding (44, 2.12%) *" I did not know what 'exact' and 'approximate' were. But when I continued reading I found something that made me know them" (Miss B1: Word Power).* These strategies may reflect the reader's confusion or non-comprehension. They may also be an indication of the readers' loss of connection with the text content, so that they have to go back to a certain part of the text to refresh their memory (17, 0.82): *" At this point I have to go back to see what the earlier part said" (Miss A1: Elixir of Youth).* They sometimes used other strategies when they were not successful in decoding (27, 1.30%): *" So I guessed from the context but I still didn't know. At last, I gave up and kept on reading, but I'm not sure so I underlined it" (Miss B1: Elixir of Youth).* Two of the subjects adjusted their reading speed at different moments (10, 0.48%): *" First I skimmed very rapidly and then reread slowly especially in difficult parts" (Miss A1: Muck into Medicine).*

Selective Attention

Readers focus on special parts, that is to say, they know which parts are important and which part they should skip. Students in this study employed these strategies with moderate frequency (10.84%). They sometimes underlined, highlighted or selected important parts (85, 4.09%): *" I paid attention to these two words and underlined here to show myself that they were important" (Miss B1: That's Us Stuffed Then)* and skipped unimportant parts (63, 3.03%).

Self Evaluation

Readers use this strategy group to assess how well they stood either at text or word level (10.84%). These strategies occur after the readers have made some kinds of interpretation, which they then later evaluate, (80, 3.85%) *" I could understand this paragraph but still doubted with the second one. I could not understand which was what, apart from this I*

could understand" (Miss B5: Word Power). This also includes when they evaluated their reading ability by recognising problems (66, 3.18%): " *I can read but the mechanism seems to be more complex for me to understand. The English language itself is not difficult, but I don't understand the mechanism" (Miss B3: Sensor Sensibility*). If they observed that their earlier interpretation was incorrect then they made a change according to their new hypothesis (40, 1.93%): " *They might have some interaction with each other when doing verbal and non-verbal. No, not this, but when they do an exact calculation" (Miss A1: Word Power*). And if they found their understandings were correct they affirmed them (39, 1.88%): " *It also told us that this research was rather difficult because it could not grow in the lab.Yes. From the next paragraph, at present Terragen solved this problem by cutting the DNA of microorganisms into large parts" (Mr.A3: Muck into Medicine).*

Monitoring

Monitoring comprehension can be described as being aware of what one is doing or bringing one's own 'mental processes under conscious scrutiny more effectively under control' (O'Malley & Chamot,1990:59). In this study monitoring was judged to be used when the readers considered whether what they read makes sense (51, 2.64%): "*If I understand what I read and it is reasonable I can say, yes, I understand it" (Mr.A5: No More Needle).* The readers were able to keep the meaning of the passage in mind (59, 2.84%): " *I did not pay much attention to every word. It's a short passage and since I got the main idea of the passage I did not have trouble reading this" (Miss B1: Sensor Sensibility).*

5.1.3.1.2 Cognitive strategies

Cognitive strategies refer to the steps or operations used in learning or problem solving that require direct analysis, transformation or synthesis of learning materials. Figure 5.3 shows the frequencies of individual cognitive strategies reported by the six subjects.

Figure 5.3: Cognitive Strategies

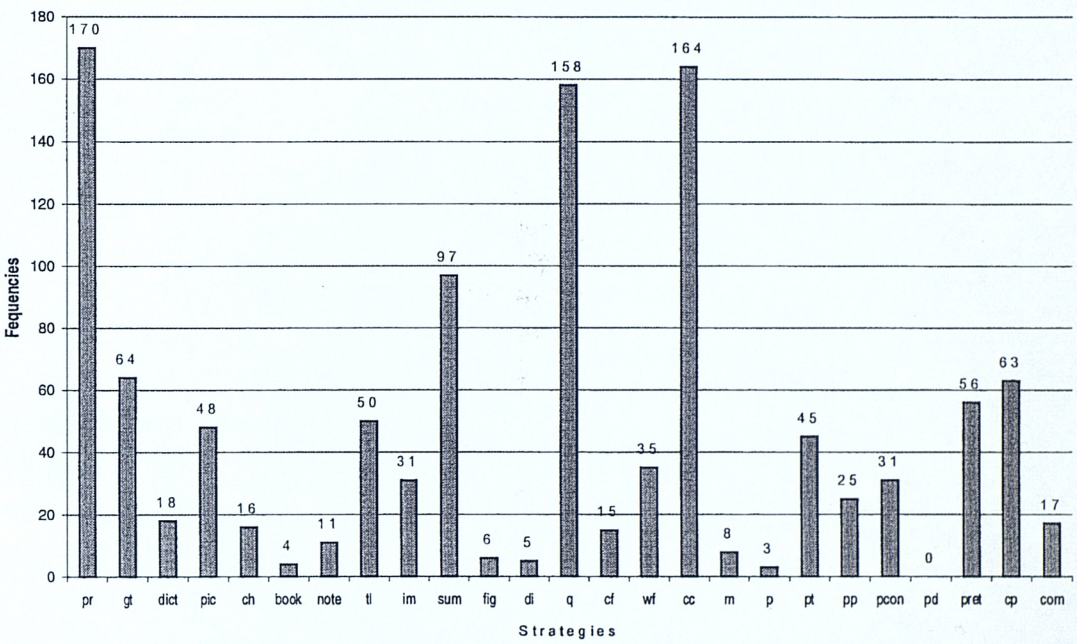


Figure 5.3 shows 25 cognitive strategies. The most frequently reported strategy was using prior knowledge (170, 8.18%). Other strategies with high frequency were self questioning (158, 7.61%) and using context clues (164, 7.90%). This suggests that readers regularly used more top down than bottom up strategies when they were reading English texts. The 25 cognitive strategies were divided into six sub groups; knowledge transfer, resource, structuring information, enquiry, guessing the meaning, prediction, and text elaboration.

Knowledge transfer

The knowledge transfer category includes both using prior knowledge and grammatical transfer. Students in this study were able to use these strategies regularly (11.18%). A

prior knowledge strategy occurs when readers use their knowledge of the world, including subject knowledge, to explain, support and clarify information in their reading texts (170, 8.18%): " *I thought of what I had learned before about lichen. What they were classified. I try to find it from my background knowledge to get some ideas as my base" (Miss B3: Muck into Medicine).* They also used their grammatical knowledge to help them to understand the text (64, 3.08%): " *But this sentence is complex and there are many words that I don't know. I have to look for the subject of the sentence and try to link with other sentences to see what happened" (Miss A1: That's Us Stuffed Then).*

Resources

Readers use reference materials such as dictionaries, pictures, charts, and text- books to understand reading texts. Every subject in this study reported using resource strategies but at a low frequency (4.14%). They preferred using pictures to other sources (31, 2.31%): "*This one 'Get stuck in' I don't understand the title so I look at the picture and get an idea that it will tell us about stud" (Mr. A5: Get Stuck in).* They rarely used a dictionary during the think-aloud study (18, 0.87%), and use of charts (16, 0.77%) or other books (4, 0.19%) was also almost none. (See discussion comparing the think-aloud study analyses with other strategy data, Section 5.3.3.)

Strategies for structuring information

Students in this study reported use of several structuring strategies, including note taking, translation, summarisation, grouping and imagery, at a moderate overall frequency (9.63%). They often summarised the information to structure and restore the received message (97, 4.67%). This strategy usually occurs when the readers read a part of the text, then engage some strategies to comprehend the information, and then sum up what the text has said so far " *Well, what I've read so far, it was about mummies but not in detail. It seems to me that they would study more about the mummies" (Mr. A5: Cloth of Ages).*

They rarely took notes (11, 0.53%) or used grouping (11, 0.53%). However, they used translation many times to comprehend the texts (50, 2.41%): " *I thought they tried to explain about a basket, shoes, etc. 'sparkle' meant lighting but 'spark off' meant 'turn off' isn't it?" (Miss B1: Cloth of Ages).* They also imagined while they were reading (31, 1.49%): " *I can imagine. Here in the third paragraph it said 'Electrodes built into the surface of the table...induces detectable currents in the coils embedded in the table top' so I think it is a solid table top which must be made of special kind of substance. This substance can receive our wave and sends it to the coils" (Miss B1: Sensor Sensibility).*

Enquiry

The functional purpose of this individual cognitive strategy is that readers ask themselves for more information in order to clarify some points which are still not clear for them. *"First I read the title then I wondered what it was. So I asked myself what 'stuff' was. In fact I heard this word before, but with a general meaning. This 'stuff is a noun but 'stuff' here is a verb. So I was confused and asked myself because I don't get clear idea about it" (Miss B1: That's Us Stuffed Then).* It reflects readers' expectation from the text, as well as their observations of a lack of information in the text. Every subject in this study employed this strategy at a moderate frequency (8.33%).

Guessing the meaning

This group of strategies is used to identify the meaning of unknown words as well as to understand information at text level. The subjects in this study employed these strategies at a quite high frequency overall (10.12%), mostly using context clues. The readers somehow accomplish this by linking unknown words with the context (164, 7.90%): " *I found the word 'novel chemicals' and I had no idea what it was. However, I reread this sentence 'Because the company is already familiar with the chemicals normally produced by the host, it only has to look for novel chemicals...' It said about which one was old. So I*

guess that 'novel' means new" (Miss B1: Muck into Medicine). Readers in this study also occasionally used word formation (35, 1.69%) and markers (but, and, however, etc.) or punctuation (11, 0.53%) to understand the texts.

Prediction

Prediction strategies demonstrate that the readers explore a segment or a part of the passage and then form a hypothesis going beyond the received information. They are able to predict, according to their assumptions about what will come next. Students in this study were able to use these strategies at a moderate overall frequency (101, 4.86%). Prediction strategies include prediction based on the title (45, 2.17%): " *When I looked at the title and sub title, there must be a chemical experiment for sure" (Miss B3: Muck into Medicine)*; based on the picture (25, 1.20%): "*The picture helps me to get clear idea about the story. I can predict that are going to talk about the ageing process" (Miss B1: Elixir of Youth)*; or based on content (31, 1.49%): "*This article is talking about medicine and agriculture. So I guess it 's about medicine" (Miss B1: Plantibodies).*

Text elaboration

The readers are able to form a hypothesis by reading the information and then going beyond the information in the text so as to interpret the text: "*They use lichen because there is a lot of lichen in our world. Yes, they make useful thing from the useless" (Miss B1: Muck into Medicine).* Every subject reported his use of this strategy, though at low frequency (56, 2.73%). Text association is a further strategy used to relate the content of the text to the reader's personal life or experience: "*I think that some companies try to make more money without thinking about people's health. They do everything for their own benefits" (Miss A1: That's Us Stuffed Then).* Every subject in this study reported use of a text association strategy, but at a low frequency (23, 1.11%).

5.1.3.1.3 Affective strategies

After reading, the readers expressed their interest or reacted emotionally to the information in the texts. Every subject expressed interest, but at a low frequency (28, 1.35%). However, they several times (80, 3.85%) expressed their feeling about the text: *" It's not enough for my interest. That's only the detail telling about the mummies. I want to know more about the relationship between the mummies in China and how it links with the western world" (Miss A1: Cloth of Ages).*

5.1.3.2 A comparison of reading strategy use between the control group and the experimental group

Section 5.1 described the overall patterns of reading strategies employed by the six students in the think-aloud study. This section considers whether there is any difference in the use of comprehension strategies, between the two groups. Table 5.6 shows frequencies and percentages for all 44 strategies, as reported by think-aloud subjects from the control group and the experimental group.

Table 5.6: Frequencies and percentage of think-aloud strategy use by the control and experimental group subjects

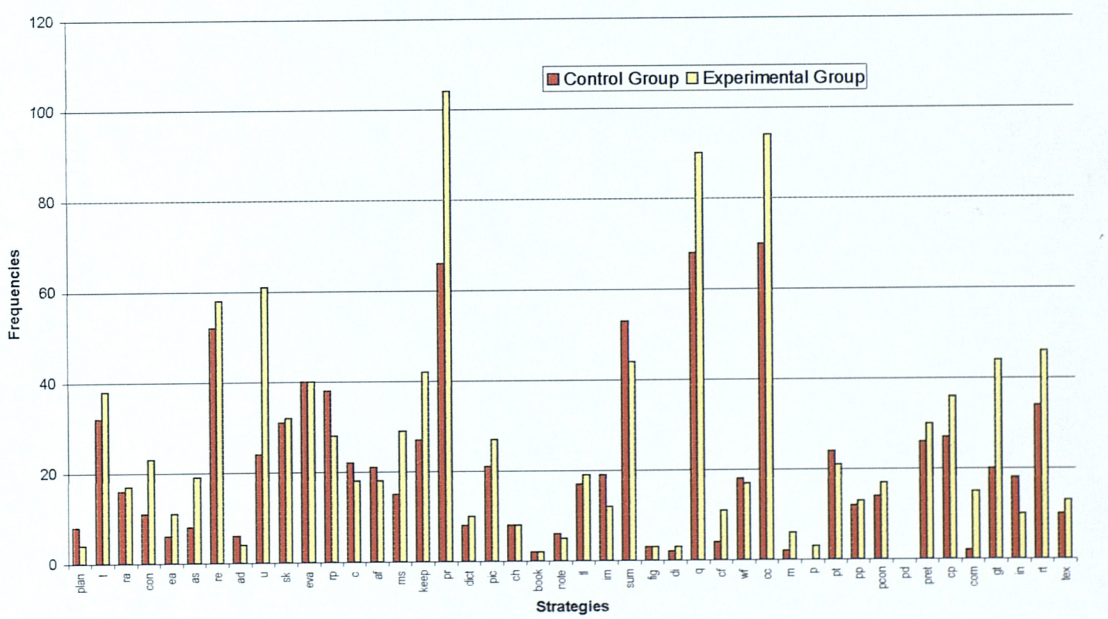
Strategies	Control Group (n = 3)		Experimental Group (n = 3)		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
plan	8	0.39%	4	0.19%	12	0.58%
t	32	1.54%	38	1.83%	70	3.37%
ra	16	0.77%	17	0.82%	33	1.59%
con	21	1.01%	23	1.11%	44	2.12%
ea	6	0.29%	11	0.53%	17	0.82%
as	8	0.39%	19	0.91%	27	1.30%
re	52	2.50%	58	2.79%	110	5.30%

ad	6	0.29%	4	0.19%	10	0.48%
u	24	1.16%	61	2.94%	85	4.09%
sk	31	1.49%	32	1.54%	63	3.03%
eva	40	1.93%	40	1.93%	80	3.85%
rp	38	1.83%	28	1.35%	66	3.18%
c	22	1.06%	18	0.87%	40	1.93%
af	21	1.01%	18	0.87%	39	1.88%
ms	20	0.96%	31	1.49%	51	2.46%
keep	24	1.16%	35	1.69%	59	2.84%
pr	66	3.18%	104	5.01%	170	8.18%
dict	8	0.39%	10	0.48%	18	0.87%
pic	21	1.01%	27	1.30%	48	2.31%
ch	8	0.39%	8	0.39%	16	0.77%
book	2	0.10%	2	0.10%	4	0.19%
note	6	0.29%	5	0.24%	11	0.53%
tl	27	1.30%	23	1.11%	50	2.41%
im	19	0.91%	12	0.58%	31	1.49%
sum	53	2.55%	44	2.12%	97	4.67%
fig	3	0.14%	3	0.14%	6	0.29%
di	2	0.10%	3	0.14%	5	0.24%
q	68	3.27%	90	4.33%	158	7.61%
cf	4	0.19%	11	0.53%	15	0.72%
wf	18	0.87%	17	0.82%	35	1.69%
cc	70	3.37%	94	4.53%	164	7.90%
m	2	0.10%	6	0.29%	8	0.39%
p	0	0.00%	3	0.14%	3	0.14%
pt	24	1.16%	21	1.01%	45	2.17%
pp	12	0.58%	13	0.63%	25	1.20%
pcon	14	0.67%	17	0.82%	31	1.49%
pd	0	0.00%	0	0.00%	0	0.00%
pret	26	1.25%	30	1.44%	56	2.70%
cp	27	1.30%	36	1.73%	63	3.03%
com	2	0.10%	15	0.72%	17	0.82%

gt	20	0.96%	44	2.12%	64	3.08%
in	18	0.87%	10	0.48%	28	1.35%
rt	34	1.64%	46	2.21%	80	3.85%
tex	10	0.48%	13	0.63%	23	1.11%
Total	933	44.91%	1144	55.12%	2077	100.00%

As can be seen from Table 5.6, out of the total number of identified strategies, 1144 or 55.12% were reported by members of the experimental group, while the control group reported 933 or 44.91% on the same ten think- aloud texts. There was 10.21% overall difference between the two groups. There were also differences in the frequencies and percentages for individual strategies, as presented in Figure 5.4.

Figure 5.4: Frequencies of individual think-aloud strategies: comparison between control and experimental group



It can be seen that the experimental group reported slightly higher use for almost every strategy. However, there were 5 strategies, which showed distinctively different use between the control group and the experimental group.

The experimental group underlined or selected important information much more often than the control group (u 61:24), and reported using prior knowledge to understand the texts considerably more (pr 104:66). The experimental group used self questioning considerably more often than the control group (q 90:68), as well as using context clues (cc 94:70). They also transferred their grammatical knowledge more often than the control group (gt 44:20). The control group subjects use the 'alternative' strategy (as 8:19) less than half as often as those from the experimental group.

However, there were some strategies, which the control group reported using slightly more often than the experimental group. So, the control group seemed to be a bit better at self evaluation. The two groups reported the same number of 'evaluate their guess' (eva 40:40), but the control group reported the 'realise their problems' strategy slightly more often (rp 38:28). They corrected their understanding slightly more often than the experimental group (c 22:18) and affirmed their understanding slightly more (af 21:19).

Among the cognitive strategy group, the control group summarised more often than the experimental group (sum 53:44). They reported using a translation strategy at a slightly higher frequency than the experimental group (tl 27:23). Surprisingly, they reported positive interest more often than the experimental group (18:10).

Figure 5.5: Comparison among High, Mid, and Low in the control group

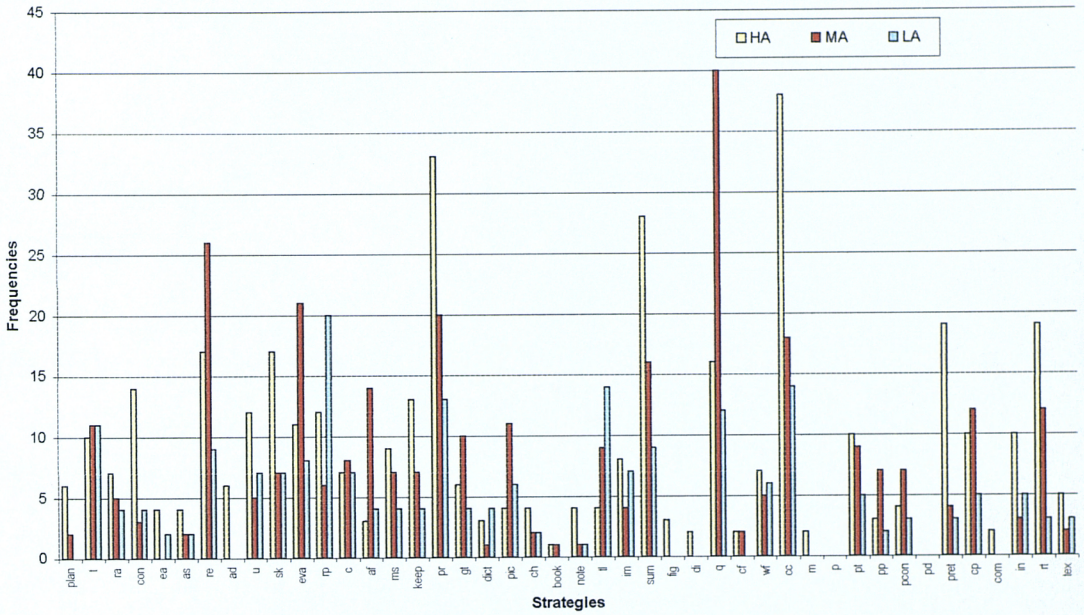
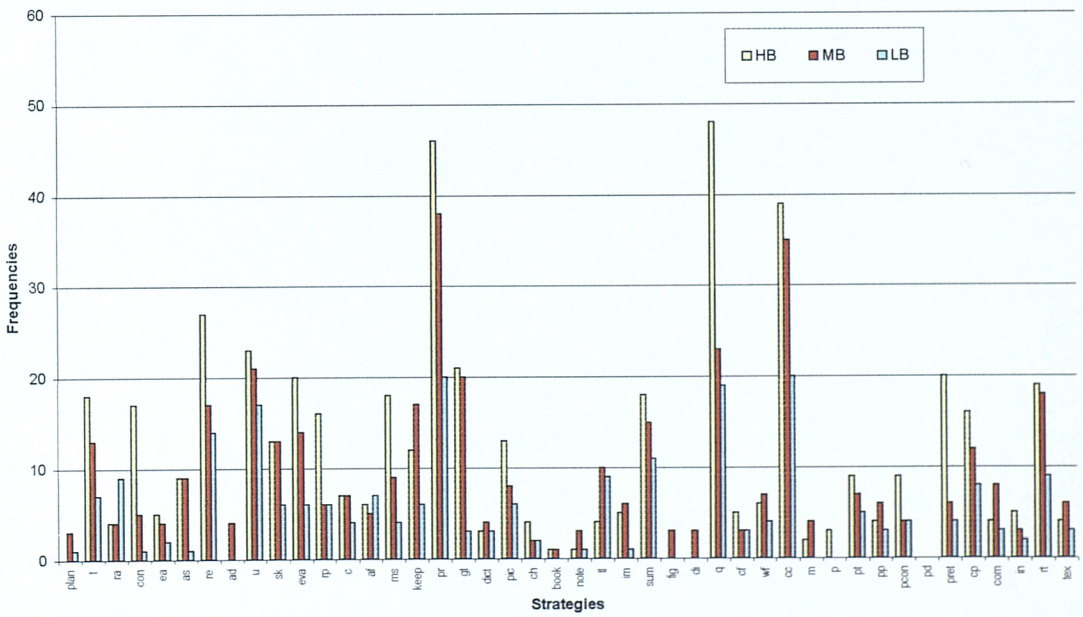


Figure 5.6: Comparison among High, Mid, and Low in the experimental group



Finally, Figure 5.5, and 5.6 show the strategies employed by each individual subject within the two groups. The most remarkable difference between the two groups concerned the favourite strategies employed by group members presented in Table 5.7.

Table 5.7: Favourite strategies employed by the students in the two groups

	Control group	Experimental group
High Ability Students	Context clue (38, 1.82%)	Self questioning (48, 2.30%)
	Prior knowledge (33, 1.58%)	Prior knowledge (46, 2.20%)
	Summary (28, 1.34%)	Context clue (39,1.87%)
Middle Ability Students	Self questioning (40, 1.92%)	Prior knowledge (38, 1.82%)
	Rereading (26, 1.24%)	Context clue (35, 1.68%)
	Evaluation (21, 1%)	Self questioning (23, 1.10%)
Low Ability Students	Realise problem (20, 0.96%)	Prior knowledge (20, 0.96%)
	Translation (14, 0.67%)	Context clue (20, 0.96%)
	Context clue (14, 0.67%)	Underline (17, 0.81%)

As can be seen from Table 5.7, the three subjects from the experimental group reported almost the same three favourite strategies regardless of ability level. This suggests they used the reading strategies in a more similar style than the subjects from the control group. Subjects in the control group tended to use reading strategies in their own style.

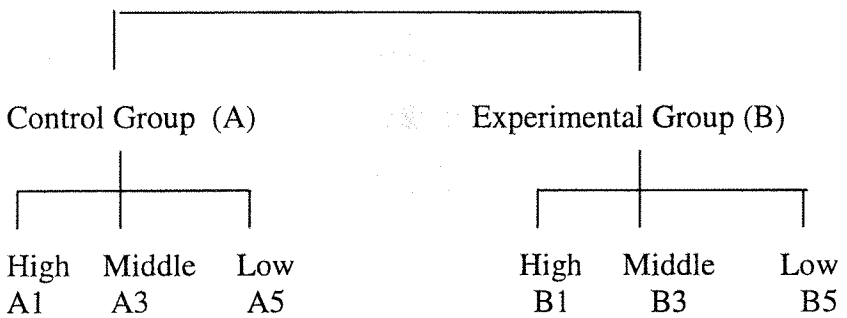
In conclusion, there were differences both in the frequency of strategies, types of strategies and also the pattern of strategy use between the control group and the experimental group.

5.2 Diary analysis

So far, the data on reading strategies reported by Thai students in this study have been derived from questionnaires and the think-aloud study, i.e., from relatively controlled techniques. However, the researcher also wanted to investigate how these subjects use reading strategies when they read English texts on their own, in natural settings. To gain such data, diaries are good tools. As mentioned by McDonough and McDonough

(1997:112) diary studies enable the researcher to relate classroom events and examine trends emerging from the diaries. They provide more natural data, and are produced without any outside observer. Thus, during 10 weeks of the 12 week field study, the researcher asked the same 12 students who participated in the think-aloud study to keep a diary about their reading activities.

The findings in this part are based on the diaries of the six subjects whose think-aloud data has been analysed in section 5.1. Details are presented in the following diagram.



The main purpose of the diary study is to answer research question number 4:

'Question No.4: Do learners transfer learned strategies to extensive reading activities?'

This section reports the analysis of the diary data, and is divided into 2 main parts. The first part gives the procedure for the diary study, including the data analysis procedure. The second part reports the results of the diary study, comprising an overall picture of their reading strategies and a comparison between the two groups.

5.2.1 The Procedure of the diary study

Keeping a diary is not an easy task. It is burdensome and time consuming. Thus, the researcher asked the students to keep their diaries in the form of a semi-structured task. The diary consists of an A4 sheet with the headings Reading Materials, Duration, Problems, Solutions and Reading Strategies as explained in section 3.2. The twelve

students were asked to 'complete briefly' with reference to their English reading activities at home, and to hand in their diaries every week. As mentioned in the think-aloud study, the twelve students who participated had to sign a consent form, and diary writing was also mentioned on the form.

At the end of the 10 weeks, the twelve students handed in a total of 105 entries (1 entry comprises a 7 day diary) or an average of 8.83 entries per student. Their reading materials could be divided into 3 types: fiction, non-fiction, newspapers and journals, which are presented in Table 5.8.

Table 5.8: Types of reading materials reported

Types of Material	Frequency									
	High		Middle		Low		Total	Percent		
	A	B	A	B	A	B			Total A	Total B
Fiction books	14	20	18	35	27	30	144	29.3%	59	85
Non-fiction books	28	49	30	37	34	36	214	43.5%	92	122
Newspapers and journals	20	27	24	27	21	15	134	27.2%	65	69
Total	62	96	72	99	82	81	492	100%	216	276
Percent	12.6%	19.5%	14.6%	20.1%	16.7%	16.5%	100%		43.9%	56.1%

As can be seen from Table 5.8, non-fiction is the most popular type of reading for the students in this study (43.5%). This includes textbooks, assignments, other books in their fields of study and books reflecting other interests. Fiction and newspapers and journals were reported in similar frequency, 29.3% and 27.2% respectively. Students in the experimental group reported reading more items than the control group: 276 and 216 or 56.1% and 43.9% respectively.

Since the data from the diaries are similar to think-aloud data, the researcher followed the steps of the think-aloud analysis reported in section 5.1.2. So the definition

and categorization of reading strategies in Table 5.2 was used as a starting point to code the strategies identified in the diaries. However, during the first stage of analysis, the researcher found some additional reported strategies, which were categorised as:

1) looking for main media (mi)
2) meditation (med)
3) concentration (conc)
4) stop reading (stop)
5) memory (mem)
6) ask someone (ask)
7) text organization analysis (ta)
8) discussion (dis).

These eight strategies were added to the checklist.

The students who kept the diaries were already familiar with the concept of reading strategies as they were trained before the think-aloud task. Also, they became more skilful at identifying strategies as they worked through their think-aloud tasks. The students also benefited by keeping a diary because they became more aware of their own reading strategies; thus, they identified clearly what strategies they used when they read (see also Appendix I). This meant the researcher had few problems with coding, and ensured reliability. All strategies reported by the students were tallied on strategy sheets. In all, 2695 strategies were identified which was counted as 100%. The data for each strategy were analysed to find frequency distributions and percentages.

5.2.2 Findings of the diary study

After the coding, both qualitative and quantitative analysis was undertaken. The findings of the diary study are presented in 2 parts:

5.2.2.1 Overall description of reading strategies employed by the six students while reading English texts at home.

5.2.2.2 A comparison of reading strategy use between the control group (A) and the experimental group (B).

5.2.2.1 Overall description of reading strategies employed by the six students while reading English texts at home

The six students in this study reported a well- developed repertoire of reading strategies. These were again divided into metacognitive, cognitive, and affective strategies. The only strategy that was not reported was prediction. 39 strategies were identified, which are presented in Table 5.9 and Figure 5.7.

Table 5.9: Reading strategies and their frequencies (Diary study)

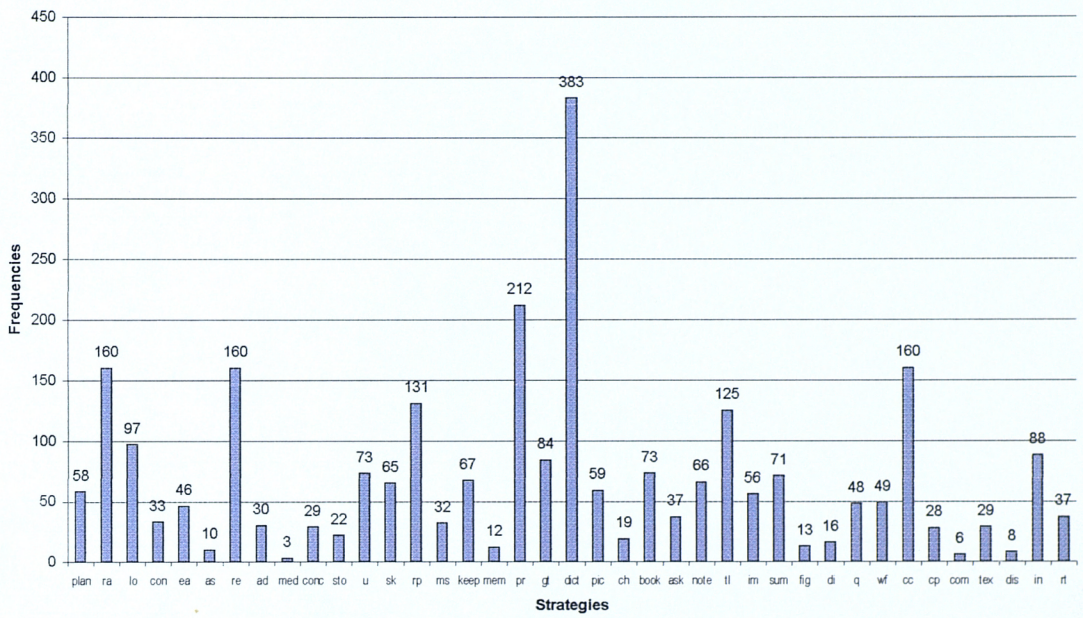
Strategies	**Codes**	**Frequency of Use by individuals**						Total Use	Per cent
		High		Middle		Low			
		A	B	A	B	A	B		
Metacognitive Strategies									
Plan									
1) Planning	plan	14	11	7	19	2	5	58	2.15%
2) Reading ahead	ra	38	33	32	30	12	15	160	5.94%
3) Looking for main idea	lo	21	23	16	17	7	13	97	3.60%
Self management									
4) Continue if unsuccessful at decoding a word or phrase	con	6	6	4	12	1	4	33	1.22%
5) Return to an earlier part	ea	14	17	10	5	0	0	46	1.71%
6) Alternative strategies	as	0	6	0	4	0	0	10	0.37%

7) Rereading	re	31	41	31	30	9	18	160	5.94%
8) Adjust speed	ad	14	4	3	9	0	0	30	1.11%
9) Meditation	med	0	3	0	0	0	0	3	0.11%
10) Concentration	conc	14	4	3	6	2	0	29	1.08%
11) Stop reading	stop	4	1	2	10	2	3	22	0.82%
Selection									
12) Underline important parts	u	10	15	11	17	6	14	73	2.71%
13) Skip unimportant parts	sk	12	14	8	7	7	17	65	2.41%
Self evaluation									
14) Realise the problems	rp	14	15	19	20	29	34	131	4.86%
Monitor									
15) Consider what is being read makes sense	ms	7	9	7	6	0	3	32	1.19%
16) Keep meaning of the passage in mind	keep	16	16	10	15	4	6	67	2.49%
17) Memory	mem	0	12	0	0	0	0	12	0.45%
Sub Total		215	230	163	207	81	132	1028	38.14%
Cognitive Strategies									
Transfer									
18) Prior knowledge	pr	46	44	31	41	23	27	212	7.87%
19) Grammatical transfer	gt	20	24	16	17	1	6	84	3.12%
Resource									
20) Dictionary	dict	60	67	57	69	61	69	383	14.21%
21) Picture	pic	6	16	13	2	2	20	59	2.19%
22) Chart	ch	1	10	5	3	0	0	19	0.71%

23) Other books	book	18	17	12	14	6	6	73	2.71%
24) Ask someone	ask	0	9	7	6	7	8	37	1.37%
Structuring Information									
25) Note taking	note	10	19	6	20	4	7	66	2.45%
26) Translation	tl	28	18	12	20	20	27	125	4.64%
27) Imagery	im	10	14	7	7	5	13	56	2.08%
28) Summarisation	sum	14	24	5	21	1	6	71	2.63%
29) Figure	fig	4	4	0	5	0	0	13	0.48%
30) Diagram	di	4	8	0	4	0	0	16	0.59%
Enquiry									
31) Self questioning	q	14	11	9	12	0	2	48	1.78%
Guessing the meaning									
32) Word formation (prefix, suffix, root)	wf	10	19	5	7	3	5	49	1.82%
33) Context clue	cc	41	44	31	21	10	13	160	5.94%
Text elaboration									
34) Connection between parts of text	cp	2	16	4	6	0	0	28	1.04%
35) Comparison between parts of text	com	0	4	0	2	0	0	6	0.22%
36) Text organisation analysis	tex	0	12	0	14	0	3	29	1.08%
37) Discussion	dis	2	6	0	0	0	0	8	0.30%
Sub Total		290	386	220	291	143	212	1542	57.22%
Affective Strategies									
38) Interest	in	16	19	12	17	10	14	88	3.27%
39) React to the text	rt	3	7	9	8	2	8	37	1.37%

Sub Total		19	26	21	25	12	22	125	4.64%
	Total	524	642	404	523	236	366	2695	100.00%
	Percent	19.4%	23.8%	15.0%	19.4%	8.8%	13.6%	100.0%	

Figure 5.7: Frequencies of reported reading strategies (Diary study)



The six students reported a variety of reading strategies when they read English texts at home. Of the 39 strategies, 20 strategies were cognitive strategies, 17 metacognitive and 2 affective strategies. The most frequently mentioned were cognitive strategies (57.22)% followed by metacognitive strategies (38.14%) and the least mentioned, affective strategies (4.64%). The rank order of popularity of strategies is presented in Table 5.10.

Table 5.10: Rank order of reading strategies (Diary study)

Rank Order	Strategies	Abbreviation	Frequencies	Percentage
1	Dictionary	dict	383	14.21%
2	Prior knowledge	pr	212	7.87%

3	Reading ahead	ra	160	5.94%
= 3	Rereading	re	160	5.94%
= 3	Context clue	cc	160	5.94%
6	Realise the problems	rp	131	4.86%
7	Translation	tl	125	4.64%
8	Looking for main idea	lo	97	3.60%
9	Interest	in	88	3.27%
10	Grammatical transfer	gt	84	3.12%
11	Underline important parts	u	73	2.71%
= 11	Other books	book	73	2.71%
13	Summarisation	sum	71	2.63%
14	Keep meaning of the passage in mind	keep	67	2.49%
15	Note taking	note	66	2.45%
16	Skip unimportant parts	sk	65	2.41%
17	Picture	pic	59	2.19%
18	Planning	plan	58	2.15%
19	Imagery	im	56	2.08%
20	Word formation (prefix, suffix, root)	wf	49	1.82%
21	Self questioning	q	48	1.78%
22	Return to an earlier part	ea	46	1.71%
23	Ask someone	ask	37	1.37%
= 23	React to the text	rt	37	1.37%
25	Continue if unsuccessful at decoding a word or phrase	con	33	1.22%
26	Consider what is being read makes sense	ms	32	1.19%
27	Adjust speed	ad	30	1.11%
28	Concentration	conc	29	1.08%
= 28	Text organisation analysis	tex	29	1.08%
30	Connection between parts of text	cp	28	1.04%
31	Stop reading	stop	22	0.82%

32	Chart	ch	19	0.71%
33	Diagram	di	16	0.59%
34	Figure	fig	13	0.48%
35	Memory	mem	12	0.45%
36	Alternative strategies	as	10	0.37%
37	Discussion	dis	8	0.30%
38	Comparison between parts of text	com	6	0.22%
39	Meditation	med	3	0.11%
		Total	2,695	100%

The most frequently mentioned strategy was dictionary use (383, 14.21%) cited by all six students with very similar frequencies. They all used expressions such as 'open the dictionary'. 'Prior knowledge' was another strategy mentioned often by every subject (212, 7.87%). As one student wrote, 'I use my prior knowledge to understand the article' (Mr. A3, 24/8/99). The other popular strategies were reading ahead, using context clues, and rereading (160, 5.94%). Every subject mentioned that these strategies often help them to understand the texts. 'Rereading makes me clearer' (Mr. A5, 3/10/99), 'Use context clues and skimming' (Miss B3, 31/8/99).

They all mentioned their problems quite often (131, 4.86%). Their main problem was vocabulary, so it was not surprising that the students cited translation as a regular reading strategy, along with dictionary use (125, 4.64%). One example cited by one diarist is 'Use the dictionary and try to translate as close as possible' (Miss B5, 22/8/99). It was interesting to see that one of their favourite reading strategies was 'looking for main idea' (97, 3.60%) since this was the strategy taught in both the control and the experimental groups. As one student wrote 'I looked for the main idea first' (Miss B3, 2/8/99). All used interest in reading (88, 3.27%) and reported grammatical transfer (84, 3.12%). These are

their most frequently used strategies which include a range of metacognitive, cognitive and affective strategies.

A second group of strategies were used with moderate frequency (defined as falling individually between 3.0% and 1.0% of the corpus). There were 19 strategies in this group. Finally, the least frequently used strategies had frequencies below 1.0%. There were 9 of these, mostly used by 1 or 2 students only. For example, only one student from the high experimental group mentioned meditation as a strategy: (3, 0.11%) 'I was confused but wanted to concentrate so I practised meditation', (Miss B1, 20/7/99). She was also the only one who reported 'memory practice' while reading (12, 0.45%). Only two students mentioned using 'comparison between parts' (6, 0.22%). Only three students reported using charts, diagrams, or figures.

5.2.2.2 A comparison of reading strategy use between the control group (A) and the experimental group (B)

The previous section described the overall pattern of strategy use reported in students' diaries. This section explores differences in the use of reading strategies between the two groups, presented in Table 5.11.

Table 5.11: Frequencies and percentages of strategies reported by the control group and the experimental group (Diary study)

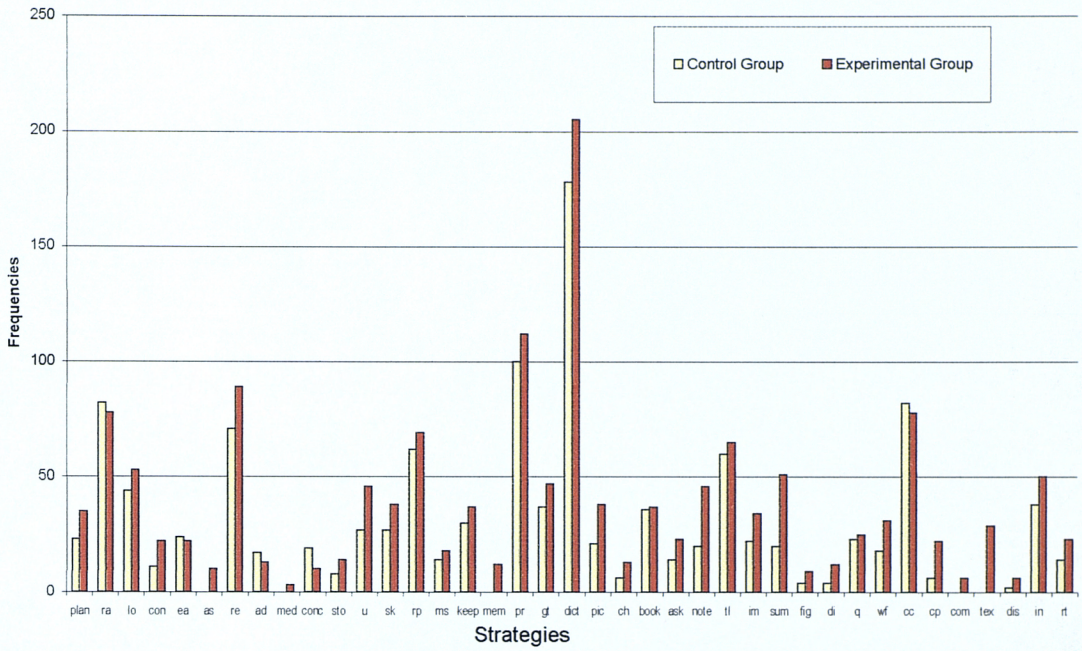
Strategies	Codes	Control Group		Experimental Group		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1) Planning	plan	23	0.85%	35	1.30%	58	2.15%
2) Reading ahead	ra	82	3.04%	78	2.89%	160	5.94%
3) Looking for main idea	lo	44	1.63%	53	1.97%	97	3.60%

4) Continue if unsuccessful at decoding a word or phrase	con	11	0.41%	22	0.82%	33	1.22%
5) Return to an earlier part	ea	24	0.89%	22	0.82%	46	1.71%
6) Alternative strategies	as	0	0.00%	10	0.37%	10	0.37%
7) Rereading	re	71	2.63%	89	3.30%	160	5.94%
8) Adjust speed	ad	17	0.63%	13	0.48%	30	1.11%
9) Meditation	med	0	0.00%	3	0.11%	3	0.11%
10) Concentration	conc	19	0.71%	10	0.37%	29	1.08%
11) Stop reading	stop	8	0.30%	14	0.52%	22	0.82%
12) Underline important parts	u	27	1.00%	46	1.71%	73	2.71%
13) Skip unimportant parts	sk	27	1.00%	38	1.41%	65	2.41%
14) Realise the problems	rp	62	2.30%	69	2.56%	131	4.86%
15) Consider what is being read makes sense	ms	14	0.52%	18	0.67%	32	1.19%
16) Keep meaning of the passage in mind	keep	30	1.11%	37	1.37%	67	2.49%
17) Memory	mem	0	0.00%	12	0.45%	12	0.45%
18) Prior knowledge	pr	100	3.71%	112	4.16%	212	7.87%
19) Grammatical transfer	gt	37	1.37%	47	1.74%	84	3.12%
20) Dictionary	dict	178	6.60%	205	7.61%	383	14.21%
21) Picture	pic	21	0.78%	38	1.41%	59	2.19%
22) Chart	ch	6	0.22%	13	0.48%	19	0.71%
23) Other books	book	36	1.34%	37	1.37%	73	2.71%
24) Ask someone	ask	14	0.52%	23	0.85%	37	1.37%
25) Note taking	note	20	0.74%	46	1.71%	66	2.45%

26) Translation	tl	60	2.23%	65	2.41%	125	4.64%
27) Imagery	im	22	0.82%	34	1.26%	56	2.08%
28) Summarisation	sum	20	0.74%	51	1.89%	71	2.63%
29) Figure	fig	4	0.15%	9	0.33%	13	0.48%
30) Diagram	di	4	0.15%	12	0.45%	16	0.59%
31) Self questioning	q	23	0.85%	25	0.93%	48	1.78%
32) Word formation (prefix, suffix, root)	wf	18	0.67%	31	1.15%	49	1.82%
33) Context clue	cc	82	3.04%	78	2.89%	160	5.94%
34) Connection between parts of text	cp	6	0.22%	22	0.82%	28	1.04%
35) Comparison between parts of text	com	0	0.00%	6	0.22%	6	0.22%
36) Text organisation analysis	tex	0	0.00%	29	1.08%	29	1.08%
37) Discussion	di	2	0.07%	6	0.22%	8	0.30%
38) Interest	in	38	1.41%	50	1.86%	88	3.27%
39) React to the text	rt	14	0.52%	23	0.85%	37	1.37%
	Total	1,164	43.19%	1,531	56.81%	2,695	100%

As can be seen from Table 5.11, 2695 strategies were identified from the diaries. 1531 or 56.81% of the total were from the experimental group, while the control group mentioned 1164 strategies or 43.19%. The difference between the two groups was 13.62%. An overview of frequencies and percentages for each strategy is presented in Figure 5.8, subdivided by group.

Figure 5.8: Strategy comparison between the control group and the experimental group



As could be predicted from other findings the experimental group reported more frequent use of almost every strategy. In this context both groups reported the same two favourite strategies, which were using a dictionary (6.60% and 7.61%) and then, using prior knowledge (3.71% and 4.16%). The overall pattern of their strategies was not different, except that the students in the experimental group mentioned more variety and frequency of reading strategies. Only students from the experimental group reported use of alternative strategies (0% and 0.37%), memory (0% and 0.45%), comparing between parts (0% and 0.22%) and text organization analysis (0% and 1.08%).

However, there are some exceptional items to be discussed. The control group reported more frequent use of reading ahead (3.04% and 2.89%), and slightly more use of adjusting speed (0.63% and 0.48%) and concentration (0.71% and 0.37%). It was surprising to find that the control group reported a lower frequency for stopping reading than the experimental group (0.30% and 0.52%).

To answer research question 4, some further discussion is needed. It was interesting to see all students reported looking for the main idea, as this was one of the strategies taught to both groups (97, 3.60%). This strategy was not identified in the questionnaire and the think-aloud data. Furthermore, all the students in the experimental group mentioned text organization analysis (29, 1.08%), which was not reported by any student in the control group. This strategy was taught in the experimental group only. The findings also showed that the students in the experimental group mentioned more reading strategies than the control group. Thus it might be concluded that the students in the experimental group who were taught through strategy instruction were more aware of strategy use, and the students in both groups were, to a certain extent, able to transfer their learned strategies to their extensive reading activities.

5.3 Conclusion

The main purpose of this research was to test the effectiveness of an experimental approach to English reading instruction with Thai students. Thus, the aim was to investigate one main question: Is this approach a better way for teaching English reading to Thai students? This main research question was operationalised as six research questions:

1. Is there any reading ability improvement after applying the two approaches: the traditional reading teaching approach and strategy instruction?
2. Is there any significant difference in the level of reading ability of the students resulting from the two approaches?
3. What reading strategies do the Thai students apply in order to understand English texts?

4. Do readers transfer learned strategies to their extensive reading processes?
5. Is there any significant difference in strategy use between students taught using the traditional and experimented approaches?
6. Is there any relationship between reported patterns of strategy use and students' scores on reading comprehension tests?

To answer these questions, finally the quantitative results and qualitative findings were integrated as a foundation of analysis. Table 5.12 presents the main results derived from both the quantitative and qualitative studies.

Table 5.12: Integration of quantitative and qualitative findings

Determined themes of effectiveness	Quantitative		Qualitative	
	Question	Result	Question	Result
Reading achievement				
– General reading ability improvement	Q1	Yes	-	-
– Experimental over control	Q2	Yes	-	-
Relationship between reading strategies and proficiency	Q6	Yes	-	-
Reading strategy use	Q3		Q3	
– Transfer of learned strategies	Q4	Yes	Q4	Yes
– Post- over pre-instruction	Q4	Yes	-	-
– Experimental over control	Q5	Yes	Q5	Yes

5.3.1 Students' English reading achievement

Quantitative results indicated that there was an improvement in reading ability over the course of the study. A statistically significant difference was found in the mean gain scores for reading achievement of both the control group and the experimental group. It is, therefore, concluded that both traditional instruction and the experimental strategy instruction have a significant effect on students' reading achievement.

However, a statistically significant difference was found in the post-instruction achievement scores in favour of the experimental group. As a result, it is concluded that the strategy instruction benefited the students in increasing their reading achievement better than the traditional method.

5.3.2 Relationship between reading strategies and reading proficiency

The results of the Pearson correlation showed that the correlation between levels of reported strategy use and reading proficiency were positive and highly significant. Thus, it can be concluded that there was a high relationship between reading strategies and reading proficiency. It seems that frequency of reading strategy use is related to the proficiency test performance.

5.3.3 Reading strategy use

Both quantitative results and qualitative findings indicate that there was a difference in the level of reported strategies for both the control group and the experimental group after ten weeks' instruction. The results of the quantitative study showed a statistically significant difference for reported strategy use between pre- and post-instruction administrations of the strategy questionnaire. However, there was also a statistically significant difference on the post-instruction reported strategies between the two groups. The students in the experimental group, again, reported use of reading strategies more often than the students in the control group. As a result, it is concluded that strategy instruction benefited the students more in their use of reading strategies.

In-depth analysis of the think-aloud study and the diary study provided the answer for research question 3. The findings confirmed that students in this study used a variety of reading strategies when they read English materials. Cognitive strategies were the most

frequently mentioned, followed by metacognitive strategies and affective strategies. Their favourite strategy was using prior knowledge. It can be concluded that they were able to transfer both linguistic knowledge and world knowledge to help them understand the English texts. They adopt a multi-purpose approach, using strategies in combination rather than isolation. The qualitative and quantitative findings are in line with the findings of other studies (O' Malley & Chamot,1990; Oxford,1990; Barnett,1988) that successful readers employ their strategies more frequently and use a wider range of strategies, both top-down and bottom-up. There was also a change or development in their strategy use. As we saw in Chapter IV, after 10 weeks instruction there was a statistically significant increase in the overall strategy use. After the course they relied less on a dictionary and reported more use of context clues. They also reported more on using their world knowledge and checking their understanding while reading. The findings from the qualitative study also indicated that the students in the experimental group reported more frequent use of almost every strategy, especially for knowledge transfer, selective strategies, and alternative strategies. However, there was a difference between their think-aloud and their diary reports. For example, all six students reported using context clues very frequently during their think-aloud, but the same students reported using a dictionary as their most frequently mentioned strategy in their diary. This suggested that their reading strategy use was flexible depending on the context.

There was some evidence suggesting that there was a transfer of learned strategies. The students in the experimental group reported strategy use more often and with a very similar pattern of favourite strategies, while the students in the control group reported their reading strategies in their own style. This indicated that after 10 week's training on activating their reading strategies, the students in the experimental group tend to use similar reading strategies to those they learned in class and they were more aware of

strategy use when reading. In addition, some identified strategies from the qualitative study indicated that the students were able to transfer the knowledge they have in class to their reading activities. More details of the conclusion and the synthesis of the quantitative and qualitative data will be further presented in the discussion section of the next chapter.

Chapter VI

Discussion of the Findings, Limitations, and Implications for Reading Instruction

This chapter is divided into three sections. The first section discusses the findings, in an attempt to compare them to the findings of other studies and evaluate their broader meaning. An evaluation of the research design including a review of the research instruments, the limitations of the study, its reliability and validity is presented next. The chapter ends with a short discussion of some implications of the study for reading instruction and suggestions for further research.

As explained in Chapter I, given the importance of English reading proficiency for Thai university students, this research was proposed, developed, and planned to introduce an alternative model of English reading instruction in Thailand. Most of Thailand's English reading classrooms practise traditional English reading instruction in which teachers direct the reading process. Since reading is a complex cognitive process in which readers interact directly with the text, it was hypothesised that a more effective role for the teacher is to activate students' awareness of their reading strategies.

Since few empirical studies have been conducted in Thailand on activating awareness of metacognition, the researcher designed an experimental study to find out the effects of such an approach to reading teaching. Quantitative and qualitative techniques were integrated to find out whether this approach is more effective for English reading instruction and how it impacts on students' reading processes. The findings of this study are related to the two issues under debate mentioned in Chapter II: whether reading in a foreign language is a language problem or a reading problem; and whether reading strategies can be taught effectively. These issues will be reviewed in this chapter, in relation to the findings of this study.

On the first key issue, as we saw in Chapter II, researchers in second language reading fall into two groups. One argues that reading ability in a second language depends mainly on proficiency in that language. Clarke (1980) and Cziko (1980) are two main ESL researchers who support this view, although Clarke does not deny some transfer of first language skills or the universal hypothesis of reading. This point of view is also supported by the studies of Cooper (1986), and Kern (1989). While these researchers support the role of L2 competence in second language reading, the other group asserts that higher level strategies developed in a first language can be transferred to a second language and can operate alongside. Goodman (1970), Coady (1979), Cummins (1979), Carrell (1991) hold a different view, which supports L1 higher level ability, cognitive/academic language proficiency, and L1 reading skills on L2 reading ability. Cummins (1979) and Hudson (1982) hypothesise that the cognitive academic aspects of L1 and L2 are interdependent.

The second key issue is in the field of strategy training. Strategy training has received mixed reactions from professionals in the field, as to whether it is always effective. Kellerman (1991) maintained that learners need not be taught compensation strategies, and was supported by Rees-Miller (1993) who concluded that strategy training was not effective. Chamot and Rubin (1994) claimed more optimistically that strategy information was teachable. They also highlighted factors which have been found to influence the effectiveness of strategy training: the length of the training, and the degree of integration of the training into regular curriculum and ongoing classroom activities. Their views were supported by the more recent work of Thomson and Rubin (1996), Nunan (1997) and Cohen (1998) who carried out experimental studies on the effects of strategies teaching on second language learners. In each case they found that the experimental groups outperformed the comparison groups on language proficiency. The results of this study are also linked to the effects of strategy teaching on both the students' reading

proficiency and their use of reading strategies, and were in line with this research. Further discussion of both quantitative and qualitative findings of the study is presented in the next section.

6.1 Discussion of the findings

The first part of this section discusses the improvement of the Thai students' English reading proficiency, including comparison with the results of other studies. The second part discusses the correlation between reading strategy use and reading proficiency. The third part elaborates the reading strategies revealed by the qualitative study as well as exploring the reported patterns of strategy use and differences in strategy use between the two groups. This part ends with a discussion of the transfer of learned strategy.

6.1.1 The improvement of English reading proficiency

As mentioned in the debate on strategy instruction in Chapter II, Kellerman (1991) and Rees-Miller (1993) made a critique of strategy training and concluded that such training was not effective.

In response to this criticism, Chamot and Rubin (1994) argued that it was not one particular strategy that led to improved performance, but rather the effective management of a repertoire of strategies (p. 774). The results of this study support the claim that strategy instruction improves both process and performance. The following discussion further explores why there should be an improvement of reading proficiency after the experimental course.

The reading test results showed that the students from both groups improved significantly after their ten-week course, and that the experimental group also

outperformed the control group. The results clearly indicated that traditional reading instruction helped students improve their reading ability. However, strategy instruction had a stronger effect on students' comprehension gain scores. A closer look at the two teaching approaches may explain why the experimental group gained more than the control group.

As outlined in Chapter III, traditional reading teaching focuses mainly on providing students with declarative knowledge about the content of the text to be read, and in this way, the teacher provides a pre-reading stage to activate students' declarative knowledge and interest. This might be expected to help students to improve their reading ability, in line with the findings of Beck et al., (1982) who reported that young readers who were provided with intensive instruction related to the difficult parts of a story improved their comprehension of the overall story significantly.

As mentioned by Cziko (1978), 'the use of contextual constraints on meaning is held to be crucial to the reading process'(p.473). In the traditional instruction used in this study, the presentation of vocabulary was also contextualised with reference to the text, and this provided students with a framework or schema for the text (Bernhardt, 1996:42). This instruction also gave an important role to linguistic knowledge, especially to grammatical features of the text, which were explained to the students. Dubin and Bycina (1991) also mentioned the importance of grammatical instruction: 'therefore, reading classes should include instruction of grammatical elements which typically occur over large stretches of text' (p.98).

In short, the traditional reading instruction was consistent with previous research showing the positive effects of enhanced declarative knowledge on text comprehension. But findings from this study pointed out the limits of traditional reading instruction as well. One of the most significant points to emerge may be that this approach was highly

teacher-centred, and the learners were passive readers, relying on the teacher to provide the necessary prior knowledge, vocabulary and content structure.

We know that the students gained significantly through the traditional reading instruction, but is this really the best preparation for occasions when learners have to read on their own? With regard to the question of which approach helped students' improvement the most, the findings were in favour of strategies-based instruction; the results of the reading comprehension post-test indicated that students in the experimental group made superior gains over students in the control group who received traditional reading instruction. What characteristics of the strategy approach led to the students' superior performance?

One key characteristic may be the objectives of the approach. The traditional reading instruction focused on providing the students with prior knowledge, vocabulary, grammatical structure and content structure of the text, i.e. enhancing declarative knowledge (including linguistic knowledge), while the strategy approach was designed to activate students' awareness of their metacognition, that is to provide them with improved procedural knowledge. The students in the experimental group developed their self-awareness of reading strategies, and were taught how, when, and why to activate their prior knowledge and their linguistic knowledge when they read texts independently. Another characteristic related to the students' tasks in class (described in detail in Chapter III). Students in the experimental group were more active learners who appeared to develop a sense of self- control over their learning. The strategy instruction may have encouraged them to take ownership of the strategy and to transfer its use and become more strategic readers. It has been suggested by several researchers that good readers possess a number of flexible, adaptable strategies that they use to maximize their comprehension (Baker and Brown, 1986; Garner, 1987). Strategic readers are active, purposeful and

reflective about the reading process. This would be consistent with statements by Wenden (1991) that point to the transfer value of teaching students to become independent learners who can use certain strategies on their own without teacher support.

Some findings from other research designed to teach students to use certain strategies seemed to be rather disappointing (e.g. Lochead and Clement, 1979; Mayer, 1988). One reason is that requiring students to use particular study methods may interfere with what students are already doing effectively. Another problem is mentioned by Chamot (1996:170): ' teachers new to learning strategies tend to provide largely implicit instruction. That is they plan activities in which students use strategies such as brainstorming what they already know about the topic or using context clues to guess at word meaning, but fail to identify these activities to students as strategies or to explain their purpose'. In the present study the researcher was aware of this weakness: thus, a handout entitled 'the strategy record' was provided, so that the students could check the strategies they used while reading. At the post reading stage there was a discussion about strategies, how, when and why the students had used them (see also the detailed account of strategy instruction, chapter III). In general, the goal of strategy instruction is to make students aware of the mental processes involved in reading and to equip them with processing strategies that will help them become more active readers. By including these components explicitly in strategy instruction, it seemed that the learners were able to maintain and transfer the skills to new reading situations. The successful results of the tests supported the findings of those other studies, which suggested that learners receiving strategy training showed greater improvement in language performance than those who had not been trained (O'Malley and Chamot, 1990; Wenden, 1991, Nunan, 1997; Cohen et al., 1998).

6.1.2 The improvement in reading strategy use and the difference between the two groups

While the gains in the English reading proficiency of the students is the main evidence of the impact of the experimental teaching, how students read, i. e. their reading strategies also provide significant evidence of impact. The results of the questionnaire completed by the students at the beginning of the course revealed that they were all aware of strategies but at moderate to low levels. After ten weeks' instruction, the students completed the strategy questionnaire again. The data from the post-questionnaire revealed that students in both groups increased their use of strategies after the course. Gains in strategy use were statistically significant for both groups but again the students in the experimental group reported significantly more frequent use than the control group.

It had been predicted that the students in the experimental group would report more familiarity with the strategies after the course. It was surprising to find out that the students in the control group also reported significantly more frequently on strategy use after traditional instruction. However, this finding can be related to the findings by Chamot and O' Malley (1994a) which suggested that students can learn how to use strategies autonomously; effective learners have already developed useful strategies for approaching learning tasks. Similar findings are reported by Nunan (1997) and Cohen et al. (1998). The latter pointed out that 'even without extensive strategy instruction, some resourceful learners can and do utilize strategies effectively - whether as a result of their own insights about language learning, as a result of suggestions provided to them by their teachers or peers, or as a result of insights provided by the textbooks' (Cohen et al., 1998:114). In Nunan's study (1997), the experimental group significantly outperformed the control group on motivation, knowledge and perceived utility but not in the area of strategy deployment. However, both groups reported a dramatic increase in the deployment of the key strategies over the course. He explained that the study was carried

out with students who were in the process of making the transition from high school to university and ' they are expected to be more independent and self-directed in their work, and to develop a range of strategies to cope with this new way of living and learning' (p.64). In the present study, the fieldwork study was also carried out during the first semester with first year students.

Overall, the findings of this study add to the empirical evidence that strategy instruction positively affects both students' strategy use and reading proficiency (Palincsar and Brown, 1986; Cohen, et al., 1998). Also, the difference in strategy use between the control group and the experimental group challenges Clarke's notion of a 'language competence ceiling' which interferes with the application of effective L1 reading strategies to L2 texts (Clarke, 1980; Kellerman, 1991). The findings that the experimental group both scored higher and reported more frequently on strategy use than the control group of equal language proficiency suggested that explicit instruction in reading strategies can override the effect of language proficiency limitations on readers' use of effective reading strategies, at least for students at intermediate and advanced levels.

6.1.3 The relationship between reading strategy use and reading proficiency

The results of this study indicated that there was a statistically significant positive correlation between the frequency of strategy use and reading scores. The results supported previous studies which found that use of language learning strategies had strong predictive validity in relation to language performance (Nunan, 1997; Cohen, 1998). Further studies (Padron and Waxman, 1988; Green and Oxford, 1993) have shown that reading strategy use has positive correlations with students' reading comprehension. This can be explained in that reading strategies are mental representations of actions employed in order to construct meaning. When readers encounter obstacles to comprehension they

need to utilise strategies to overcome their difficulties. Thus, a good reader is a reader who knows more about what strategies are, and when and how to use them appropriately.

Regarding a more qualitative evaluation of the relationship between use of reading strategies and reading proficiency, it has been pointed out by some researchers that use of particular strategies might lead to increased proficiency, but increased proficiency might also lead to increased use or abandonment of particular strategies (Oxford, 1990). Cohen (1998) has commented that 'repeated use of a strategy may just be a sign that the learner is continuing to use a given strategy unsuccessfully' (p.8). This study did not have a direct measure of how successfully the learners used the strategies. However, a closer look at the frequency of each strategy revealed that not every strategy had a positive relationship with the reading scores. After the course, for example, frequencies for most of the reported strategies increased except for using a dictionary, reading every word and skipping problematic parts.

6.1.4 Reading strategies of Thai students

According to Clarke (1980), L2 proficiency plays the most important role in L2 reading. The present study confirms that English language proficiency has some effect on the efficiency of the reading process, revealed by the presence of some reading strategies such as grammatical transfer, translation and use of linguistic knowledge. It appeared in this study that strategies involving vocabulary, context clues and using a dictionary are also important for the Thai readers. The frequent use of strategies related to vocabulary by the students in this study might be an indication that Thai students view linguistic knowledge as essential to their understanding.

Although it is undeniable that foreign language proficiency plays some role in the English reading comprehension of Thai students, the findings support the view that

cognitive processes play a more important role than L2 proficiency at least at this overall proficiency level. This view is based on the finding that a large number of reading strategies were used by the readers from each level of L2 proficiency. Moreover, the most popular strategies are background knowledge, rereading and context clues, which shows subjects' reliance on cognitive processes in reading.

The findings showed that the participants in this study used background knowledge or world knowledge strategies more often than language related strategies when reading English texts. This finding supported the idea that 'reading comprehension is a process whereby a message intended by the writer is recognised by the reader against the background of information already stored in the readers' memory' (Rumelhart, 1980; Kintsch and van Dijk, 1978).

Another favourite strategy reported by the students in this study is rereading. In their study of native English speakers, Bereiter and Bird (1985) identified two main reasons why rereading occurs. One is that the reader fails to comprehend the last part read and the other is that the reader loses connections with previous segments. The strategy of rereading is usually considered a helpful strategy if used appropriately; it was one of the four main strategies, used effectively by Bereiter and Bird's subjects when faced with comprehension difficulties. The presence of this strategy implies that readers monitor their understanding and control their reading activity to comprehend the text.

However, there was some difference in students' favourite strategy depending on the situation. On the think-aloud study they all reported using context clues very often, while data from the diary study showed that their favourite word-related strategy was using a dictionary. This finding showed that readers are flexible to some extent in their strategy use.

6.1.5 The transfer of learned strategies

The results from the think-aloud and diary studies demonstrated that the 44 strategies found in this study were used overall by both groups of readers, but with different relative as well as absolute frequency. The finding that the two groups did not share similar patterns of reading strategies when approaching the same reading materials revealed the effects of strategy instruction on the experimental group. This finding is in line with the study by Nunan (1997) that found most students reported increased use of strategies after instruction and indicated increased familiarity with the strategies and their use.

6.1.6 Conclusion

It is clear from the results of both the quantitative and qualitative studies that explicit strategy instruction was beneficial and positively affected both students' reading proficiency and their strategy use. The findings are consistent with several other research studies of strategy instruction, and provide new empirical evidence that strategy instruction can improve students' reading process. Though strategy instruction is not a magic approach, which can make every learner become a proficient reader, it has proved an effective approach to enhance students' reading abilities.

6.2 Evaluation of the study

The results discussed above clearly indicated that explicit reading strategy instruction had a strong positive effect on Thai students' reading comprehension. However, in interpreting these results, several factors must be considered. This study aimed at finding a better solution to English reading instruction in Thailand. Four research instruments were carefully prepared at every step to gain reliable data. With a true experimental design and

active management of internal factors as described in section 3.1.1, this study can be said to have been well controlled and to have achieved high internal validity. The researcher also tried to maximise external validity by the pilot study and controlling other external validity factors as also described in 3.1.1. Furthermore, the consistent data revealed by various research tools raise the validity and generalisability of this study. However, there are some limitations to be considered.

6.2.1 Limitations of the study

This study has certain limitations resulting from both the nature of the experimental design and the fieldwork process, which may affect the generalisability of the results.

The classroom situation led to several limitations. First, the usual limitations of a doctoral project meant that there was only one teacher: the researcher who designed, planned and carried out the fieldwork by herself. Thus, the researcher had no chance to evaluate her instruction or research procedures independently during the fieldwork. This created a question whether the students would respond similarly to instruction administered by other teachers. Higher generalisability could have been achieved if the researcher had worked with regular teachers by training them to conduct the strategy instruction. During the fieldwork the researcher would then have had a chance to discuss and evaluate the instruction with other teachers. Also the researcher could have observed their teaching, which could reveal additional useful information.

Furthermore, due to the limited time available for the fieldwork study, it was impossible to carry out a longitudinal study to see how lasting the effect of strategy instruction is. Further study on this question should be carried out.

The 74 students in this study were all first year science students in the Applied Physics Department, KMITNB. It can be said that they were students of average academic

level. The fact that they were all first year students in the same department, so they had a similar academic background and according to the university entrance system in Thailand, they also had a relatively similar level of academic performance, means that applications to other groups of students should be cautious.

Another limitation of the study was its focus on the frequency of strategy use rather than on successful use. As mentioned in section 6.1.1.3, this study did not have any direct measure of how successfully the learners used the strategies, though an indirect measure was the positive correlation between reported strategy use and reading ability. Correlation simply indicates that increased strategy use was related to gains in reading proficiency, but does not pinpoint precise causal relationships.

Finally, though both the quantitative and the qualitative results showed successful overall effects for strategies instruction, there was minor evidence which indicated that this approach did not always have a positive effect on every learner. The results of pre-test and post-test scores revealed that scores for some students declined over the course. One student from the control group scored less after the course while three students from the experimental group scored less. Furthermore, paired student comparisons showed that seven students in the control group got higher scores in the post-test than their peers in the experimental group. As Pearson and Dole (1987) cautioned: ' we have to consider the possibility that all the attention we are asking students to pay to their use of strategies and to the monitoring of these strategies may turn relatively simple and intuitively obvious tasks into introspective nightmares' (p.162). It could be that for some students, strategies instruction forced them to make an automatised, easy, effortless, task more difficult. There has been some research suggesting that some readers may not need, or may be hindered by, some kinds of instruction (Wade, Trathen, and Schraw, 1990). These studies have indicated that higher achieving readers comprehend more when they used their own

preferred strategies than when other strategies were imposed on them through instruction. Perhaps, as Wade, Trathen, and Schraw (1990) argued, students benefit more from becoming metacognitive about the strategies they already use, rather than from learning different strategies.

6.2.2 Evaluation of the research tools

Chapter III presented the characteristics of each research tool, however, this part discusses some of their strengths and limitations found from the study.

6.2.2.1 Reading test

The reading test was developed to reflect as closely as possible the interaction that takes place between a reader and the text. To minimise linguistic constraints the multiple choice question format was employed, instead of e.g., a cloze test or short answer questions. Furthermore, this was a familiar assessment format for Thai students. The test was piloted to ensure adequate internal validity and reliability, and no further problems emerged during the main study.

6.2.2.2 Reading strategy questionnaire

In order to explore the strategy use of 74 students, a questionnaire was the only feasible instrument. The reading strategy questionnaire was also piloted to check internal validity and reliability. The researcher studied previous strategy research to design and construct the reading strategy questionnaire as a structured questionnaire reflecting frequency of use of 37 possible strategies. One limitation was the indirect nature of the data since the questionnaire relied on self-report. However, in this study the questionnaire was

complemented by think-aloud and diary studies. The data revealed by these three instruments were very consistent, and mutually re- enforcing.

6.2.2.3 Think-aloud study

One concern about the use of think-aloud is its possible negative effect on respondents' reading. Verbal report has been criticised by researchers who have claimed that immediate retrospection may distort the process of reading if the readers read more closely than normal, read sentence by sentence or concentrate on the additional cognitive task (Stratman and Hamp-Lyons, 1984). Thus, in this study, after the think-aloud tasks, the researcher interviewed the students about the think-aloud process. Most of the respondents felt that think-aloud did indeed affect their thinking about reading, though in a positive way. Only one student from twelve respondents had negative comments about verbal report. This supports the findings by Wade et al.(1990); and Dole, et al. (1996) that a think-aloud procedure could be used to actively engage students while reading ' it was reported to enhance their awareness and assessment of various aspects of the reading process' (Dole et al., 1996:86). However, it raised questions about the stability of the reading process during think-aloud.

Another concern regarding think-aloud is variability among respondents. The respondents may differ with respect to their verbal skills and may also use different terms to describe similar processes. The researcher was aware of this limitation so the respondents were trained to think-aloud before the study. Such training was useful to control variability, but still could not eliminate all individual differences. Another criticism of verbal report is that much cognitive processing is inaccessible because it is unconscious (Cohen, 1998:37). The researcher noticed that there were other non-verbal behaviours in use during the reading process such as reread silently, pause, look ahead, go

back, etc. Yet, sometimes the respondents did not report these strategies. Some more information would be available if the researcher had used video to record instead of only audio recording. However, it is likely that think-aloud can never capture all strategies actually used by the readers.

With the in-depth qualitative data presented in Chapter V, despite some limitations mentioned above, the researcher found the think-aloud study a very effective tool, which gave more direct introspection into the reading process than can be obtained using any other research tools.

6.2.2.4 Diary study

The diary study was conducted to obtain data on reading processes when students read on their own. Since keeping a diary is a burdensome task, the researcher designed an A4 sheet with headings about the details of their reading activities at home for them to complete briefly and students responded by writing the names of the reading strategies they used. This was convenient for analysis, but it gave only summary data. Furthermore, it raised another problem about the credibility of these records. However, in this research the diary study revealed some useful information about the flexibility and variability of strategy use as well as providing data which triangulated with that from the other instruments.

Overall, it can be said that three research instruments have stability in revealing the reading strategies. The numbers of reading strategies revealed by three research instruments are quite close, e.g. 37 strategies were found from questionnaire, 44 strategies from the think-aloud task, and 39 strategies from the diary study.

6.3 Implications and suggestions for reading instruction

6.3.1 Implications of the study

This study was undertaken to determine whether strategy based instruction was a better approach to English reading instruction in Thailand. It would seem that despite some limitations of the study, this approach was indeed a more effective way to enhance English reading proficiency. The findings of the study suggest that explicitly describing, discussing and evaluating strategy use in the classroom can not only help students increase and focus their use of strategies but also improve students' reading proficiency. The strategy instruction outlined in this study was shown to be not only practical but also effective. As a result of the realisation that traditional instruction is a less effective approach, there is a need to change to a focus on enhancing awareness of reading strategies. Three important components in this approach are to be conscious of what to study (task awareness), how to read effectively (strategy awareness), and how to evaluate the outcome (performance awareness) (Wade & Reynolds, 1989).

6.3.2 Suggestions for further research on strategy instruction

In chapter II a number of studies on strategy instruction were described, and it is clear that a substantial body of research in the area has already been undertaken. However, none of the research we have discovered relates specifically to EAP learners, and much of it relates to strategy instruction of general rather than specifically to reading strategies. We therefore suggest that further research should be carried out focusing on reading strategies with EAP students, taking account of the accomplishments and limitations of past research. As mentioned in 6.2.1, there are several aspects to consider in order to obtain more information about effective teaching of English reading.

First, if strategy training is involved, more than one teacher and other groups of students should be included to see whether this instruction remains effective when applying it more widely. The following questions need further attention:

- What strategies should be covered in the course, how, for whom, and for how long?
- Do second language learners of different levels benefit equally from direct instruction in reading strategies?
- How lasting is the effect of strategy instruction?
- Is strategy instruction always appropriate? If not, when it is most and least valuable?
- Does the active teaching of some strategies interfere with students' own preferred strategies?
- Should strategy instruction be embedded within other reading instruction?

Second, the relationship between strategy use and reading proficiency is probably more complex than the picture presented here. Use of particular strategies might lead to proficiency, but increased proficiency might lead to increased use or abandonment of particular strategies (Oxford, 1990). A closer and more complex analysis of the relationship between strategy use and reading proficiency will be needed to clarify these issues.

Third, as mentioned in Chapter II, there is still a lack of clear definition and agreement concerning a definitive taxonomy of reading strategies. Different researchers use different terms and concepts. Research comparing the studies in this field will be very useful to create a clearer, more generalisable set of concepts and greater agreement on the definition of reading strategies. It is hoped that the definition and categorisation of reading strategies developed for this study can contribute a clearer taxonomy of reading strategies.

In sum, the benefits for reading proficiency and reading strategy development from strategy instruction are clearly evidenced from this research, both quantitatively and qualitatively. Hopefully, all elements from this study would provide some practical guidelines for teaching English reading in Thailand, as well as for other researchers to conduct related research for academic development in Thailand.

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Appendix A

Lesson plans

(Control group and experimental group)

Appendix A 1 Control Group

Before reading	While reading
Title	Paragraph 1
What I have known about this:	Paragraph 2
	_Paragraph 3
What I expect to know about this:	_Paragraph 4
	_Paragraph5
	_Paragraph 6
	_Paragraph 7
	_Paragraph 8
	_Paragraph 9

Lesson Plan 15 June 1999
Time: 90 minutes
Topic: Pollution and the Environment

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion about air pollution in Bangkok. The teacher draws a diagram of the causes of air pollution. 2. Complete the vocabulary list. The teacher explains the meaning and then the sentence structure. 3. Exercise on present simple tense.	1. Pictures of traffic jams, exhaust gases from cars and industries. 2. Vocabulary list 3. Reading guide	1. Motivate students' interest. 2. Provide related vocabulary. 3. Elicit what students know. 4. Present grammatical structure.
While-reading	30	4. Individual work on reading comprehension and finish the exercise that followed. 5. The teacher walks around the class and helps.	5. Reading text: Pollution and the environment.	6. Students practise reading skills.
Post-reading	30	6. Students check their answers peer. 7. The teacher answers questions about the exercise. 8. The teacher explains the whole text again, confirming on text understanding, then makes the conclusion and summary of the text.	6. Reading text with exercise. 7. OHP	7. Confirm of understanding. 8. Summarise

Lesson Plan 22 June 1999
Time: 90 minutes
Topic: Information from Graph

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Group work: Students are divided into 7 groups. Each group makes a bar graph explaining the height of the students in their group. Each group presents their work to the class. 2. Individual work: Students complete the vocabulary list. After that the teacher explains the meaning of the vocabularies, then explain the grammatical structure. 3. The students complete the reading guide.	1. OHP 2. Vocabulary list 3. Reading guide	1. Motivate students' interest. 2. Provide related vocabulary. 3. Provide the procedural knowledge of the text grammatical structures.
While-reading	30	4. Individuals work on reading comprehension and do the exercise. 5. The teacher walks around the class and helps the students who have problems.	4. Reading text.	4. Students practise reading skills.
Post-reading	30	6. Pair work: Students check their answers with their peer. 7. The teacher explains the whole text in detail, both content and vocabularies. 8. Class work on summarisation.		5.Confirm understanding. 6. Summarise

Lesson Plan: 29 June 1999
Topic: Noise Pollution

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	Class activity: 1. The teacher plays a piece of music, first a normal level, then louder it up. The teacher then stops the music and asks the students how they feel. 2. teacher asks students to give some examples of sources of loud noises and their effects on people. The teacher lists students' suggestions on the board. 3 Individuals: Students complete the vocabulary list, then teacher explains the meaning of the vocabulary and the sentence structure. 4. Students complete Reading guide.	1. Radio 2. Reading guide	1. Motivate students' interest. 2. Elicit students' background knowledge. 3. Provide students with vocabulary and grammatical structures.
While-reading	30	5. Individual work students read the text and complete the exercises. 6. The teacher walks around the class and helps the students who have problems.	3. Reading text.	4. Students practice reading skills.

Post-reading	30	7. Pair work: Students check their answers with their peer. 8. The teacher explains the answers. 9. The teacher explains the whole text again in detail, both content and vocabularies then class disscusion on the reading guide 10. Class work on Summarisation		5. Self - evaluation 4 Confirm understanding 7. Summarise

Lesson Plan: 6 July 1999
Topic: Sugar Cane

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion: Teacher discusses with students the sources of sugar, plantation, and manufacturing process. Teacher lists the students' idea on the board. 2 Individual work: Students complete the vocabulary list. After that the teacher explains the meaning of the vocabulary and sentence structure. 3. Students complete the reading guide.	1.Vocabulary list 2.Reading guide	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the text. 4. Provide students with vocabulary and grammatical structures.
While-reading	30	4. Individual work: Students read the first passage and complete the diagram. 5. The teacher explains the text and the students check their answers. 6. Group work: Students are divided into groups of 5 and complete the task, then present their work to the class.	3. Reading text. 4. OHP	5. Students practise reading skills. 6. Identify key points. 7. Students learn about the relationship between parts. 8. Practise note-taking.

Post-reading	30	7. Class work: Discuss note-taking techniques and link this to text organisation. 8. Class work: Summary of the text		9. Apply this technique to their learning. 10. summarise

Lesson Plan: 13 July 1999
Topic: Fax

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion: teacher and students discuss the fax machine; how it works, its shapes and components. The teacher makes the lists of those topics on the board. 2. Students work individually on vocabulary list. 3 The teacher explains the meaning and the students check their answers, then explain the sentence structure. 4 The students complete reading guide	1.Vocabulary list 2. Reading text 3. Reading guide	1. Motivate students' interest. 2. Activate students' background knowledge. 3 Provide related vocabulary and grammatical structures. 4 Transition to the text.
While-reading	30	5. Individual work: Students read the text individually and answer the questions. The teacher walks around and helps the students who have any questions.	Reading text	5. Practise reading skills.
Post-reading	30	6. Teacher explains the text in detail and lets students check their answers. 7. Class work: teacher and students make a summary of the text.	4. OHP	6.Confirm understanding. 7. Summarise

Lesson Plan: 3 August 1999
Topic: The Building of the Future

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class activity: The teacher shows the pictures of skyscrapers and asks the students to express their opinion about skyscrapers, why do we need them and what they think future building will be like. Teacher writes down students' suggestion on the board. 2 Individual activity: Students complete the vocabulary list, then the teacher explains the meaning and the sentence structures 3. Students complete their exercies and check the answers. 4. Students complete reading guide.	1. Vocabulary list 2. Reading text 3. Reading guide	1. Motivate students' interest. 2. Provide students with vocabulary and grammatical structures. 3. Activate students' background knowledge. 4. Transition to the reading text.
While-reading	30	5. Individual work: Students read the passage individually and answer the questions. Teacher walks around and helps the students who have problems.	Reading text	Practise reading skills

Post-reading	30	6. Pair work: Students compare and check their work with their peers. 7. The teacher explain the text in detail and answer of any questions. 8. Individual work on text summarisation.		6.Confirm understanding 7. Summarise

Lesson Plan: 10 August 1999
Topic: The Birth of Stars

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion: The teacher shows the pictures of stars and the galaxy and writes the vocabulary web on board. 2. Students complete vocabulary list. 3. The teacher explains the meaning of the vocabulary and students check their answers. 4. The teacher explains the sentence structures. 5. The students complete reading guide.	1. Pictures 2. Vocabulary list 3. Reading guide	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Provide students with vocabulary and grammatical structures. 4. Transition to the reading text.
While-reading	30	6. Students read the passage individually and answer the questions. 7. Teacher walks around and helps the students who have problems.	4. Reading text.	5.Practise reading skills.
Post-reading	30	8. Students check their answers with their peers. 9. The teacher explains the text in details and explains the answers. 10. Individual work: Text summarisation		6.Confirm understanding. 7. Summarise

Lesson Plan: 17 August 1999
Topic: Gene in Action

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion: teacher and students discuss genetic engineering, what they do in the laboratories, new experiments about genetic engineering. The teacher writes down the key words on the board. 2. Students complete vocabulary list. 3. Teacher explains the meaning of the vocabulary, and the sentence structures. 4. Students complete the reading guide	1. Vocabulary list 2. Reading text 3. Reading guide	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Provide students with vocabulary and grammatical structures.
While-reading	30	5. Students read the text individually and answer the questions. 6. Students compare the information the reading guide the full text. 7. Teacher walks around and helps the students who have problems.	3. Reading text	4.Practise reading skills.

Post-reading	30	8. The teacher explains the text in detail. 9. The students check their answers. 10. Individual work: text summarisation		5. Confirm understanding. 6. Summarise

Lesson Plan: 24 August 1999
Topic: The One and Only You

Stage	Time mins	Activity	Materials	Aims
Pre-reading	30	1. Class discussion: Teacher asks one student to show his ID. or credit card, then discuss with students its function, how it works. Teacher writes key points from the discussion on the board. 2. Students complete vocabulary list. 3 The teacher explains the meaning of the vocabulary, students check their answers. 4. Teacher explains the sentence structures. 5. Students complete reading guide	1. ID card 2. Vocabulary list 3. Reading guide	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Provide students with vocabulary and grammatical structures.
While-reading	30	6. Students read the text individually and answer the questions exercise. 7. The teacher walks around and helps the students who have problems.	4. Reading text	4.Practise reading skill.
Post-reading	30	8. The teacher explains the text in detail. 9 The students check their answers. 10 Students make a summary of the text individually.	5. OHP	5.Confirm understanding. 6.Summarise

Lesson Plan: 31 August 1999
Topic: The Electric Motor

Stage	Time	Activity	Materials	Aims
Pre-reading	30	Class discussion: 1. Discuss about those electric appliances, how they work, how they are made of 2. Discuss things in everyday life that use electric motors. 3. The teacher writes key words on the board. 4. The vocabulary list is distributed to the students. 5. The teacher explains the vocabulary and some expressions showing component and places such as *consist of, connect to, etc.* 6. Students work individually on the exercise.	1. Electrical appliances such as electric fan 2. Vocabulary list 3. Exercise	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Provide students with vocabulary and grammatical structures.
While-reading	30	7. Students read individually and silently, then do the exercises that follow. 8. The teacher walks around the class and helps the students who have problems.	4. Reading text	4. Students practise reading

Post-reading	30	9. Students check their work with their peers. 10. The teacher explains the whole text again. 11. Students summarise the text individually.		5.Confirm understanding 6.Summarise

Appendix A2 : Experimental Group

Strategy definition sheet

Observable study methods

Highlight or underline

Copy

- Write down information either on note paper or in the margins exactly as it is written in the text.

Write down in your own words
- either on note paper or in the margins.

Outline
- Organise idea on paper in categories or under headings to show which are the main ideas and which are supporting ideas or examples.

Draw a diagram
- Organise idea on paper in diagrams that show how they relate to each other.

In-the-head study methods

Look over before reading
- This is a very fast type of reading. It involves either reading for the main ideas in order to get an overview of the passage, or moving very quickly over unimportant information.

Read at your usual rate
- This is right for some materials.

Read slowly
- Slow down your reading for better comprehension or concentration.

Go back and read again
- Read certain parts of the text a second time, usually when information is confusing or you want to understand it better.

Special attention!! Review or memorise
- Concentrate on specific information in order to remember it. This includes mentally reciting material, concentrating on specific information, memorising, reading aloud, and going back over notes or underlinings.

Put together ideas in your head

- Stop to get the whole picture, to summarise the information in your head, and to connect ideas.

Relate ideas to what you already know

- Create associations between a new idea and something you already know or have experienced.

Make a picture in your mind

- imagine a picture of a place, object, event.

Ouestion or test yourself

- Think of questions and answer them as you read along; test your comprehension and memory as you go over your notes or underlinings.

Guess what will happen???

- Make predictions about what will happen next or what the reading will be about.

Other

- anything you do when reading or studying that is not listed above.

Record of reading strategies used

	Passages							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Observable strategies								
Highlight or underline text								
Copy from the text								
Write down in your own words								
Outline								
Draw a diagram								
In-the head strategies								
Look over before reading								
Read at your usual rate								
Read slowly								
Go back and read again								
Special attention: Review								
Put together ideas in your head								
Relate to what you already know								
Make a picture in your mind								
Ouestion or test yourself								
Guess what will happen								
Other								

(Wade & Reynolds, 1989)

Lesson Plans: Experimental group

Lesson Plan 18 June 1999
Time: 90 minutes
Topic: Pollution and the Environment

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Group discussion: students are divided into 7 groups. Each group discusses the problems of pollution and how to solve the problems. Each group presents their discussion to the class. 2. The teacher writes on the board key points from the discussion and discuss on how to solve the problems. 3. The teacher helps the students to develop the criteria on how to how to get the important gist of the text..	1. OHP	1. Motivate students' interest. 2. Activate their background knowledge 3. Transition to the reading text. 4. Activate students' text awareness.
While-reading	40	4. Teacher asks students to skim the text by reading the title and the first sentence of each paragraph. 5. Class discussion to get the main idea and supporting ideas of the text. 6. Ask the students to explain their selection of idea.	2.Reading text.	5. Survey the text. 6 Set purpose before reading. 7. Activate the students' awareness of the clues of the text. 8. Activate selective strategy.

Stage	Time	Activity	Materials	Aims
While-reading		7. Class discussion: students anticipate and discuss what they will find in the text 8. Individual works on reading comprehension. The students read the text individually and answer the questions. Students also check their strategies used on the record	3 Strategy Definition sheet 4. Record of strategies used	9. Predicting. 10. Practise reading skills. 11. Monitoring 12. Activate strategy awareness.
Post-reading	25	9. Pair work: Students check their answers with their peer. 10. Class discussion: Teacher and students discuss how to use the strategies effectively.		. 13. Self- evaluation. 14. Compare strategy use. 15. Evaluate effective strategy use.

Lesson Plan: 25 June 1999
Time: 90 minutes
Topic: Information from graphs

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class work: Teacher shows different types of graphs and asks the students to match the graphs with the descriptions. 2. Group work: Students are divided into group of 7. Each group makes a bar graph explaining the height of the students in their group and then present their findings to the class. 3. Class discussion: Teacher and students discuss the makes of cars in Thailand. Teacher writes down key words, sentences and help the students identify important criteria .	1. OHP	1. Motivate students' interest. 2. Prediction. 3. Interpret the graph. 4. Activate students' background knowledge and task awareness. 5 Transition to the text. 6. Selective strategy

While-reading	40	4 Teacher asks students to skim the text by reading the title and the first sentence of each paragraph. 5. Class discussion to get the main idea and supporting ideas of the text. 6. Discuss on their purposes of reading 7. Discuss about the chart and the graph. 8. Encourage students to anticipate what they will find in the text. 9. Individual work: students read the text individually, answer the questions, and record their strategy use on the handout.	2. Reading text. 3. Handout on strategy use.	7. Survey. 8. Set purpose. 9. Resources strategy. 10. Prediction. 11. Keep the meaning of the passage in mind. 12. Monitoring. 13. See the connection between parts of the texts. 14. Guess the meaning.
Post-reading	25	10. Class work: teacher explains the questions for students to check their answers. 11. Class work: students with the help of teacher assess effectiveness of their strategy use.		15. Self evaluation. 16. Assess effective strategy use

Lesson Plan: 2 July 1999
Topic: Noise Pollution

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	Class activity: 1. The teacher plays a piece of music, first a normal level, then louder it up. The teacher then stops the music and asks the students how they feel. 2. Discuss the sources of loud noises and their effects on people. Teacher lists on the board the sources and effects of the loud noises. 3 Group work: brainstorming on the reading text; what type of information should you pay more attention to? Why? 4 Class discussion on that topic.	1. Radio 2. Reading text	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the text. 4. List of important criteria that students should keep in mind while reading.

While-reading	40	5. Students skim through the passage rapidly and find the information from the text from the list: a. Effects of noise on people b. Ways of controlling noise pollution. c. Economics of noise pollution. d. Measurement of noise. e. Effects of noise on animals and plants. 6. Look for information on the following topics: a. Definition of frequency. b. The audible range of frequency. c. Types of helpful noise. d. The amount of sound produced by a rock-and-roll band. e. Causes of hearing damage in young children. f. Example of physiological reaction to noise. 3. Individual work: students read the text individually and work on the strategy use record.	3. OHP 4. Strategy use record 5. Diagram	5. Survey the text 6. Locate specific information. 7. Keep the meaning of the passage in mind. 8. See the connection between parts of the text. 9. Monitore own use of strategies

Post-reading	25	3 Class work: teacher explains the text. Students check their answers. 4 Discuss students' opinions about the passage. 5 Class discussion on strategy use.		10. Self evaluation 10. React to the text 12. Compare on different strategy use.

Lesson Plan: 9 July 1999
Topic: Sugar Cane

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class discussion: teacher discusses with students the sources of sugar, plantation, and manufacturing process. Teacher lists the students' ideas on the board. 2 Group discussion: brainstorming ;what type of information should you pay more attention to? Why? 3 Class discussion: on the topic above. Teacher, then writes 'types of important information' on the board and record students' responses as they say what clues the provides in the text.	1. Reading text	1. Motivate students' interest. 2. Activate students' background knowledge. 3 Transition to the text. 4 Analyse the text. 5 Promote selective attention.

While-reading	40	4. Help the students survey, the first passage: Sugar Cane, by reading the title and the first sentence of each paragraph. 5. Individual work: Students read the text individually and record their reading strategies as they read. 6. Pair work: Students compare their work with their friends. 7. Teacher discusses questions the students have. 8. Group work: Students are divided into 7 groups. Each group works on each exercise on note-taking. Teacher walks around every group. Students survey the text and list important ideas before making note-taking chart. Each group presents their work in front of the class.	2. Record of strategy use. 3. OHP	6. Survey text 7. Strategy awareness. 8. Practise note-taking techniques.
Post-reading	25	10. Class work: Discuss of note-taking techniques and text organisation and link these to other subjects. 11. Group work on comparing strategy use.		9. Apply this technique to their learning. 10. Assess effective strategy use.

Lesson Plan: 16 July 1999
Topic: Fax

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class discussion: Teacher and students discuss the fax machine; on how it works, its shapes and components. Teacher lists those topics on the board. 2. Group discussion: brainstorming ;what type of information should you pay more attention to? Why? 3 Class discussion on the above topic. Teacher writes down 'types of important information' on the board and records the students' responses as they tell what clues the author provides in the text.		1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the reading text. 4 Analyse the text. 5 Promote selective attention.

While-reading	30	4. Group work: Jigsaw reading – Each group is given the text which has been cut into sections and jumbled up. Students work in group to put them into the right order. 5. Teacher walks around every group and ask students to explain why they have arranged the text in that way. 6. Individual work: Students read the text individually and record their strategies as they read.	1. The split reading text 2. The full reading text 3. Record of reading strategies used	6. Reading as a guessing game. 7. Text organisation 8. Strategy awareness
Post-reading	25	7. Pair work: Students compare their work with their peers. 8. Teacher explains any Questions. 9. Class work: compare strategy use.		9. Self evaluation 10 Assess effective strategy use

Lesson Plan: 6 August 1999
Topic: The Building of the Future

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class activity: teacher shows the pictures of several types of buildings, then ask the students' opinions about skyscrapers, why we need them and what they think future building will be like. Teacher writes down key idea of the discussion on the board. 2. Group discussion: brainstorming ;what type of information should you pay more attention to? Why? 3. Class discussion on the above topic. Teacher writes down 'types of important information' on the board and records the students' responses as they tell what clues the author provides in the text.	1. Pictures	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the reading text. 4. Text analysis. 5. Develop use selective attention.

While-reading	40	4. Group work: Jigsaw reading – Each group is given the text which has been cut into sections and jumbled up. Students work in group to put them into the right order. 5. Teacher walks around every group and ask students to explain why they have arranged the text in that way 6. Each group has to write down the topic sentence or main idea of the passage. 7. Each group has to make a note-taking diagram of the passage. 8. Each group has to draw the picture of the building described in the text. 9. Each group presents their work to the class. 10. Individual work: students read the complete text again individually and record their strategy use.	2. Split reading texts 3. OHP 4. Reading text 5. Record of reading strategy use.	6. Text organisation 7. Reading as guessing game 8. Strategy awareness. 9. Monitoring 10. Using imagination.
Post-reading	25	11. Discuss the text, and the students' opinions on the text. 12. Compare strategy use in group.		11. React to the text 12. Assess effective strategy use.

Lesson Plan: 13 August 1999
Topic: The Birth of Stars

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class discussion: teacher shows the pictures of stars and the galaxy, asks the students to discuss this topic and write the vocabulary web on the board. 2. Group discussion: brainstorming ;what type of information should you pay more attention to? Why? 3. Class discussion on the above topic. Teacher writes 'types of important information' on the board and records the students' responses as they tell what clues the author provides in the text.	1. Pictures 2. Reading text	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the reading text. 4. Text analysis 5. Motivate Selective Attention.

While-reading	40	4. Students are asked to read silently the first paragraph of the passage. 5. Then tell them to close the book and invite the students to recall as much as they remember from what they read. Teacher writes the ideas, words, phrases on the board. 6. Teacher encourages students to ask as many questions as they can think of. Teacher writes down the questions on the board. 7. Teacher asks students to predict the next paragraph and writes their predictions on the board. 8. Students are asked to read silently the remainder of the text and record the the strategies they use.	3. Record on reading reading strategy use	6. Predict 7. Memorise 8. Question 9. Keep the meaning of the important idea. 9. Guess 10. Find the main idea of each paragraph.
Post-reading	25	9. Discuss the outcome of the passage and compare the prediction with the actual passage. 10. Compare strategies use.		11. Self evaluation 12. Assess effective use of reading strategies.

Lesson Plan: 20 August 1999
Topic: Gene in action

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class discussion: teacher and students discuss genetic engineering and writes the key words on the board. 2. Group discussion: brainstorming ; what type of information should you pay more attention to? Why? 3. Class discussion on the above topic. Teacher writes down 'types of important information' on the board and records the students' responses as they tell what clues the author provides in the text.	1. Pictures about work on genetic engineering	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the text. 4. Text analysis 5. Selective attention

While-reading	40	4. Group work: Jigsaw reading: Students are divides into groups of 5. Each group has to put the split text in order, then: a. find the two main areas of genetic research are? b. Describe genetic construction of e-coli. c. Describe the background to current work in genetic study. d. Look for possible future development in genetic study. e. Predict what might come next in the article. 5. Teacher gives the next part of the paragraph to every student and asks them to read quickly on their own and record their reading strategies. 6. Students complete questions exercise.	2. Split reading passage 3. Record of reading strategy used	6. Text organisation 7. Guessing 8. Context clue 9. Find the main ideas of each paragraph. 10. Predict 11. Look for supporting details.
Post-reading	25	7. Teacher and students discuss the text and asks the students to make a diagram of the text. 8. Students compare the strategy use.	4. OHP	12. Summarise 13. Note-taking 14. Evaluate

Lesson Plan: 27 August 1999
Topic: The One and Only You

Stage	Time mins	Activity	Materials	Aims
Pre-reading	25	1. Class discussion: teacher asks one student to show his ID. or credit card, then discuss with students its function, how it works. The teacher writes key points from the discussion on the board. 2. Group discussion: brainstorming ; what type of information should you pay more attention to? Why? 3. Class discussion on the above topic. Teacher writes down 'types of important information' on the board and records the students' responses as they tell what clues the author provides in the text.	1. ID card or credit card	1. Motivate students' interest. 2. Activate students' background knowledge. 3. Transition to the text. 4. Text analysis 5. Selective attention

While-reading	40	4. Teacher asks student to read the first paragraph of the passage then close the book. 5. Teacher invites students to discuss as fully as possible the main idea of the paragraph and supporting details. Teacher writes key points from the discussion. 6. Teacher invites students to ask as much as possible about the first paragraph. Teacher writes the students' questions on the board. 7. Teacher asks students to predict the next part and teacher writes the predictions. 8. Students read the next part and record the reading strategies as they read.	2. Reading text 3. Record of reading strategy use	6. Survey the text 7. Find the main idea and supporting details of the paragraph. 8. Question. 9. Guess. 10. Predict. 11. Memorise
Post-reading	25	9. Class discussion about the text and the predictions. 10. The students their answers. 11. Compare students' strategy use		12. Self evaluation 13. Assess effective strategy use

Lesson Plan: 3 September 1999
Topic: Electric motor

Stage	Time	Activity	Materials	Aims
Pre-reading	25	Class discussion: 1. Discuss how electric fan works. 2. Discuss how an electric motor works. 3. Ask the students what text they think they are going to read.	1. Electrical appliance such as electric fan.	1. Motivate students' interest and background knowledge. 2. Predict. 3. Encourage students to use their imagination.
While-reading	40	4. Distribute the text to students, then, ask them what kind of text it is, and the purpose of this kind of text. 5. Ask students to work into groups of 4 to find the following information: a. The component of electric motor b. What is an electromagnet, how does the iron become magnetized? c. What is an armature and its role in the electric motor? d. How to reverse the direction of the current? 6. Students read individually and silently complete the work sheet and do the exercise.	2. Reading text 3. Record of reading strategy use	4. Set purpose before reading. 5. Encourage selective attention. 6. Monitoring 7. Activate strategy awareness.

Post-reading	30	7. Students check their exercises in their group. Teacher helps students solve any problems. 8. Compare strategy use.		8. Self evaluation 9. Assess effective strategy use

Appendix B

Materials for Reading instruction

(Control group and experimental group)

Lesson 1: Pollution and the Environment

Content Objective:

To learn about human impact on the environment

Language objectives:

Vocabulary: Construct, congest, contribute, cause, destroy, displace, decrease, eliminate, improve, impair, exploit, challenge, private enterprise, reduce, recycle, rest

Structure: The use of present simple tense

Function: Reporting factual information with declarative sentences

Reading skill: Techniques for guessing or inferring the meaning of some words from context clues

Lesson 2: Marketing

Content Objective:

To learn about the market structure

Language objectives:

Vocabulary: claim, competitive, launch, policies, predict, utility, data, rise, increase, climb, fall, decrease, decline, drop, remain, constant

Structure: The use of present perfect and present simple tenses

Function: Interpret information from graphs and transfer the data from graphs into description

Reading skill: Skim and scan reading passages

Lesson 3: Noise Pollution

Content Objective:

To learn about noise pollution

Language objectives:

Vocabulary: physiological, psychological, distinguish, high-pitched, requisition, accompaniment, reveal, economic effect, adversely affected, environmental concern, apathetic attitude, vigorous, anxiety, symptoms, nausea, irritability

Structure: Subject verb agreement, adverbial clauses of reason

Function: Declarative sentences showing causes and effects

Reading skill: Use an English dictionary

Lesson 4: Sugar Cane

Content Objective:

To learn about the process of sugar production

Language objectives:

Vocabulary: cane, crude, crystalise, juice, molasses, purify

Structure: Passive voice

Function: Describe processes

Reading skill: Note taking

Lesson 5: Fax

Content Objective:

To learn about the fax and its operation

Language objectives:

Vocabulary: signal, transmission, reproduction, contain, image, convert, binary information, digital information, analogue tone, thermal head, printer, heat-sensitive paper

Structure: Gerunds

Function: Process description

Reading skill: Pronouns as contextual reference terms

Lesson 6: The Building of the Future

Content Objective:

To learn about construction

Language Objectives:

Vocabulary: assembly, skyscraper, suspend, span, escalator, module, install, erect, monitor, operation, maintenance, low-intensity energy, exterior cladding

Structure: Future tense

Function: Describing objects

Reading skill: Pronouns as contextual reference terms

Lesson 7: The Birth of Stars

Content Objective:

To learn about the birth of stars

Language objectives:

Vocabulary: thermo-nuclear reaction, evolve, emit, optical telescope, wavelength, vicinity of interstellar gas clouds, thermal, collapse, protostar, gravitational condensation, convert

Structure: Relative pronoun, relative clause

Function: Describing a process

Reading skill: Pronouns as contextual reference terms

Lesson 8: Genes in Action

Content Objective:

To learn about genetic study

Language Objectives:

Vocabulary: nucleic acid strands, elucidating, chromosome, structural genes, regulatory abstruse, gene regulation, snip out

Structure: Present simple and present perfect

Function: Paragraph development

Reading skill: Text organisation

Lesson 9: The One and Only You

Content Objective:

To learn about the new technique to proof of identity

Language Objectives:

Vocabulary: unique, identity, physical characteristic, fingerprint, palmprint, retina, iris, biometric, verify, optical scanner, unveil

Structure: Relative pronoun, relative clause

Reading skill: Word formation

Lesson 10: The Electric Motor

Content Objective:

To learn about the function and parts of an electric motor

Language Objectives:

Vocabulary: magnetic field, universal motor, direct current, alternative current, loop of wire, motor frame, field windings, armature, commutator, brush, drive shaft

Structure: Expression showing components and parts

Function: Describing the function of an apparatus

Reading skill: Reading for details

LEAD-FREE PETROL

Why is it important that people should be aware that petrol which contains lead is a dangerous pollutant and we should not use it?

Lead (Pb) is used in petrol to make car engines run more smoothly. But lead is a deadly poison. It especially harms the brains of growing children. It causes their mental development to be slow. This can result in problems in how they behave.

Lead stays in the human body and builds up in our skeletons as we grow. It remains for life.

In Bangkok there are more than five million cars. The number is increasing all the time. Because of this, the level of lead in the air is very high, particularly in busy, commercial areas.

Because we sit in traffic jams and inhale this harmful substance every day, it is important to switch to lead-free gasoline. This type of fuel will be less damaging to the air we breathe and will do less harm to our brains and bodies.

POLLUTION AND THE ENVIRONMENT

Bangkok, like other big cities, is busy and crowded. City buses and other vehicles are moving during the working hours and even at night time. Super-highways, fly-overs and other express land-travel systems have been constructed to overcome traffic congestion. Motor vehicles, contribute a high percentage of air pollutants, causing major problems in cities. But there are other primary sources of pollution besides motor vehicles. Industry, electricity generating plants, and refuse disposal all send polluting materials into the air. Carbon monoxide, sulphur oxides, hydrocarbons, nitrogen oxides and lead are the most common air pollutants. These not only cause unpleasant odours and fill cities with smog, but also impair health and destroy the ozone in the atmosphere.

What should we do to save our environment? There are several ways we can decrease pollution. By using cleaner fuels we reduce the quantity of pollutants. Recycling more materials means that we have less refuse to dispose of. Protecting the rain forests from exploitation and destruction means that there will be more trees to use the carbon dioxide that will still be produced. Certainly, restoring the quality of the atmosphere ranks as one of the most difficult and challenging tasks faced by our generation. But with coordinated national effort by government, private enterprise and the people, this problem can be eliminated for the improvement of our environment.

5. What does the first sentence of each paragraph tell you about?

HUMAN IMPACT ON CLIMATE

Human Activities Affect Weather

Since the beginning of human society, people have tried to change the weather. On a local level, cutting down a forest can reduce the rainfall in an area. If the forest is cut down, leaving soil with few plants in it, rain that falls on the soil does not stay in the area but drains immediately into the nearest river. The rainfall downwind may decrease.

International concern today, however, centers not on these local effects, but on two important problems that affect the whole world : ozone depletion and the greenhouse effect.

Ozone Depletion

We are destroying the ozone layer in the atmosphere, and this permits increasing amounts of ultraviolet radiation to reach the earth. Ultraviolet radiation damages the genetic material, causing skin cancer in humans and killing many smaller organisms outright. A large, and growing, hole in the ozone layer over the Antarctic was discovered in the 1980s, adding urgency to the quest for a solution to this problem.

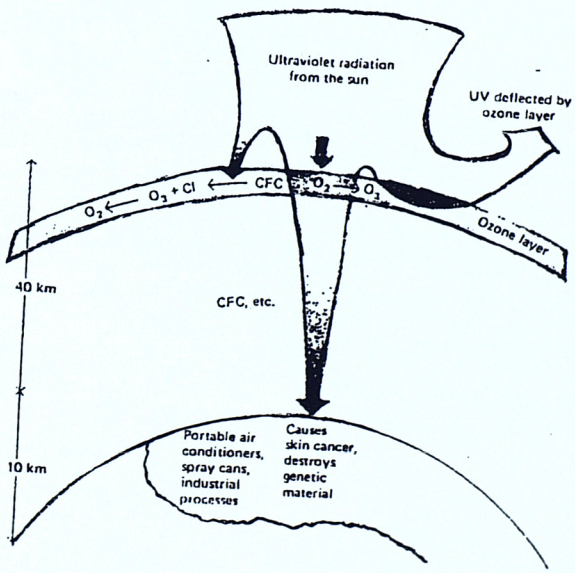


Figure 4-11 How the ozone layer is formed and destroyed.

The Green House Effect

In the atmosphere, carbon dioxide acts rather like a one-way mirror; it allows the sun's rays to pass through easily on the way to the earth's surface, but prevents heat emitted by the earth from escaping back into space. It would, in fact, be true to say that a concentration of carbon dioxide acts like the glass in the roof of a greenhouse. The glass roof allows the sun's rays to enter but prevents the heat from escaping.

Since observations have shown that the level of carbon dioxide in the atmosphere is rising, many meteorologists predict that this greenhouse effect'will warm up the world. According to one of their projections, the atmosphere will be 3 degrees Celsius warmer in the year 2050 than it is today, if man continues to burn fossil fuels at the present rate. If this warming up took place, the polar ice caps would begin to melt, thus raising sea level several metres and severely flooding coastal cities. Also, the increase in atmospheric temperature would lead to drastic changes in the climate of the northern hemisphere, possibly resulting in an alteration of the earth's chief food - growing zones.

Exercise 3 : You want to write a report on Health Effects of Air Pollution. You are searching for information on this topic. Survey the following titles and headings. Decide which text (s) you want to survey further or to read in detail.

A

"Medical Care and Community Health Services"

Problems of medical care
Hospital facilities
Financing medical service

B

"Environmental Health"

Air pollution
Water pollution
Noise pollution
Government agencies and pollution control

C

"Air pollution"

pure air and polluted air
the effects of air pollution
The control of air pollution
Problems

D

"Urban Land Use"

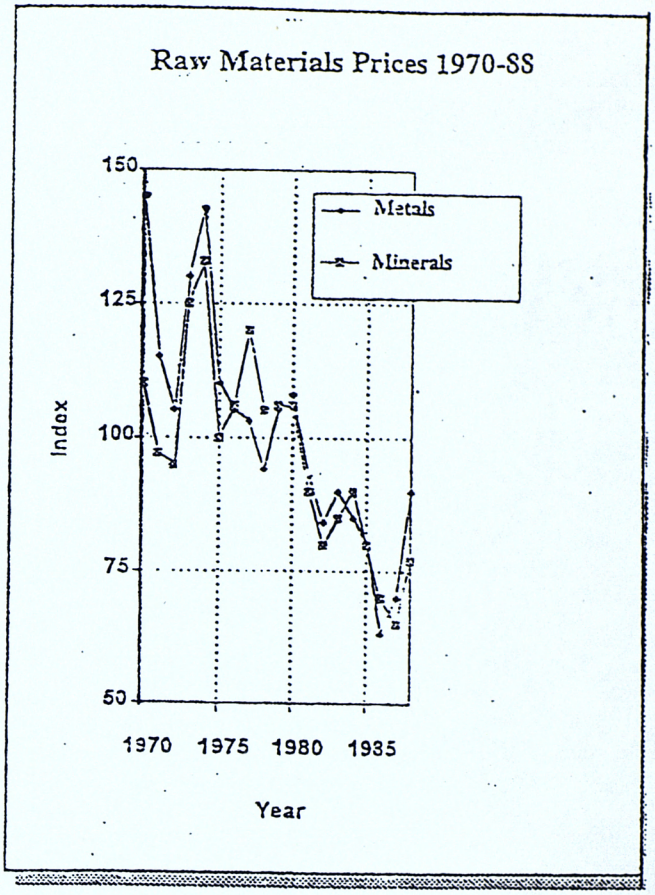
Urban growth
Urbanization in developing countries
The Urban crisis
Urban structure

E

"Conservation for Survival"

Atmosphere
Air pollution
Noise pollution
Effects on plants
Effects on animals
Effects on man

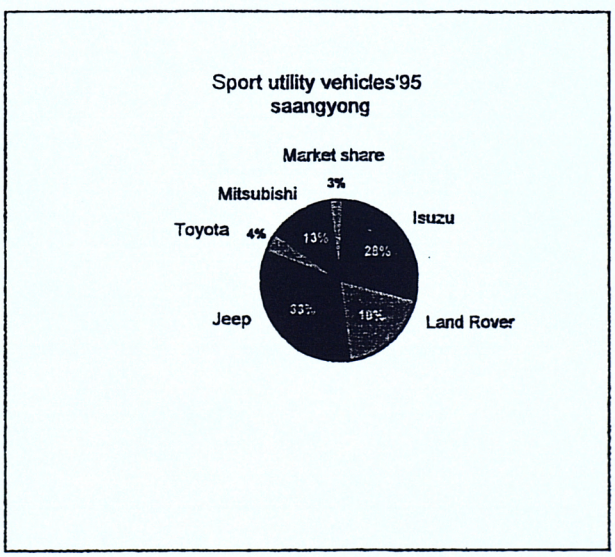
The economies of developing countries depend on *raw materials*. The prices of raw materials *declined* steadily during the past few years. In 1987 they reached their lowest level in 50 years.



1. What does the graph refer to?
2. Two kinds of raw materials are presented, what are they?
3. What happened to the *raw materials* in 1987?
4. Which of these words is closest in meaning to the verb "*decline(d)*"?
   a. slope(d)
   b. develop(ed)
   c. decrease(d)
   d. graph(ed)

Thai Chrysler is hoping to win 50% of SUV market

THAI Chrysler Automotive Co. hopes to gather about 50% of the sports **utility** vehicle (SUV) market this year. The company has three models in both the large and medium sized areas of the market.



A company official said sales o Jeep Cherokee SUVs should double to 3,500 units this year. He **predicte** that the total SUV market would reach about 8,000 units this year. This is compared with about 4,000 last yea

The Chrysler Company has **policie** that keep prices **competitive.** Thes policies make Jeep sales successful. Bu the Jeep is considered a little too datec by some people when it is compare with Land Rover and Japanese vehicle

Earlier this week, the firm **launched** cheaper version of the Jeep Cherokee. It is the Sport 2.5L. It will compete in the market with vehicles like the Nissan Terrano II, at a price of 1.05 million baht.

The firm **claims** that Jeep had the largest share of 33% in the SUV area last year. The number amounted to 1,320 units. Isuzu and Land Rover followed with 1,120 and 760 units.

2) Scan the table and write T for true and F for false in the blanks.

Plastic Resins Import

(Unit : metric tonnes)

	1992	1993	increase/decrease %
PE	103,000	98,000	5
PVC	88,100	56,100	36
PP	47,000	59,600	27
Total	238,100	213,700	10

..... 1. The import of PE decreased in 1993.
..... 2. Thailand imports less PVC in 1993.
..... 3. The import of PP decreased by 27% in 1993.
..... 4. Thailand imports less plastic resins in 1992.
..... 5. Thailand produced more plastic resin in 1993.

3) Scan this passage and answer the questions that follow.

Retail petrol stations rise 25%

Retail petrol stations increased by 2,031 stations or 25% in 1996 from 1995 to 10,045, with the state-run Petroleum Authority of Thailand accounting for the largest share, according to the Commercial Registration Department.

Of the total, PTT owns 1,525 stations, followed by Bang Chak 1,095, Shell 1,057, Esso 845, Caltex 564, PT Petroleum 307, MP Petroleum 136, TPI 93, Sukhothai Petroleum 89, Jet 61, with the rest being hand pump stations.

The Northeast has the largest number, with a 30% increase to 3,005 stations, followed by the Central Region with a rise of 10% to 1,967, the North 18% to 1,831, Bangkok and its environs 11% to 1,114, the South 11% to 1,106, and the East 10% to 1,022.

Director-general Somsak Yamasamit said yesterday the increase mean his department would have to work harder to protect customers from sub standard products.

The department would send mobile units to inspect the quality of oi products at stations throughout the country regularly, he added.

1. How many retail petrol stations increased in 1996?
2. Which company or organization has got the largest share?
3. How many retail petrol stations does Shell own?
4. Does Caltex own more petrol stations than TPI?
5. Which region has got the lowest percentage increase?
6. What would be sent to inspect the quality of oil products?

4) You are doing a research about the advantages of using robots. Skim the following texts and decide which can be used as a reference for your research.

Text A

It is obvious that robots have many advantages over human beings. However, it is also true that humans can do many things that robots can't. For example, humans can carry out a task without having to be told exactly how to do it first - in other words, they don't always have to be programmed. Humans can walk, run, swim, drive cars, fly airplanes, and so on, but robots are usually fixed in one place. If they are able to move, robots can do so only in a very limited way. Another advantage humans have is the way the same person can do jobs as different as making a cup of tea and designing a new type of motor car. And unlike robots, people can know whether what they are doing is good or bad, and whether it is boring or interesting. Also, robots are only just beginning to be able to understand speech and writing, but humans can communicate easily with each other by these methods, and by many others - telephone, drawings, radio, and so on - as well.

Text B

For many jobs a robot is much better than a human operative. Once it has been programmed, it will do its job over and over again. It never gets bored; it works at a constant speed; it doesn't make mistakes; its work is always of the same standard; it doesn't get tired; it doesn't go on strike; it can work for 24 hours a day without breaks for food, rest or sleep; it doesn't take holidays or demand higher wages.

Robots have other advantages, too. They can be designed to do almost any job. You can't change the human body, but a robot's arms, for example, can be made to move in any direction. Robots can also do very heavy work and they can operate in conditions that are too dangerous, too hot or too cold for people to work in. They can work under water, in poisonous gas and in radioactive areas. And on top of all this, robots never complain.

STRACT

NOISE POLLUTION

A well-documented body of information exists showing that noise can adversely affect humans in both physiological and psychological ways. Hearing losses in particular occupations such as boiler-making and construction work are well known. In fact, however, we all find hearing more difficult as we age. Young ears can distinguish a wide range of sounds from low to very high frequencies, while older ears lose the ability to distinguish high-pitched sounds. A comparison of some industrialized versus non-industrialized peoples suggests that this hearing loss may not be a requisite accompaniment of old age.

Furthermore, a closer inspection of other data reveals economic effects. For instance, an increased turnover in property has been observed in noisy areas near airports. Job performance can be adversely affected by loud noise, especially if accuracy and mental effort are involved. The use of outdoor areas for conversation is not possible for an estimated 5 to 10 million people who live or work in urban areas. When interference with television or speech or sleep is included, as many as 22 to 44 million people can be said to have lost part of the use of their homes and grounds because of noise.

Thus noise pollution is a serious environmental concern. The apathetic attitude toward noise should be overcome; vigorous efforts should be made to alert people to the grave effects which may stem from an excessively noisy environment.

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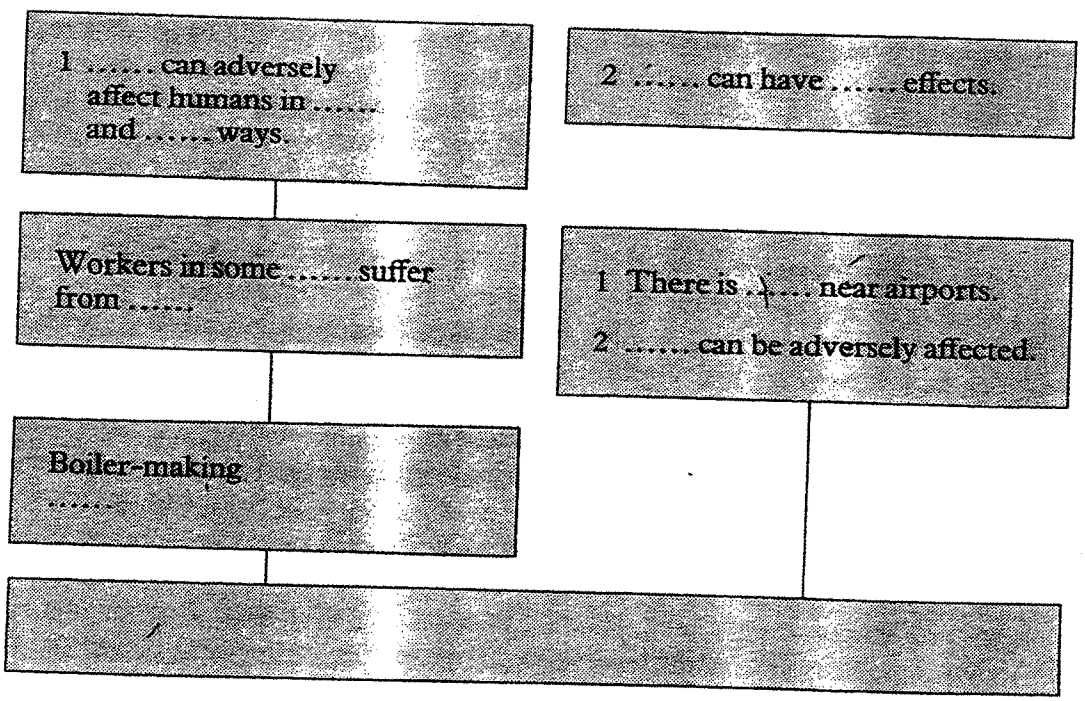
2 Complete this summary of the abstract:



SECTION 2

Research has shown that noise affects people in several different ways. Hearing damage is the most well-known effect. Hearing damage involves some injury to the receptor cells, or the structure containing them, in the inner ear. The eardrum and middle ear are very rarely damaged by noise. Only an extremely loud sound pressure could burst the eardrum.[8] Noise can also have more subtle effects. It may influence task performance, deteriorate one's mental or physical state, interfere with sleep, and increase the rate of accidents.

In the age range 5 to 10 years, significant hearing damage is mainly caused by toy caps. In the range 10 to 18 years, loss is caused by toy caps and firearms. The main problem in the 18 and over group is occupational exposure. It is estimated that 6 to 16 million workers in such occupations as construction, heavy industry, flying, printing, mechanized farming and truck driving are exposed regularly to hazardous noise levels. In addition, some recent studies contain disturbing evidence of hearing loss among non-occupationally exposed young people. It is suspected that listening to amplified rock-and-roll music may be causing hearing loss among young people on an epidemic scale. At one subcommittee hearing it was averred that certain rock groups contract that they will produce 120 decibels or forfeit payment.

Frequent exposure to noises of 80 db(A) or above and even exposure of a sufficient duration to sounds in the 70 to 80 db(A) range probably lead to diminished hearing ability. It has been suggested that noises in the range of 70 db(A) or greater should be reduced or avoided to prevent gradual hearing loss with age.[9]

Noise causes three types of physiological responses. First, there is a voluntary muscle response in which the head and eyes turn to the noise source and the body prepares for action. This is exemplified by a startled response to a sudden loud noise.

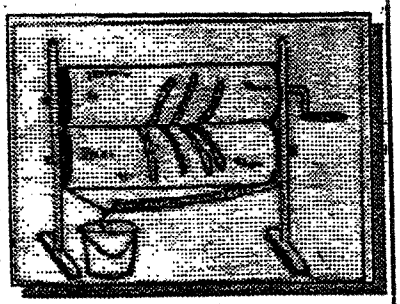
Second, the involuntary muscles respond to noises over 70 decibels by general reduction in blood flow to the peripheral body parts (fingers, toes, ears) and changes in such functions as heart rate and breathing.

Third, loud noises can cause neuroendocrine responses which, from animal experiments, appear to affect sexual and reproductive functions and which cause overgrowth of the adrenal glands, among other effects. These results of course cannot be directly extrapolated to humans.[10] Nonetheless, workers exposed to high noise levels exhibit an increased incidence of cardiovascular disease, ear, nose and throat problems, and equilibrium disorders. For instance, German steelworkers have been shown to have a higher than normal incidence of abnormal heart rhythms.[11]

Adverse psychological responses to noise have been noted in several areas. Task performace is affected by noise that is intermittent, although steady state noise even up to 90 db(A) does not seem to have much effect.[12] Complex tasks are affected more than simple ones, and accuracy is reduced more than quantity. Even when good performance is maintained, excess noise is fatiguing. People working in noisy environments are much less tolerant of noise in their non-occupational environment than those working in quiet surroundings.[13] Time judgement is another response upset by noise. Certain types of noise can of course be helpful, such as rhythmic noises or those which mask distracting sounds. More commonly, however, noise has been shown to produce anxiety symptoms such as headache, nausea and irritability. One study indicated that mental hospital admissions are more numerous in noisy areas than in comparable quiet ones.

Sugar Cane

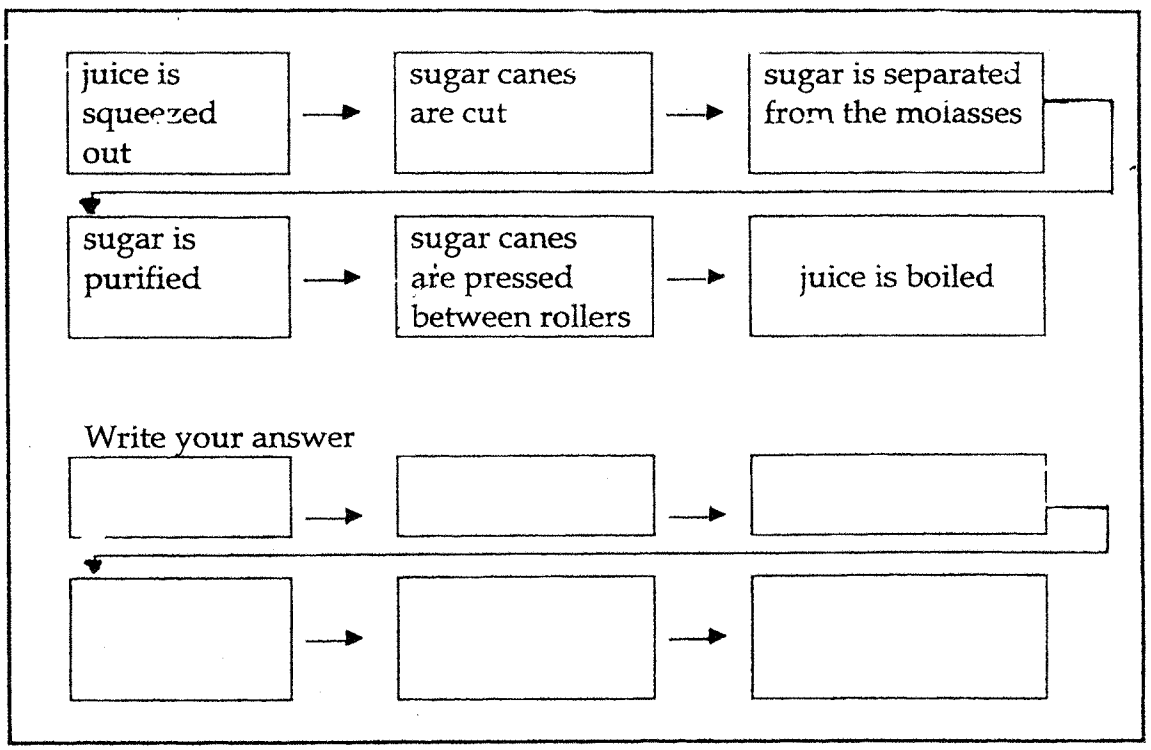
Sugar cane is basically a tropical crop and **it**[1] is grown in many countries including Thailand. Some of the sugar cane is eaten fresh but most of it is refined into sugar. For sugar making purposes, the cane must be squeezed within 24 hours of cutting as the juice will otherwise turn bad. So after reaping, the cane is sent immediately to the factory.



Sugar Cane Press

There[2], the individual canes are first cut to lengths of two or three feet and put into rollers by which the juice is squeezed out. The crude juice **which**[3] contains 80% water and 20% sugar is then boiled with a chemical in a copper pot and the floating impurities are removed. The juice is boiled further until the sugar is separated from the molasses, **which**[4] is a thick, dark liquid.

A lot of **this**[5] – about 60 gallons – is produced for every ton of sugar. When the sugar is on the point of crystallizing, it is sent to refinery to be purified. Then it is sent to shops to be sold. Similarly the molasses, the sugar cane by-product, is also marketed, especially for use in manufacturing rum.



YPES OF PARAGRAPH AND SUGGESTED NOTE-TAKING FORMATS

A cause-effect/reason-consequence/paragraph is often noted vertically, using a numbered list.

ARAGRAPH 1

he risks of smoking are serious during pregnancy since there is evidence of a greater chance spontaneous abortion or premature birth. The new born babies of mothers who smoked uring pregnancy are, on average, slightly lighter than babies of non-smoking mothers.

Risks of smoking during pregnancy

smoking → possibly

1. spontaneous abortion
2. premature birth
3. slightly lighter babies

ARAGRAPH 2

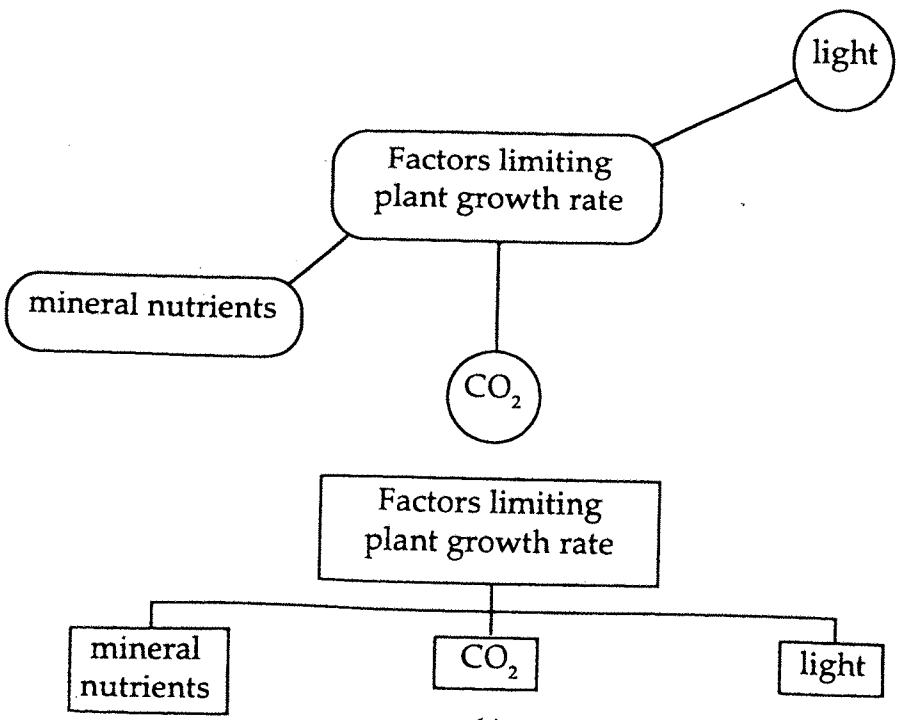
Plants can be limited in their growth-rates by a variety of factors.
[1]Mineral nutrients must diffuse through the soil to the roots, and from there, they must be carried through the body of the plant.

[2]Carbon dioxide must be taken into the leaves. Sufficient [3]light must fall upon the plant to cause a rate of photosynthesis greater than the rate of consumption of energy by the plant.

Factors limiting plant growth rate

1. mineral nutrients
2. CO_2
3. light

This type of paragraph can also be noted down in the form of connected loops or upside down trees.



EXERCISE 1: Read the following paragraph and mark important points. Then make notes in the box below.

PARAGRAPH 3

Within the animal world, populations change all the time. Changes in the animal population depend on many factors. These include the rate of production of the young and the number of the young that survive through the breeding age.

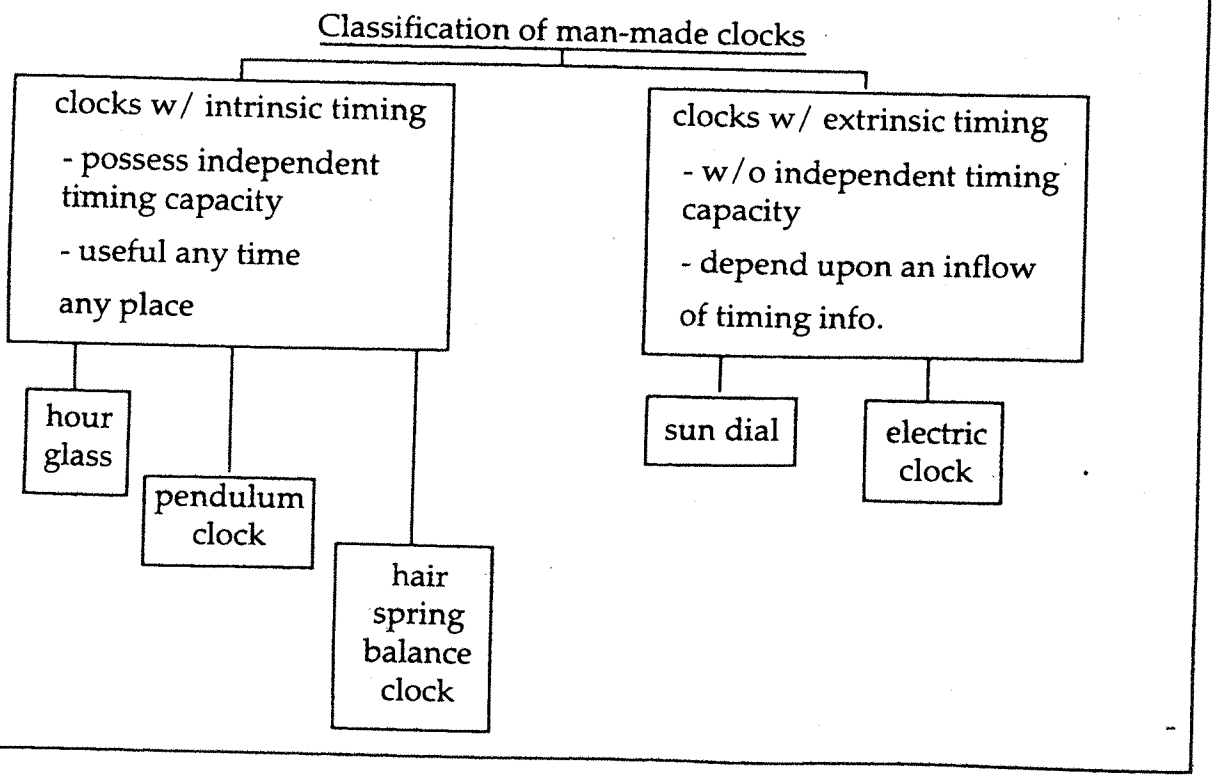
Factors → Changes in animal population

e.g.

o) A classification paragraph (w/ definition and examples) is usually transformed to a chart.

PARAGRAPH 4

Man-made clocks are of two types---those with intrinsic timing and those with extrinsic timing. Examples of the intrinsic type are the hour-glass, the pendulum clock, and the hair spring balance clock. Intrinsic clocks possess independent timing capacity and are useful any time and any place. Extrinsic clocks such as the sun dial and the electric clock, have no independent timing capacity but depend upon an inflow of timing information. The sun dial depends on the sun's shadow and the electric clock depends on the alternating electric current.



XERCISE 2 : Read the following paragraph, mark key points and arrange important information in an appropriate format.

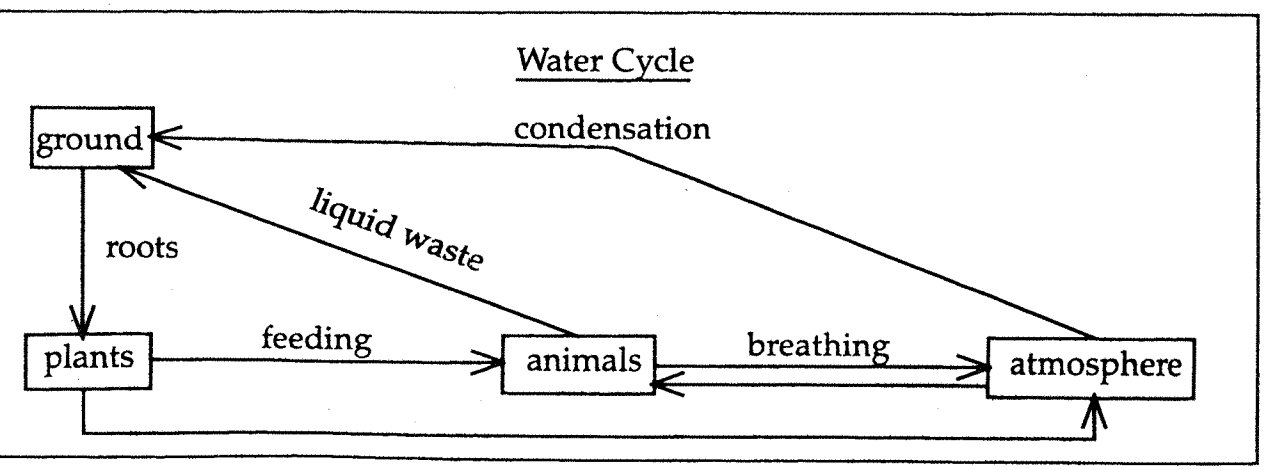
ARAGRAPH 5

There are three main types of cancer, and they have been given different names. 'Carcinomas' are the most common type of cancer. They affect the skin, and the skin-like linings of the lungs, the stomach and the intestines, and other internal organs. 'Sarcomas' are the type that occur in the connective tissues of the body---in bone, cartilage and fat. The other type of cancer is that which attacks cells of the bone marrow, blood cells, and the tissues of the lymph glands. These are called 'leukemias' and 'lymphomas.'

c) The concept of process / cycle (w / sequence of action) is often transformed into chains.

ARAGRAPH 6

All plants and animals need water in order to carry on the activities of living. Plants get water from the ground through their roots. Excess water that is not used by green plants in making food is given off into the atmosphere. Animals feed directly or indirectly on plants, thus taking in some water. Animals also take water vapor from the air and replace it in the atmosphere during the process of breathing. Water is also put back in the soil in the form of liquid waste products. All water vapor in the atmosphere condenses and finds its way back to the soil, where the cycle continues.



XERCISE 3 : Read the following paragraph, mark key points and arrange important information in the appropriate format.

ARAGRAPH 7

The following is a general description of the carbon cycle. All living tissue whether it is from plants or from animals—is made up of complex carbon compound. In the first place, the plants take in the carbon dioxide (CO_2) from the air. Then, by means of the process known as photosynthesis, the plants make it into various complex compounds. Later, animals eat the plants. At this point, a great deal of carbon is returned to the atmosphere in the form of carbon dioxide in the animals' respiration. When the plants and animals eventually die, the decaying process frees the carbon which has been a large part of their body composition.

d) A description of objects, functions or a measurement description is transformed into tables.

ARAGRAPH 8

Life expectancy at birth in England and Wales remained fairly constant during the 19th century, and it was not until the 20th century that a great increase occurred. For example in 1840 a new born baby boy could expect to live to 40, whereas the average life-span of a girl was 42. By 1900 average life-span had increased to 44 for males and 48 for females, but in 1930 we find that the average life expectancy for males was 59 and for females it was 63. In 1970 a new born baby boy could look forward to an average life-span of 69 years whereas a girl could expect 75 years.

Life expectancy in Eng & Wales

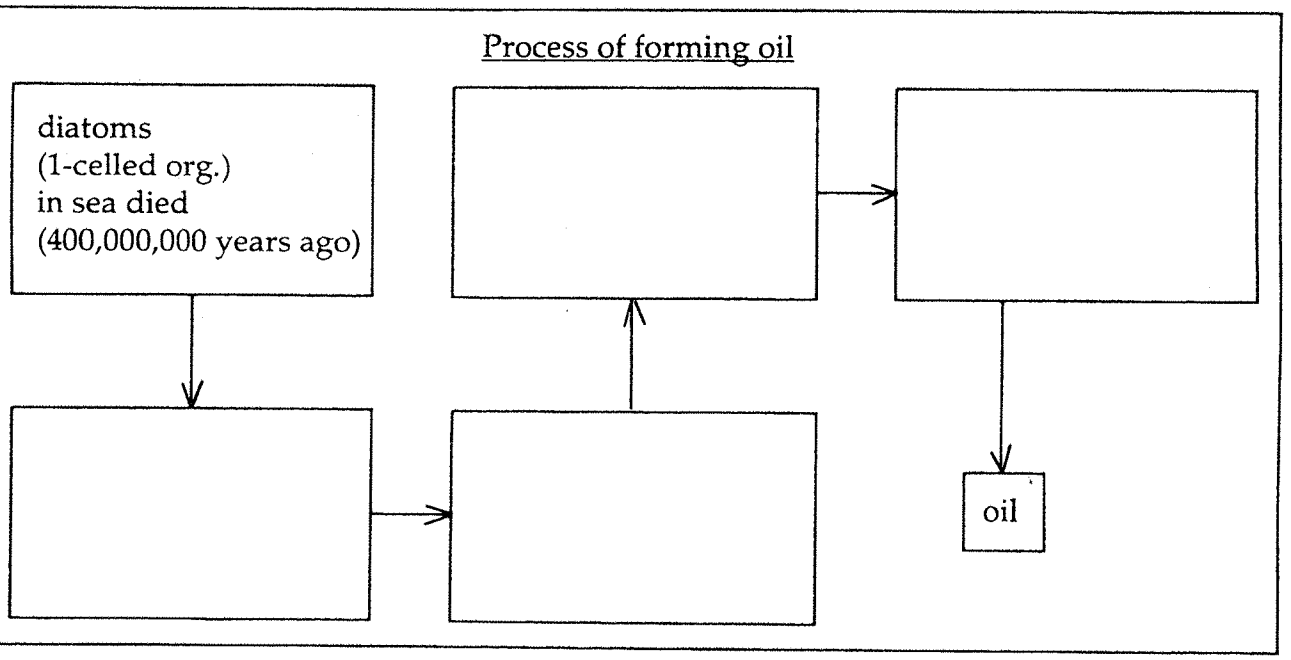
Date	Males	Females
1840	40	42
1900	44	48
1930	59	63
1970	69	75

EXERCISE 4 : Now look at the following paragraphs. Mark important words. Then organize the essential information in each paragraph in an appropriate outline form.

PARAGRAPH 9

The process of forming oil began about 400,000,000 years ago. At that time, single-celled organisms called diatoms lived in warm shallow seas. When they died, their bodies settled on the bottom of the sea. Layers of mud covered them. Bacteria absorbed oxygen from the dead diatoms and left new compounds known as hydrocarbons. Later on, these hydrocarbons were compressed and liquefied by the weight of new rocks on top of them. This way, the oil is produced.

What type of paragraph is this? _____



PARAGRAPH 10

The inorganic compounds found in living systems are acids, bases and salts. An acid is a compound which releases hydrogen ions (H+) when dissolved in water. Acids turn blue litmus paper to red and have a sour taste. Hydrochloric (HCL) and sulfuric (H_2SO_4) are inorganic acids. A base is a compound which releases hydroxyl ions (OH-) when dissolved in water. Bases turn red litmus paper blue. Sodium hydroxide (NaOH) and ammonium hydroxide (NH_4OH) are common inorganic bases. When an acid and a base are mixed, the hydrogen ion of the acid unites with the hydroxyl ion of the base to form a molecule of water (H_2O). The remainder of the acid combines with the rest of the base to form a salt. Hydrochloric acid, for example, reacts with sodium hydroxide to form water and sodium chloride. A salt may be defined as a compound in which the hydrogen atom of an acid is replaced by some metal.

What type of paragraph is this? _____

FAX

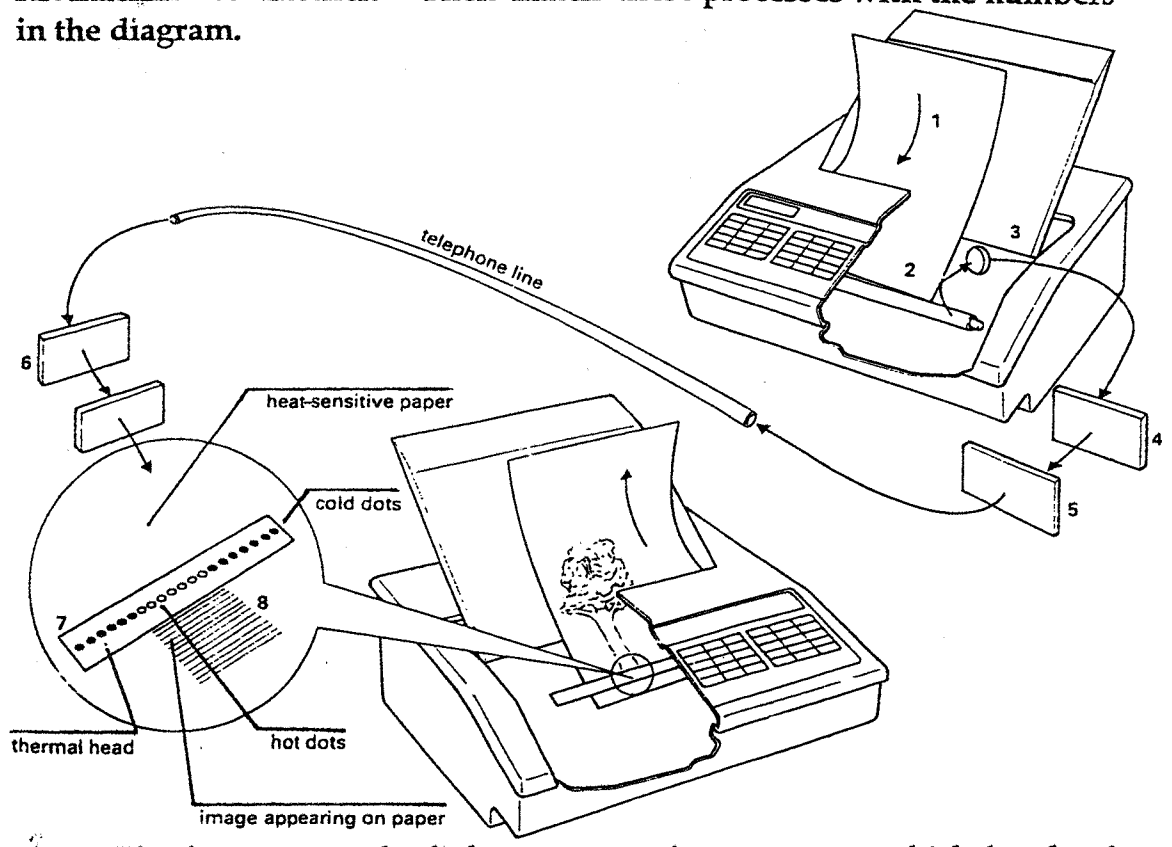
Facsimile machines only came into widespread use in the late 1970s when international standards were set by the Comite Consultatif International Telegraphique et Telephonique (CCITT), a body based in France. Before this, machines could only communicate with **those**[1] made by the same manufacturer. Since then, facsimile technology has become increasingly sophisticated. The latest **machines**[2], which must be linked to a special digital phone line, can send a document to several places at once for the price of one phone call.

Facsimile transmission involves sending a document along a telephone line and converting the received signals into a reproduction of the original. 'Fax' machines can now send an A4 document, containing images as well as words, in less than a minute. When you feed a document into the machine, a fluorescent lamp reflects the image on to a series of mirrors which reduce its size so that the whole document can be reflected on to a camera lens. The lens can only read the image in black and white. **This information**[3] is converted, via a microprocessor, into binary information. The machine records black as 0 and white as 1.

Another microprocessor then converts the **binary data**[4] into digital information, which allows more data to be stored on the microchip. But, because most telephone systems cannot read digital information, this is again changed, via another microprocessor (modem), into analogue tones, or pitches of noise. The first machine transmits **these tones**[5] to the second. The receiving machine converts the analogue tones back into digital and then binary information. **It**[6] sends a signal (in binary code) to the thermal head, or printer. This turns heated elements on or off according to the pattern of 0s and 1s contained in the signal. The pattern of black and white is then printed on to heat-sensitive paper.

Fax machines send information at the rate of 9,600 baud, or bits of information per second. A few seconds' interference on the phone line can make several lines of a document illegible. If **the line**[7] is noisy, the sending machine will slow down to reduce the amount of information lost.

C. Study this diagram which shows how a document can be sent from one fax machine to another. Then match these processes with the numbers in the diagram.



..... a. The lens passes the light on to a microprocessor which breaks the image into a series of horizontal lines.

..... b. The thermal head contains elements which turn on or off according to the signal.

..... c. A document is fed into the sending machine.

..... d. At the receiving machine, the analogue tones are converted back into binary signals and fed into a thermal head.

..... e. Another microprocessor converts each line into a series of binary coded dots. These in turn are converted into digital information.

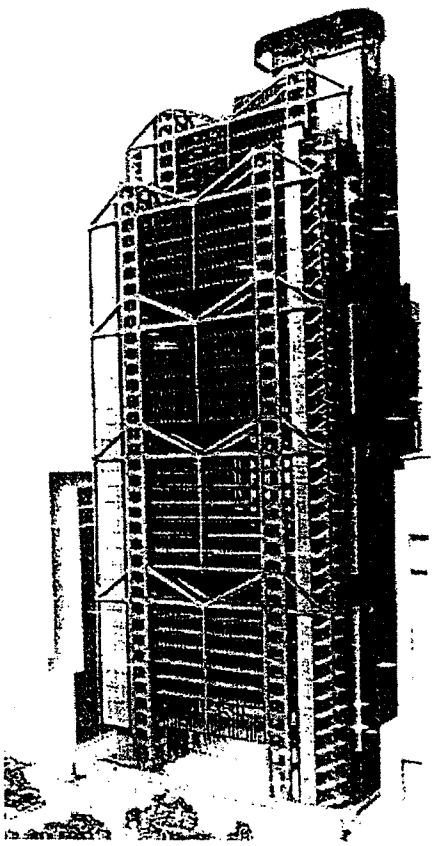
..... f. The image is printed onto heat-sensitive paper.

..... g. The digital information is converted by a modem into analogue tones for transmission by the telephone lines.

..... h. The document passes over a fluorescent tube which bounces light off the paper, reflecting the image on to a lens.

The Building of the Future

Usually, skyscrapers are encased in a concrete 'case' for fire protection. The new bank building's steel frame has been designed to be seen, and is the most unusual feature of the external frame. The steel in the new bank is specially treated for fire resistance. The floors of the building will be **suspended** from wide, bridge-like **spans** at five points up the building. This [1] has been done before, but never on such a large and complex scale. The high-speed lifts and **escalators** reaching throughout the building are unique. Even the design for the floors has drawn heavily on high technology. Developed with reference to the aerospace industry, the floors can be compared to those [2] of a Boeing 747.



But perhaps the most interesing feature about this project is that most of the building is pre-constructed off-site and will be transported at a later date to the actual building site for **assembly**. One example of this [3] is the service **modules.** Unlike a more conventional building, where [4] the services would be located in a central core, the main services in the new building are 'outboard', i.e. on two sides of the building.

The 139 modules, which [5] are made in Japan, come in two lengths of 30 feet and 40 feet. The 30-foot modules are fitted on the east side of the building and generally contain toilets at the front end and auxiliary plant such as heat exchangers, extract fans and hot and cold water storage at the back. The toilets arrive on site completely fitted out down to the light fittings, ashtrays and toilet-roll holders. The longer modules are **installed** on the west side of the building. They [6] also contain toilets at the front, but at the back they contain plant rooms with combinations of air-conditioning plant. One of the main advantages of the modules is the speed with which they [7] can be **erected** and fitted in just four weeks.

Operations and maintenance will likewise be more efficient, and so less expensive than in a conventional building. A computer system will **monitor** the building constantly to ensure that each individual component is functioning efficiently, that energy is not being wasted, and that nothing is about to fail. Low-intensity energy lighting and exterior cladding will keep the heat low, reducing operating costs of the building.

[1] "Excerpt" from **Technical English for Industry** by C. ST J. Yates A Fitzpatrid pages 67-68

UNIT 6
THE BIRTH OF STARS

So far as we know most of the matter in the Universe is in the form of stars. The majority of stars, including our Sun, are clouds of gas which are maintained at a high temperature by the energy liberated by thermo-nuclear reactions in their centres. Most of our knowledge of stars and how they evolve comes from the study of the visible light they emit. The birth of stars, however, cannot be followed by an optical telescope, since it takes place in regions of space from which light cannot escape. To study this process, therefore, astronomers have to make use of telescopes operating at other wavelengths. The recent technical developments in radio, millimetre-wave and infra-red astronomy have turned the study of star-formation into one of the most exciting areas of astronomy.

The birth of a star is a rare, slow event; all but a very few of the stars visible to the naked eye have existed longer than mankind. We must therefore first consider the evidence that new stars are now being formed at all.

The energy which a normal, so-called 'main sequence' star radiates into space is generated by the conversion of hydrogen to helium. If we compare the mass of hydrogen 'fuel' in a main-sequence star with the rate at which energy is being emitted we can estimate its potential lifetime. It is found that the main sequence lifetime of a star depends strongly on its mass; low mass stars are small, cool and long-lived, while high mass stars are large, hot and short-lived. Our sun is now half-way through its total main sequence lifetime of 10^{10} years, but a star with a mass thirty times greater than the Sun would live for only a few million years. The fact that such bright stars are seen to exist now implies that star formation must have taken place over the past few million years; since our Galaxy is some ten thousand million years old it is therefore reasonable to assume that somewhere in the galaxy the same process is taking place even now. Moreover, the fact that these hot bright stars are almost always found in the vicinity of interstellar gas clouds leads us to conclude that it is out of such clouds that new stars condense.

The evolution of a cloud of interstellar gas depends on a balance between internal gravitational forces tending to make it contract, and thermal pressure tending to make it expand. James Jeans, in 1926, first showed that a cloud of a given temperature and density can collapse only if its mass is greater than a certain minimum value; a typical cloud with a temperature of 100 K and a density of 100 hydrogen atoms per cu cm has to be 3000 times more massive than the Sun in order to start collapsing. However, later theoretical work showed that once the collapse process has started and the density has risen significantly, fragmentation into progressively smaller cloudlets (protostars) is possible These cloudlets eventually collapse to form individual stars. The theory of gravitational condensation therefore predicts, in agreement with observation, that new stars form in clusters containing hundreds of thousands of stars rather than as isolated entities.

Unit 6

Recognition

1 Word recognition by shape

Which of these words are correctly spelled? Underline the correct one(s).

Timed activity

evolition evollution evolution evolution

connversion converson canversion conversion

astronomer astronnomer astronommer astronomer

interstelar intrestellar interstelar interstellar

temprature temperaturre temmperature temperature

fraggmentation fragmentation frogmentation fragmentation

conndensation condennsation condensation condensation

theretical theorretical theoretical theoretical

thermonuklear therrmonuclear thermonuclear thermmonuclear

observeation obbservation observattion observation

2 Word recognition by context

Here are some phrases from the text. Each short line stands for one missing letter. The words in italics will help you.

Timed activity

a. Stars are main__ __ __ __ __ __ at a high temperature (*kept*)

b. It takes place in reg__ __ __ __ of space from which light cannot escape (*areas*)

c. a cloud of a gi__ __ __ temperature (*stated*)

d. They ev__ __ __ __ __ __ __ __ collapse to form individual stars (*finally*)

e. The theory pre__ __ __ __ __ that (*forecasts*)

f. We must the__ __ __ __ __ __ consider the evidence that (*for that reason*)

Now use your dictionary to check the words you have written.

3 Word recognition by derivation

Complete this box where possible:

Timed activity		
convert	convertible	conversion
imply		
assume		
		evidence
radiate		
		evolution
		condensation
		fragmentation
exist		

Now use your dictionary to check the words you have written.

4 Word recognition by synonym

After each of the following sentences there is a choice of three words. Pick the word that is closest in meaning to the word in italics as used in the sentence.

a. The temperature of stars is maintained by the energy *liberated* by thermonuclear reactions in their centres.
produced/freed/given up

b. Our knowledge of stars and the way they *evolve* comes from the study of the visible light they emit.
grow/age/develop

c. The theory predicts that new stars form in *clusters* of hundreds or thousands of stars. *areas/series/groups*

d. The energy which a star *radiates* into space is generated by the conversion of hydrogen to helium.
emits/creates/heats

e. If we compare the mass of hydrogen in a star with the *rate* at which energy is being emitted, we can estimate its potential lifetime.
volume/amount/speed

Structure

5 Sentence structure

Groupwork

Look at the five sentences you have studied in the previous question. Use the ideas in them to complete these sentences.

a. The energy radiated . . .

b. A comparison . . .

c. It is from . . .

d. The formation . . .

Here are some sentences connected with the text. Make a sentence to follow each one using the phrases given.

1. The composition of stars is well established.

in their centres
the majority
which are maintained at a high temperature
including our Sun
are clouds of gas
by thermonuclear reactions

2. The birth of stars cannot be followed by an optical telescope.

astronomers have to make use of telescopes
to study this process
therefore
other than those of visible light
operating at wavelengths

3. This is not a simple process.

on a balance between
and
internal gravitational forces
the evolution of a cloud of interstellar gas depends
tending to make it expand
tending to make it contract
thermal pressure

4. A cloud of a given temperature and density can collapse only if its mass is greater than a certain minimum value.

the density has risen significantly
recent theoretical work has shown
fragmentation into progressively smaller cloudlets is possible
that
once
the collapse process has started and

Interpretation

6 Search reading

Look at these questions, then read through the passage quickly to try to find the answers.

Groupwork. Discuss your answers.

a. What is the effect of the thermonuclear reactions at the centre of the stars?

b. Why can an optical telescope not be used to study the birth of stars?

c. Have techniques for studying the birth of stars been available long?

d. Are most stars relatively old or relatively young compared to mankind?

So far as we know most of the matter in the Universe is in the form of stars. The majority of stars, including our Sun, are clouds of gas which are maintained at a high temperature by the energy liberated by thermonuclear reactions in their centres. Most of our knowledge of stars and how they evolve comes from the study of the visible light they emit. The birth of stars, however, cannot be followed by an optical telescope, since it takes place in regions of space from which light cannot escape. To study this process, therefore, astronomers have to make use of telescopes operating at other wavelengths. The recent technical developments in radio, millimetre-wave and infra-red astronomy have turned the study of star-formation into one of the most exciting areas of astronomy.

The birth of a star is a rare, slow event; all but a very few of the stars visible to the naked eye have existed longer than mankind. We must therefore first consider the evidence that new stars are now being formed at all.

7 Text completion

As you read, choose the word from each group of words in italics which completes the passage best. N.B. ø means that no word is necessary.

Timed activity

The energy which a normal, so- (1) *names/called/labelled* 'main sequence' star radiates into space (2) *are/be/is* generated by the conversion of hydrogen (3) *to/from/by* helium. If we compare the mass (4) *from/of/to* hydrogen 'fuel' in a 'main-sequence' star (5) *at/ø/with* the rate at which energy is (6) *being/made/having* emitted we can estimate its potential (7) *length/time/lifetime*. It is found that the main (8) *sequence/part/ø/* lifetime of a star depends strongly (9) *in/at/on* its mass; low mass stars are small, (10) *hot/young/ø/* cool and long-lived, while high

mass (11) *stars/lifetimes/length* are large, hot and short-lived. Our (12) *star/lifetime/sun* is now half-way through its total (13) *ø/main/long* sequence lifetime of 10^{10} years, but a (14) *length/star/rate* with a mass thirty times greater (15) *as/than/like* the Sun would live for only (16) *a/ø/the* few million years. The fact that (17) *this/our/such* bright stars are seen to exist (18) *must/can/now* implies that star formation must have (19) *taken/had/held* place over the past few million (20) *years/days/weeks*; since our Galaxy is some ten (21) *ø/million/thousand* million years old it is therefore (22) *likely/good/reasonable* to assume that somewhere in the (23) *star/galaxy/year* the same process is taking place (24) *but/here/now*. Moreover, the fact that these (25) *cold/small/hot* bright stars are almost always found (26) *at/in/on* the vicinity of interstellar gas clouds (27) *leads/obliges/must* us to conclude that it is out (28) *from/ø/in* of such clouds that new stars (29) *make/create/condense*.

8 Speed reading

Read this section as quickly as you can. After it you will find a number of questions. Select the best answer to each question as quickly as you can. Keep a record of your score and the time it takes you to complete the exercise.

The evolution of a cloud of interstellar gas depends on a balance between internal gravitational forces tending to make it contract, and thermal pressure tending to make it expand. James Jeans, in 1926, first showed that a cloud of a given temperature and density can collapse only if its mass is greater than a certain minimum value; a typical cloud with a temperature of 100 K and a density of 100 hydrogen atoms per cu cm has to be 3000 times more massive than the Sun in order to start collapsing. However, later theoretical work showed that once the collapse process has started and the density has risen significantly, fragmentation into progressively smaller cloudlets (protostars) is possible. These cloudlets eventually collapse to form individual stars. The theory of gravitational condensation therefore predicts, in agreement with observation, that new stars form in clusters containing hundreds of thousands of stars rather than as isolated entities.

1. The evolution of a cloud of gas into a star depends on

a. gravitational forces.

b. thermal pressure.

c. the interplay between a and b.

2. It has been

a. argued

b. hypothesized

c. established

that a typical cloud must be 3000 times more massive than the Sun in order to start collapsing.

3. The views held by astronomers as a result of James Jean's work in 1926 were

a. confirmed by

b. modified in the light of

c. shown to be completely false by

later theoretical work.

4. Individual stars are made

a. in isolation.

b. from the progressive collapse of clouds of gas.

c. from the Sun.

5. The theory of gravitational condensation is

a. supported by

b. disproved by

c. irrelevant to

observation.

Structure

9 Text structure

Look at the sections of text you studied in Exercise 6 (Search reading) and Exercise 7 (Text completion). What do you think is the function of the text in Exercise 7?

a. To provide background information about the way stars are born?

b. To show how difficult it is to study the birth of stars?

c. To support the idea that stars are now in fact being formed?

Now look at the third section of the text in Exercise 8 (Speed reading). What link does this have with the rest of the passage?

1. It develops a point made in the first section.

2. It argues against a point made in the second section.

3. It develops a point made in the second section.

UNIT 18
GENES IN ACTION

The text for this unit is not printed here. If you work throught the exercises, you will be able to build up the text for yourself. The full text is printed at the back of the book, on page 108.

Structure

1 Paragraph structure

1. Here are some sentences that make up the first paragraph of the article. Put them in the right order.

a. The latter is, of course, the central technique of genetic engineering, and it is clear that many laboratories are poised to launch scores of experiments once the problems relating to the control of such experiments are fully worked out.

b. There are two keenly productive areas of research at the moment.

c. The prodigious output from these two areas is linking in with many other aspects of gene regulation, creating for the first time a real chance of an insight into the way genes are selectively active in controlling the development of complex organisms.

d. The past few months has been a busy time for biologists probing the molecular basis of genetic machinery in higher organisms.

e. The first follows from the breakthrough in elucidating the detailed organisation of the nucleic acid (DNA) strands and their associated proteins; and the second rests on the newly developed ability to snip out segments of genes so that they can be studied in the relatively simple environment of a bacterial cell rather than in the daunting complexity of the nucleus of a higher organism.

2. Now do the same with these sentences. They make up a paragraph to follow on from the one you have just made.

a. Genes coding for proteins (known as structural genes) are turned on and off by the action of adjacent controlling elements which respond to regulating substances in the cell.

b. In general terms this turns out to be correct, but for many reasons, some of which are clear while others are frankly abstruse, the whole system is many times more complicated in higher organisms.

c. During the 1950s and 60s molecular biologists managed to work out many of the details of gene regulation in bacteria, *Escherichia coli* being the organism under closest scrutiny.

d. This, basically, is the scheme which earned Jacques Monod, Francois Jacob and Andre Lwoff their Nobel Prize in 1965, and they proposed it to be the probable basis of gene control in higher organisms too.

e. In *E. coli* about 1000 genes are strung together in a single chromosome.

3. Groupwork

Discuss your answers to 1 and 2.

4. Groupwork

Find the sentences from Questions 1 and 2 in which the author does these things:

a. Explains what the two main areas of genetic research are.

b. Describes the genetic construction of *E. coli.*

c. Describes some of the background to current work in genetic studies.

d. Looks forward to future developments in genetic studies.

5. What do you think is the most important idea in each of these two paragraphs? How does the author make a link between the two paragraphs? What do you think the next paragraph might be about?

Interpretation

2 Text completion

1. Here is the next part of the text. Think of suitable words to fill in the blanks. Each blank represents one missing word.

One of the simplest differences between single-(1)_____ multi-cellular creatures is that in the latter (2)_____ cells become specialized to perform particular functions— (3)_____ are differentiated. This means that in these (4)_____ not only does the genetic material have (5)_____ contain the information required for the specialized (6)_____ but it also carries in a switched-off (7)_____ the genetic information for all the other (8)_____ activities. For instance, in mammalian cells only (9)_____ 10 per cent of the genome (the (10)_____ genetic component) is active. As organisms grow (11)_____ an unspecialized fertilized egg, sections of the (12)_____ of genetic information have to be shut (13)_____ in a controlled fashion so as to (14)_____ liver cells, blood cells or muscle fibres, (15)_____ example (not to mention the problem of (16)_____ that the right cells finish up in (17)_____ right place at the right time!).

2. Were you right in your prediction of the topic? Can you see any link between the paragraphs you have studied?

3. Which blank space could these words go in? They are *not* the words from the original text.

role form approximately bank

3 Paragraph development

Here is the next paragraph of the text. Read it quickly.

At a recent meeting Walter Gehring, from Basle, pinpointed some aspects of cell differentiation when he described the early development of the fruit fly, *Drosophila.* After the egg is fertilized the nucleus begins dividing, going through eight divisions before anything else happens. At this stage the embryo is simply a single bag of nuclei. The nuclei then begin to migrate, forming a single layer on the inner surface of the bag, apart from one end where a clump of cells accumulates. Some of the cells in this group eventually form the germ cells in the adult fly.

1. Gehring's work, described here, does which one of these things?

a. It contradicts what was said earlier in the passage.

b. It proves the difficulties of research in this area.

c. It is an example of work done in an area introduced earlier in the passage.

d. It shows that fruit flies are very complex insects.

2. What is the purpose of the first sentence in the context of the paragraph? How do the other sentences relate to it?

4 Speed reading

Here are the next three paragraphs of the text. But they are in the wrong order. How quickly can you sort them out?

a. Whatever molecular mechanisms are involved in this stepwise determination, the final product—the differentiated cell—is remarkably stable in terms of genetic expression. In other words, it is not easy to persuade a muscle cell to become anything else once it has assumed that role. Plant nuclei, on the other hand, are much more labile, and it is possible to raise a whole new plant from a single differentiated cell.

b. There is clearly a delicately balanced relationship between the state of the pre-germ cell nuclei and the position in which they find themselves. For instance, although these cells can be moved to another part of the 'bag', and still finish up as germ cells, other nuclei moved into the clump do not become germ cells. However, if some of the cytoplasm which bathes the cells in the clump is transferred to another part of the periphery, the cells now in contact with the cytoplasm become germ cells.

c. Gehring and his colleagues are currently analysing the contents of the cytoplasm to discover what substances are performing the regulatory role. They have found two proteins which bind with specific parts of the DNA, offering the possibility eventually to map

the areas in the genome involved in this early regulation. Similar events to this early stage are likely throughout the development of the embryo, events being controlled, probably, through a hierarchy of genes.

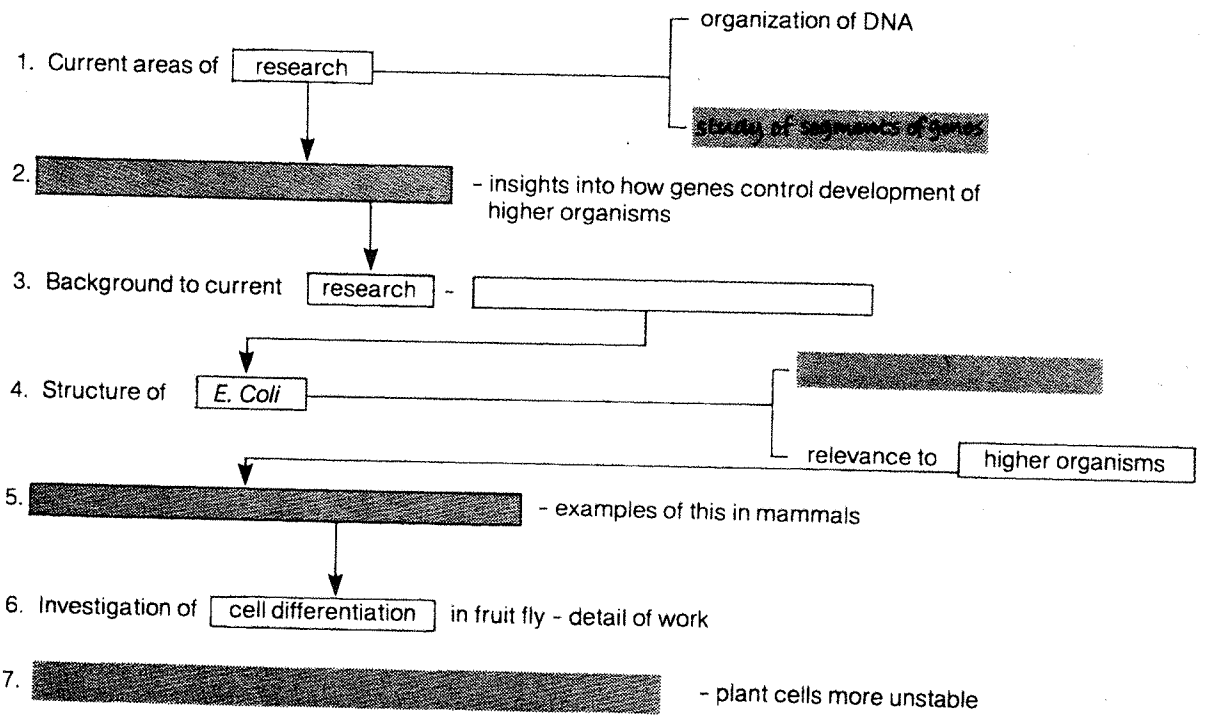
5 *Themes*

Here is an outline of the article you have just constructed showing the main themes and how they are connected.

Fill in the blanks using the following labels. The first has been filled in for you.

work in 1950s and 60s on *E. Coli*; Higher organisms show cell differentiation; study of segments of genes; importance of research in these areas; outline of structure; contrast between behaviour of animal and plant cells.

The whole text of the article is printed at the back of the book. Read it if you need help.



The One and Only You[1]

Passwords and personal codes are daily necessities. We need **them**[1] for cash machines, credit cards, e-mail accounts, and maybe for the front door to the office or apartment, too. Forgetting them is inconvenient; losing them to a thief can be costly. You'd think there would be a better way to allow secure access—proof of identity **that**[2] cannot be lost or forged or stolen, does not have to be committed to memory, and is unique to every individual.

Such systems exist. For the past 20 years, engineers have been refining computer-based devices capable of distinguishing one person from another by sampling physical characteristics--for instance, speech patterns, fingerprints and palmprints, and the unique structures in the retina and iris of the eye. The field, a branch of the security industry, has a suitably technical name : biometrics. **It**[3] refers to the use of mathematical representations of human characteristics **that**[4], when matched against previously stored data, provide an effective method of verifying a person's identity.

Recently, Singapore's Changi International Airport introduced an automated immigration checkpoint **that**[5] incorporates biometric techniques. The trial project allows holders of special "smart cards" containing personal fingerprint data to clear immigration in a matter of seconds. Participants simply pass **their**[6] card through a machine while pressing their thumb against an optical scanner. If the print matches the digital record stored on the card, the traveler is afforded swift passage, (i.e. he is allowed to pass through quickly).

The technology is finding its way into the personal computer industry, too. Scanners-on-a-chip appear ideal for use in notebook computers, cellular phones, and personal digital assistants. Incorporated into a computer monitor or keyboard, fingerprint-recognition features would add only about $50 to the cost of a PC. Software researchers have also developed inexpensive programs **that**[7] enable a desktop PC, equipped with an inexpensive video camera, to "recognize" the face of its user—no password required.

The solutions each have drawbacks. Face recognition is still not fully reliable. Optical fingerprint scanners can be duped by a plastic mold of a fingerprint or thrown off by moisture on the hands. To reduce error, American manufacturer Diebold unveiled a prototype automated teller machine **that**[8] uses both face and voice recognition as a biometric screening device. By combining different methods, "at least one will work," says Jackie Fenn, an analyst with market research firm Gartner Group. "The real advantage," Fenn says, "is you are much surer the person is who he says he is"

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1. adapted from "The One And Only You - Bio - sensing identification systems push ahead" by Andrea Hamilton. Asiaweek. March 27, 1998.

Electric Motor

Objectives: In this unit, you will learn to:

1. identify some expressions showing components and places of parts: **consist of, composed of, connected to, joined to,** etc;
2. describe the function of something;
3. recognize the writer's purpose and the reader's purpose.

Warm-up Activity

Work in groups, list as many items as you can in the home which use electric motors. Which room has the most items?

Input

The Electric Motor

In an electric motor an electric current and magnetic field produce a turning movement. This can drive all sorts of machines, from wrist-watches to trains. The motor shown in Fig. 1 is for a washing machine. It is a universal motor, which can run on direct current or alternating current.

An electric current running through a wire produces a magnetic field around the wire. If an electric current flows around a loop of wire with a bar of iron through it, the iron becomes magnetized. It is called an electromagnet; one end becomes a north pole and the other a south pole, depending on which way the current is flowing around the loop.

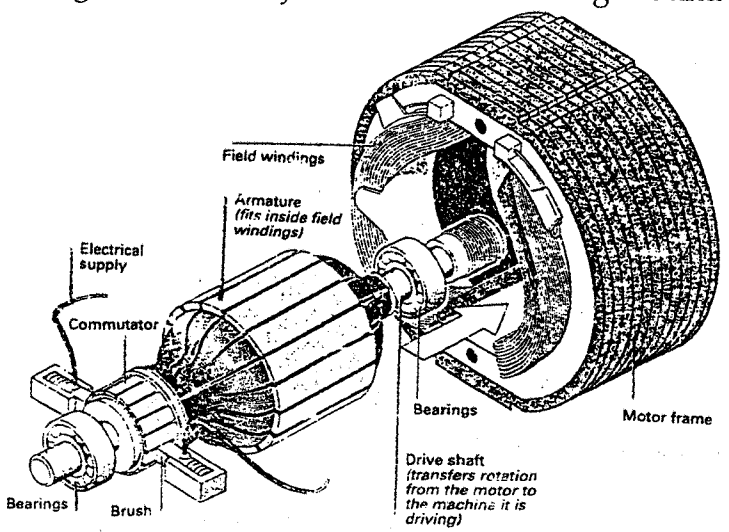


Fig. 1

If you put two magnets close together, like poles--for example, two north poles--repel each other, and unlike poles attract each other.

In a simple electric motor, like the one shown in Fig. 2 a piece of iron with loops of wire round it, called an armature, is placed between the north and south poles of a stationary magnet, known as the field magnet. When electricity flows around the armature wire, the iron becomes an electromagnet.

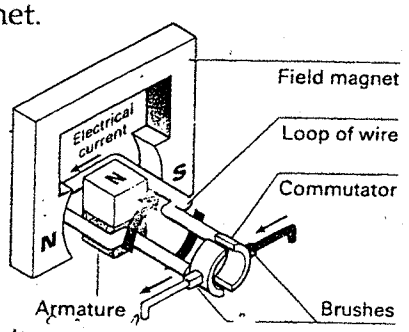


Fig. 2

The attraction and repulsion between the poles of this armature magnet and the poles of the field magnet make the armature turn. As a result, its north pole is close to the south pole of the field magnet. Then the current is reversed so the north pole of the armature magnet becomes the south pole. Once again, the attraction and repulsion between it and the field magnet make it turn. The armature continues turning as long as the direction of the current, and therefore its magnetic poles, keeps being reversed.

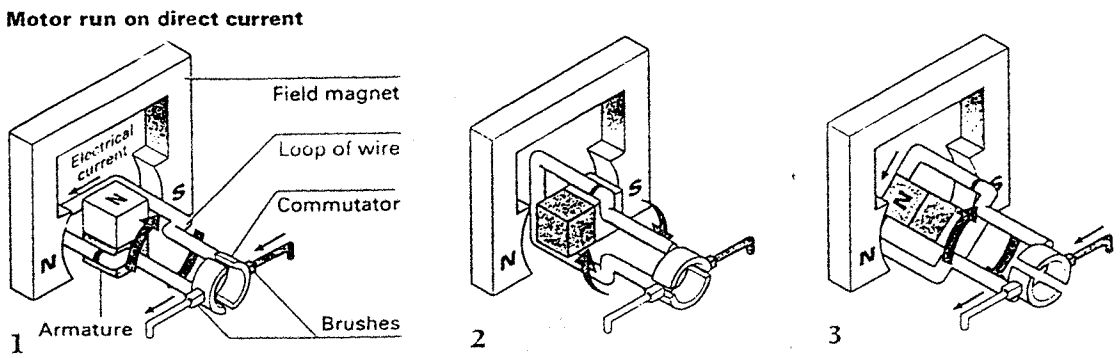
To reverse the direction of the current, the ends of the armature wire are connected to different halves of a split ring called a commutator. Current flows to and from the commutator through small carbon blocks called brushes. As the armature turns, first one half of the commutator comes into contact with the brush delivering the current, and then the other, so the direction of the current keeps being reversed.

Source: Adapted from 'Inside out: Electric Motor', *Education Guardian*

A. Skim this text and identify the paragraphs which contain information on each of these topics. The first one has been done for you

a. What electric motors are used for — paragraph 1
b. The commutator — .....
c. Why the armature turns — .....
d. Electromagnets — .....
e. Effect of putting magnets together — .....
f. The armature — .....

B. Match each of these diagrams with the correct description, A, B, C, or D. One of the descriptions does *not* match any of the diagrams.
(The diagrams are in the correct sequence, but the descriptions are not.)



..... A.
The armature turns a quarter of a turn. Then electric contact is broken because of the gap in the commutator, but the armature keeps turning because there is nothing to stop it.

..... B.
When current flows, the armature becomes an electromagnet. Its north pole is attracted by the south pole and repelled by the north pole of the field magnet.

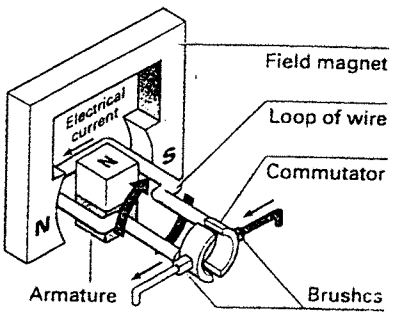
..... C.
When a universal motor is run on direct current, the magnetic poles in the armature change while those of the field magnet remain constant.

..... D.
When the commutator comes back into contact with the brushes, current flows through the armature in the opposite direction. Its poles are reversed and the turn continues.

Language Focus

Describing Components

Study this description of the motor.



A simple DC motor **consists of** a field magnet and an armature. The armature **is placed between** the poles of the magnet. The armature **is made up of** a loop of wire and a split ring **known as** a commutator. The loop **is connected to** the commutator. Current is supplied to the motor through carbon blocks **called** brushes.

To write a description, you need to use language to:

1. dismantle a piece of equipment into its main parts. These expressions will help:

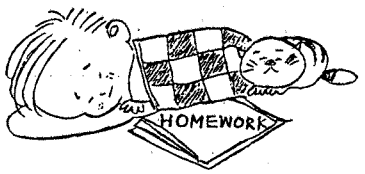
		consists of		X
A	A	**is made up of**	X and Y	
		is composed of		Y

2. name components:

	known as	
Carbon blocks		brushes.
	called	

3. locate components:
   The armature **is placed between** the poles.

4. connect components:
   The loop **is connected to** the commutator.
   is joined to



Review Exercises

Exercise 1 : Read each item below and then circle the answer which means the same as the underlined word. You can guess the meaning by looking at the words around the underlined word which help to explain its meaning in the context.

1. One thing they discovered was that both affluent families and poor families tended to waste less than those whose incomes were in between.
   a. unhappy
   b. artistic
   c. middle-income
   d. wealthy

2. The Garbage Project estimates that middle-income families waste an average of $100 a year by throwing out beef that could be eaten; this means that the city of Tucson is wasting at least $500,000 worth of edible beef each year.
   a. tasty
   b. eatable
   c. bad
   d. cheap

3. Since the snow deterred us from going ice-skating, we stayed in and watched our favourite television program.
   a. pleased
   b. stopped
   c. warned
   d. invited

4. The dog had a despondent look. His ears and tail drooped. His head was hanging low. His eyes were misty. In fact, he looked for all the world as if he were just ready to weep.
   a. sad
   b. lazy
   c. wet
   d. untidy

5. Everyone else was too afraid to move. Jason, however, the only intrepid one of the men, showed his bravery by quickly leaping forward to struggle barehanded with the beast.
   a. frightened
   b. masculine
   c. thoughtful
   d. fearless

6. I can hear quite well through these walls. The patient in the adjoining room was complaining about the decline in the standard of medical care.
   a. rational
   b. immense
   c. neighboring

7. The prisoner seemed to relax, but actually he was thinking about the possibility of escape. His eyes stared straight ahead, while his hand moved so slowly that the movement was imperceptible. It was only when the keys accidentally fell from the table that the guard suddenly realized that the prisoner's hand had almost reached them.
   a. hardly noticeable
   b. heavy-handed
   c. not capable of fast or immediate action
   d. a matter of habit

8. The Managing Director is not accessible to anyone this morning because he is at an important conference. Please make another appointment to see him.
   a. available
   b. considerable
   c. rational

9. As a result of the Company's collapse, the workers became unemployed, and all its property was sold to pay its debts.
   a. failure
   b. cooperation
   c. success

10. Superstition, or false beliefs, often inhibits progress in science.
    a. speeds up
    b. changes
    c. holds back

UNDERSTANDING REFERENCE

References are words which substitute for other words or phrases. They usually refer back to ideas that have a already been expressed, but they can occasionally refer forward to ideas yet to be stated.

Examples :

1. Mr. Schorger bought a new car. His wife hasn't seen it yet.
2. The Smiths' old television didn't work, but their new one is fine.
3. Everyone seems to think my boss is guilty. If so, she will probably resign. If not, we should apologize to her.
4. Mary thought the moon landing was a waste of money, and Martin, her husband, thought the same.
5. Although the President doesn't seem to trust the polls, everyone else does.
6. Janice liked the yellow curtains but her husband, Jack, preferred the red.
7. The chair was so well made that Ms. Grant decided to buy two

In the paragraph below discuss what these words or phrases refer to.

> Some students read slowly but don't know that they do ; others read slowly and know it. Their reading problems are the same, but the latter can be helped more easily because they are already aware of their problem. Before the former can be helped, however, they must be made aware of the problem.

they: _____

do: _____

others: _____

it: _____

Their: _____

the same: _____

the latter: _____

they: _____

their problem: _____

the former: _____

they: _____

the problem: _____

Exercise : After each passage write what the italicized reference words refer to.

1. We expected the teacher to be angry, but *such* was not the case.
   such : _____
2. While my wife's car is in the garage, she is using *mine*.
   mine : _____
3. The voters have heard many extravagant promises in the past, but this *one* was perhaps the greatest of *all*.
   one : _____
   all : _____
4. In 1962, an earthquake struck Iran. *The same* happened also in 1968, 1972, and 1977.
   The same : _____
5. Although we have only one mouth for tasting and one nose for smelling, we have two eyes for seeing and two ears for hearing. Stereo is the reason — the perception of depth. Almost every living thing shares *this characteristic* with us because *it* is necessary for survival.
   this characteristic : _____
   it : _____
6. Last summer we spent our holiday at old Orchard Beach. *It* was the best holiday we ever had *there*.
   It : _____
   there : _____
7. Some people still believe that Shakespeare could not have written the plays attributed to him, but *they* have difficulty explaining the fact that many contemporaries, *who* knew and worked with *him*, considered Shakespeare the actual author, and a very fine author indeed.
   they : _____
   who : _____
   him : _____
8. A mosquito, filled up on blood, manages to fly off carrying twice its own weight. *To do this*, it beats its wings more than 300 times a second.
   To do this : _____
9. Smoking can be dangerous to your health. *It* is also expensive.
   It : _____
10. Why would anyone want to buy a big, expensive, gas-guzzling car these days? *This* is something I can't understand.
    This : _____
11. In December 1941 almost the entire United States Pacific fleet was anchored at Pearl Harbor. I can't understand *why*.
    why : _____
12. Some newspapers think there'll be a serious earthquake in California soon, but I don't think *so*. At least I certainly hope *not*.
    so : _____
    not : _____
13. In their early years in Washington the members of Congress expect to accomplish a lot. They are very idealistic *then*.
    then : _____

Appendix C

Reading test

Read the following passages and answer the questions or unfinished statements that follow. You must choose the one which fits best. Give one answer only to each question.

Passage I

There are a number of folk remedies for common **ailments** that villagers swear are effective. Medical doctors have other opinions. The determining factor is one's distance from a doctor. If none are around, do what the villagers do to relieve the pain.

The two most common swimming accidents are encounters with jellyfish and with sea urchins. Jellyfish are most prevalent in the monsoon season when sea winds blow them towards the shore.

The jellyfish floats on the surface, or just beneath it, dangling its long, poison-filled tentacles deep in the water to stun fish that accidentally brush against them. When the swimmer comes into contact with **one**, he **is rewarded** with a sharp, searing pain, usually in a long line that reddens and forms a welt. The full effect of the burn does not become evident until four or five hours later. The pain can be reduced by bicarbonate of soda or steroid cream rubbed gently over the affected area. Even then, it will continue to hurt and may leave scars.

Villagers treat jellyfish stings with a leafy vine that grows along the edge of the beach. They crush **it** to release its juice and then clamp it onto the affected area. The chemicals in the plant work to neutralise the chemical poisons of the jellyfish.

The other main affliction is from sea urchin spines. The wader steps on the animals and drives their sharp spines into his foot. The spines are **brittle** which makes removing them difficult. The pain comes more from the foreign object embedded in the foot, than from the mild poison in the spines. Doctors will use a scalpel to incise **them** and tweezers to pull them out.

Villagers simply take a large stone to crush the spines, arguing that the pain goes away quickly and that with time; the crushed bits will work themselves out of the foot. Doctors suggest that pounding the foot with a stone will only drive the spines deeper and perhaps cause a secondary infection.

Both the villagers and doctors agree that the spines must be removed quickly. If the swimmer isn't carrying a scalpel with him and he is far from the doctor, he may want to try a local method which, as many foreigners who have used it attest, seems to work without unpleasant after effects. The area should then be swabbed with Mercurochrome and covered with a gauze pad.

One method to reduce the pain is to hollow out a large coconut and urinate into it. The foot is immersed in the urine and the uric acids counteract the poison. Obviously to make it more effective you get by with a little help from your friends.

1. The word 'brittle' means _____
   a. slippery
   b. small and sharp
   c. hard and easily broken
   d. soft and easily broken

2. According to paragraph 3 which statement is correct?
   a. The jellyfish is a kind of deep- water fish.
   b. The burn caused by a jellyfish will show after four or five hours.
   c. As a matter of fact, the pain is caused by chemicals.
   d. Villagers believe that eating some kinds of leaves can relieve the pain.

3. The phrase 'is rewarded' means_____
   a is stung
   b. is wrapped
   c. faints
   d. receives a prize

4. The part of the jelly-fish mentioned as poisonous is its _____
   a. body
   b. meat
   c. top part
   d. string-like part

5. Which statement is correct according to paragraphs 1 and 2?
   a. The villagers' remedy for certain kinds of diseases is to take an oath.
   b. Medical doctors usually agree with the villagers in reducing pain.
   c. The writer introduces two kinds of accident involving two kinds of animals.
   d. The writer believes that the villagers' treatments in reducing pain are better than those of medical doctors.

6. The word 'ailments' means_____
   a. treatment
   b. illnesses
   c. carries
   d. medicines

7. Who makes the suggestion about using the villagers' method if there is no doctor nearby?
   a. the villager
   b. the doctor
   c. the visitor
   d. the writer

8. The villagers' method of reducing the pain from the urchin spine is to _____

a. crush the urchin with a large stone
b. pound the spines in the foot with a large stone
c. make a cut in the foot and take the spines out
d. pound the foot and use tweezers to pull the spines out

9. The pain from urchin spines is caused by _____

a. the spines rather than the poison in them
b. the poison in the spines rather than the spines themselves
c. the bite rather than the spines and the poison
d. the operation rather than the poison

10. According to the last paragraph, the pain can be reduced by _____

a. putting the foot in a large coconut with urine in it.
b. pouring coconut juice onto the foot and then urinate on it
c. urinating on the foot and then pouring the coconut juice on it.
d. mixing coconut juice with urine and putting the foot in it

11. According to the whole passage, the writer believes that

a. the villagers' methods are better than the doctors'.
b. the doctors' methods are better than the villagers'.
c. both methods are equally good.
d. neither method can be used effectively.

12. What is the most appropriate title for this passage?

a. Local Healing Methods
b. Horrors of the Beach
c. Treatments for Sea Injuries
d. Medical Advice

13. The underlined word 'one' in paragraph 3 refers to _____

a. a jellyfish
b. an urchin
c. a reddened welt
d. a sharp pain

14. The underlined word 'them' in paragraph 5 refers to _____

a. sea urchins
b. sea urchin spines
c. embedded objects
d. tweezers

15. The underlined word ' it' in paragraph 4 refers to _____

a. a leafy vine
b. a jellyfish sting
c. a sea urchin
d. a jelly fish

Passage II

Discarded oyster shells are to be used to clean household waste water in a prototype plant being built in Japan. The plant will purify water that would otherwise pollute local beaches. "Oyster shells harbour large numbers of anaerobic and aerobic microbes on their surfaces," says Toyokuni Asahino, one of the plant's designers at the Kesennuma City Council. "Dirty water is food for **these microbes**."

The £3.5 million prototype is being built on Oshima, an island 200 kilometres north of Tokyo where oysters are farmed, and is due to start working in March 2000. About 250 tonnes of shells will be required annually to maintain layers 4 metres deep in the plant's six filtration tanks. Filthy kitchen, bath and laundry water from 265 households will be filtered through the tanks, passing through each in turn.

The more organic waste there is in water, the more oxygen micro-organisms need to break **it** down. Untreated waste water on Oshima has a biochemical oxygen demand (BOD) of about 200 parts per million, but this should be reduced to less than 20 ppm after the water has been filtered through the oyster shells, Asahina says. **Suspended solids** will be reduced from 200 ppm to less than 50 ppm.

Micro-organisms are already widely used to treat water, but the new plant should be more effective than gravel beds and will provide a use for hundreds of tonnes of waste shells. Another advantage is that oyster shells make acidic waste water alkaline, providing a perfect environment for the micro-organisms.

(New Scientist, January, 1999)

16. Which statement best represents the main idea of the text?
    a. Oyster shells are used to clean waste water in Japan.
    b. Oyster shells are effective micro-organisms to treat waste water.
    c. Oyster shells turn acidic waste water into alkaline.
    d. The £3.5 million prototype is being built near an oyster farm in Japan.

17. How do the oyster shells clean the waste water?
    a. Dirty water is food for oysters.
    b. Oyster shells break down dirt into anaerobic and aerobic microbes.
    c. Anaerobic and aerobic microbes on oyster shells consume dirty water.
    d. Oyster shells provide more oxygen into water.

18. How do they use the oyster shells to clean wastewater?

a. Discard them in waste water.
b. Harbour them to produce anaerobic and aerobic minerals.
c. Use them as treatment plant filtration.
d. Layer them on gravel beds in a treatment plant.

19. Suspended solids will be reduced from 200 ppm to less than 50 ppm. What do suspended solids refer to?

a. Oyster shells in the filter plants.
b. Anaerobic and aerobic microbes on the surface of oyster shells.
c. Organic waste in untreated waste water.
d. Biochemical waste discovered in untreated waste water.

20. The more organic waste is in water, the more oxygen oyster micro-organisms need to break it down. What does it refer to?

a. Organic waste.
b. Waste water.
c. Oxygen micro-organism.
d. Aerobic micro-organism.

21. Which one is not an advantage of using oyster shells to treat waste water?

a. More effective than other micro-organisms.
b. Provide a use for hundreds of tons of waste shells.
c. Reduce biochemical oxygen demand.
d. Make acidic waste water alkaline.

22. What is the most appropriate title for this passage?

a. Discarded Oysters Pollute the Beach
b. Discarded Oysters Take a Part in Cleaning Water
c. Discarded Oysters Contribute to Waste Water
d. Discarded Oysters Play a Role in Providing Micro-organism

23. 'Dirty water in food for these microbes'. These microbes refer to...

a. larvae oyster
b. anaerobic and aerobic microbes on oyster shell surfaces
c. micro-organisms used to make acidic waste water alkaline
d. micro-organisms which pollute the beach

Passage IV
Who needs a real body?

For decades, virtual organs were one of medicine's pipe dreams. But powerful new computers, and a better understanding of how the heart and other body parts are made up cell by cell, are making such lifelike simulations a reality. In 1999 computerised models of the heart, lung and pancreas will be available for pharmaceutical companies to test their latest blockbuster drugs.

A computerised heart is already in action. An American company called Phisiome Sciences has produced a virtual heart made not of flesh and blood but of thousands of mathematical equations which describe how the organ's biochemical and electrical activities culminate in a heartbeat. These equations are combined with a detailed blueprint of the heart's architecture to create a visual model **which** swells and surges on its own, just like a living heart.

The virtual heart is so real, and so reliable, that a Swiss drug company, Roche, has used it to test one of its new medicines for cardiovascular disease. Scientists are also studying the model to understand how new genetic mutations, which affect essential heart proteins can cause lethal conditions such as cardiac arrhythmia and congestive heart failure. **These are common disorders** which drug companies would dearly like to treat with profitable new products. The virtual heart allows medicines to be tested and refined in cyberspace, boosting their benefits and reducing their nasty side effects. The proof, of course, still lies in the patient.

Phisiome is also building a virtual pancreas and lung, which will be ready for drug developers by the end of 1999. Other enterprising scientists are preparing computer models of the liver, kidney, immune system, circulatory system and gut. By early in the next century, scientists will have connected these and other models together into a virtual human body, which they can use to study physiology in ways simply not practical (or ethical) in living patients. One-day, click and drag, rather than cut and tear, will be all it takes to probe the body's inner workings.

(The Economist, The World in 1999)

24. According to the first paragraph what do people in the medical world want to make?
    a. medical simulations
    b. powerful new drugs
    c. virtual organs
    d. tests for blockbuster drugs

25. What is a computerised heart?
    a. a virtual reality model which shows how the heart works
    b. a biochemical, mechanical and electrical heart
    c. a lifelike simulation of mathematical equations which describes the activities of the heart
    d. a combination of visual model and a living heart

26. "These equations are combined with a detailed blueprint of the heart's architecture to create a visual model, **which** swells and surges on its own". The underlined 'which' refers to...

a. the equations
b. a blueprint
c. a 'visual' model
d. a living heart

27. The computerised heart is used by Roche to test

a. reducing side- effects of new drugs.
b. the effect of essential heart protein.
c. a new medicine for cardiovascular disease.
d. new genetic mutations which might cause lethal conditions.

28. "**These are common disorders** which drug companies would dearly like to treat....." The underlined phrase refers to

a. cardiovascular diseases
b. genetic mutations
c. essential heart proteins
d. cardiac arrhythmia and congestive heart failure

29. What does the third paragraph tell us about the virtual heart?

a. The virtual heart is so real and so reliable that it can be used to test drugs.
b. The paragraph gives more detail of understanding of how the heart is made up cell by cell.
c. The virtual heart reacts with the heart proteins, which can cure lethal conditions.
d. The virtual heart can be used to test new drugs but the real effects work on the human body.

30. What is the author's idea about a virtual body ?

a. It will be useful to test new drugs.
b. It will be useful for a better understanding of diseases.
c. It will make it easier to conduct operations.
d. It can only be used in cyberspace.

ANSWER SHEET

NAME _____ GROUP _____

1. a b c d
2. a b c d
3. a b c d
4. a b c d
5. a b c d
6. a b c d
7. a b c d
8. a b c d
9. a b c d
10. a b c d
11. a b c d
12. a b c d
13. a b c d
14. a b c d
15. a b c d
16. a b c d
17. a b c d
18. a b c d
19. a b c d
20. a b c d
21. a b c d
22. a b c d
23. a b c d
24. a b c d
25. a b c d
26. a b c d
27. a b c d
28. a b c d
29. a b c d
30. a b c d

Appendix D

Indexes of test difficulty and reliability

```
**********************************************************
*                                                        *
*                  C T I A /GRADING 7.0                  *
*                                                        *
*          WRITTEN BY DR. SUPHAT SUKAMOLSON, Ph. D.      *
*                                                        *
*        LANGUAGE INSTITUTE, CHULALONGKORN UNIVERSITY    *
*                                                        *
**********************************************************

* * * C L A S S I C A L  T E S T  I T E M  A N A L Y S I S  7.0 * * *
```


REFERENCES :1. SUPHAT SUKAMOLSON, NEW TECHNIQUES FOR COMPUTERIZED ITEM ANALYSES, BANGKOK: WITTHAYAPHAT Co. Ltd., 1995.

2. SUPHAT SUKAMOLSON, COMPUTERIZED ITEM ANALYSES AND GRADING, BANGKOK: WITTHAYAPHAT Co. Ltd., 1998.

PILOT36 CONTROL PARAMETERS

```
      TOTAL ITEMS  30
    ITEMS ANALYZED  30
         FROM ITEM   1
           TO ITEM  30
     NUMBER OF CHOICES  4
     NON-STANDARD INPUT FORMAT
       RAW SCORES PRINTED
    RANKED SCORES PRINTED - STD SCORES ARE PERCENTAGES

       ALPHABETIC ANSWER KEYS

KEYS              CBADCBDBAACCABCACCCAACBACCCDDD

 CBADC BDBAA  CCABC ACCCA  ACBAC CCDDD
```

PILOT36 RAW SCORES

IDENTIFICATION	SCORE	LAST ANSWER	ITEMS OMITTED OR IN ERROR(*)
AA	18	30	
AB	24	30	
AC	9	30	
AD	8	30	
AE	11	30	
AF	9	30	
AG	9	30	
AH	8	30	
AI	6	30	
AJ	16	30	
AK	16	30	
AL	8	30	
AM	12	30	
AN	13	30	
AO	15	30	
AP	15	30	
AQ	10	30	
AR	15	30	
AS	14	30	
AT	16	30	
AU	19	30	
AV	20	30	
AW	14	30	
AX	14	30	
AY	8	30	
AZ	9	30	
BA	14	30	
BB	4	30	
BC	11	30	
BD	3	30	
BE	6	30	
BF	15	30	
BG	11	30	
BH	13	30	
BI	11	30	
BJ	13	30	
BK	11	30	
BL	13	30	
BM	15	30	
BN	20	30	
BO	11	30	
BP	23	30	
BQ	22	30	
BR	21	30	
BS	15	30	
BT	21	30	
BU	25	30	
BV	24	30	
BW	11	30	
BX	23	30	

PILOT36 RAW SCORES

IDENTIFICATION	SCORE	LAST ANSWER	ITEMS OMITTED OR IN ERROR(*)
BY	15	30	
BZ	15	30	
CA	14	30	
CB	14	30	
CC	17	30	
CD	18	30	
CE	7	30	
CF	16	30	
CG	17	30	
CH	14	30	
CI	15	30	
CJ	15	30	
CK	20	30	
CL	15	30	

CM	13	30
CN	15	30
CO	22	30
CP	26	30
CQ	20	30
CR	7	30
CS	16	30
CT	17	30
CU	17	30
CV	23	30
CW	10	30
CX	17	30
CY	16	30
CZ	19	30
DA	8	30
DB	12	30

PILOT36 RANKED SCORES

SCORES				SCORES				SCORES			
RANK	RAW	PERCENT	IDENTIFICATION	RANK	RAW	PERCENT	IDENTIFICATION	RANK	RAW	PERCENT	IDENTIFICATION
1	26	86.7	CP	50	13	43.3	BH				
2	25	83.3	BU	50	13	43.3	BJ				
3	24	80.0	AB	50	13	43.3	BL				
3	24	80.0	BV	50	13	43.3	CM				
5	23	76.7	BP	55	12	40.0	AM				
5	23	76.7	BX	55	12	40.0	DB				
5	23	76.7	CV	57	11	36.7	AE				
8	22	73.3	BQ	57	11	36.7	BC				
8	22	73.3	CO	57	11	36.7	BG				
10	21	70.0	BR	57	11	36.7	BI				
10	21	70.0	BT	57	11	36.7	BK				
12	20	66.7	AV	57	11	36.7	BO				
12	20	66.7	BN	57	11	36.7	BW				
12	20	66.7	CK	64	10	33.3	AQ				
12	20	66.7	CQ	64	10	33.3	CW				
16	19	63.3	AU	66	9	30.0	AC				
16	19	63.3	CZ	66	9	30.0	AF				
18	18	60.0	AA	66	9	30.0	AG				
18	18	60.0	CD	66	9	30.0	AZ				
20	17	56.7	CC	70	8	26.7	AD				
20	17	56.7	CG	70	8	26.7	AH				
20	17	56.7	CT	70	8	26.7	AL				
20	17	56.7	CU	70	8	26.7	AY				
20	17	56.7	CX	70	8	26.7	DA				
25	16	53.3	AJ	75	7	23.3	CE				
25	16	53.3	AK	75	7	23.3	CR				
25	16	53.3	AT	77	6	20.0	AI				
25	16	53.3	CF	77	6	20.0	BE				
25	16	53.3	CS	79	4	13.3	BB				
25	16	53.3	CY	80	3	10.0	BD				
31	15	50.0	AO								
31	15	50.0	AP								
31	15	50.0	AR								
31	15	50.0	BF								
31	15	50.0	BM								
31	15	50.0	BS								
31	15	50.0	BY								
31	15	50.0	BZ								
31	15	50.0	CI								
31	15	50.0	CJ								
31	15	50.0	CL								
31	15	50.0	CN								
43	14	46.7	AS								
43	14	46.7	AW								
43	14	46.7	AX								
43	14	46.7	BA								
43	14	46.7	CA								
43	14	46.7	CB								
43	14	46.7	CH								
50	13	43.3	AN								

PILOT36 SCORE STATISTICS

NO. OF ITEMS	30
RESPONDENTS	80
MEAN SCORE	14.53
STD DEVN	5.10
MEAN STD ERROR	0.574
MAXIMUM	26
MINIMUM	3
RANGE	23.00
QD	3.00
MEDIAN	15.00
MODE*	16
SK	0.01
KU	2.60

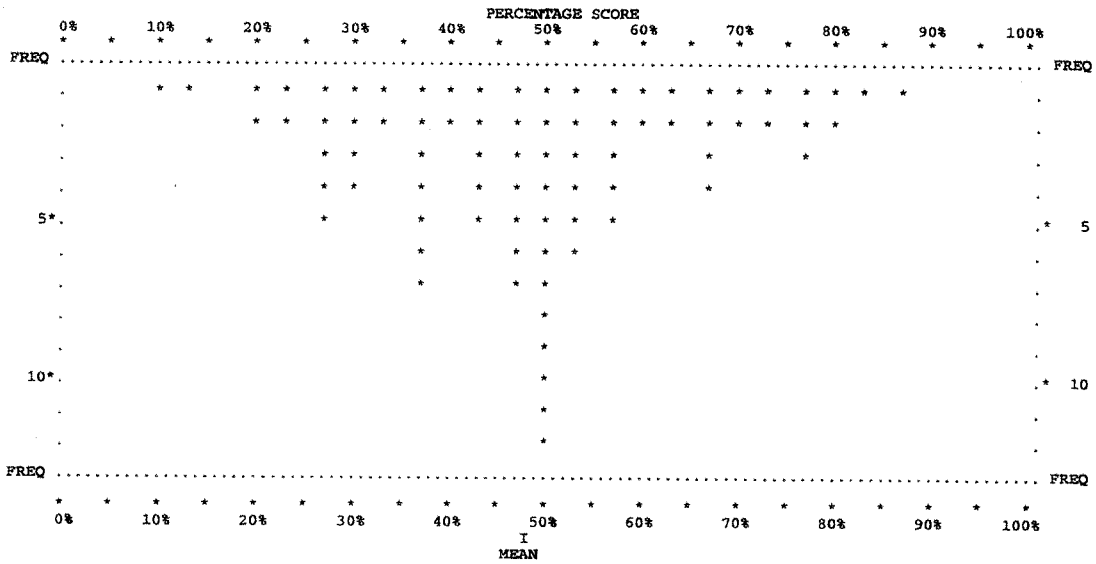
* ESTIMATED MODE,
IF THE SCORE DISTRIBUTION IS NOT NORMAL.
LOOK FOR THE ACTUAL MODE.
(THE SCORE WITH HIGHEST FREQUENCY)

PILOT36 DISTRIBUTION OF SCORES

SCORES			CUMULATIVE	PER CENT	CUMULATIVE PER CENT	PERCENTILE	NORMALIZED	STANINE	Z	LINEAR
RAW	PERCENT	FREQUENCY	FREQUENCY	FREQUENCY	FREQUENCY	RANK	T-SCORE	SCORE	SCORE	T-SCORE
26	86.7	1	1	1.3	1.3	99.4	75	1	2.250	72.5
25	83.3	1	2	1.3	2.5	98.1	71	1	2.054	70.5
24	80.0	2	4	2.5	5.0	96.3	68	1	1.858	68.6
23	76.7	3	7	3.8	8.8	93.1	65	2	1.662	66.6
22	73.3	2	9	2.5	11.3	90.0	63	2	1.466	64.7
21	70.0	2	11	2.5	13.8	87.5	62	3	1.270	62.7
20	66.7	4	15	5.0	18.8	83.8	60	3	1.074	60.7
19	63.3	2	17	2.5	21.3	80.0	59	3	0.878	58.8
18	60.0	2	19	2.5	23.8	77.5	58	3	0.682	56.8
17	56.7	5	24	6.3	30.0	73.1	57	3	0.485	54.9
16	53.3	6	30	7.5	37.5	66.3	55	4	0.289	52.9
15	50.0	12	42	15.0	52.5	55.0	52	5	0.093	50.9

14	46.7	7	49	8.8	61.3	43.1	49	5	-0.103	49.0
13	43.3	5	54	6.3	67.5	35.6	47	6	-0.299	47.0
12	40.0	2	56	2.5	70.0	31.3	46	6	-0.495	45.0
11	36.7	7	63	8.8	78.8	25.6	44	6	-0.691	43.1
10	33.3	2	65	2.5	81.3	20.0	42	7	-0.887	41.1
9	30.0	4	69	5.0	86.3	16.3	41	7	-1.084	39.2
8	26.7	5	74	6.3	92.5	10.6	38	8	-1.280	37.2
7	23.3	2	76	2.5	95.0	6.3	35	8	-1.476	35.2
6	20.0	2	78	2.5	97.5	3.8	33	9	-1.672	33.3
4	13.3	1	79	1.3	98.8	1.9	30	9	-2.064	29.4
3	10.0	1	80	1.3	100.0	0.6	26	9	-2.260	27.4

PILOT36 HISTOGRAM OF SCORE DISTRIBUTION



PILOT36 ITEM ANALYSIS

ITEM NO.	RESPONSE	NUMBER RESPONDING UPPER	MIDDLE	LOWER	DIFFICULTY INDICE UPPER	LOWER	TOTAL	DELTA		DISC. INDEX	CORRELATION COEFFICIENTS BISERIAL RBIS	t	POINT-BISERIAL RPB	t	SCORE
1	A	0	2	0	0.000	0.000	0.025	20.88		0.000	-0.110	-0.98	-0.048	-0.42	13.0
	B	2	7	7	0.095	0.333	0.200	16.41		-0.238	-0.230	-2.09	-0.168	-1.50	12.8
	* C	* 15	22	9	*0.714	0.429	0.575	12.20	*	0.286	0.246	2.24	0.198	1.78	* 15.4
	D	4	7	5	0.190	0.238	0.200	16.41		-0.048	-0.079	-0.70	-0.058	-0.51	13.9
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
2	A	0	2	7	0.000	0.333	0.112	17.89		-0.333	-0.560	-5.98	-0.370	-3.52	9.2
	* B	* 20	29	5	*0.952	0.238	0.675	11.14	*	0.714	0.751	10.05	0.590	6.45	* 16.6
	C	1	7	7	0.048	0.333	0.188	16.59		-0.286	-0.427	-4.18	-0.320	-2.98	11.1
	D	0	0	2	0.000	0.095	0.025	20.88		-0.095	-0.507	-5.19	-0.221	-2.00	7.5
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
3	* A	* 16	12	4	*0.762	0.190	0.400	14.05	*	0.571	0.628	7.12	0.501	5.12	* 17.7
	B	2	12	11	0.095	0.524	0.313	14.99		-0.429	-0.433	-4.24	-0.344	-3.24	11.9
	C	1	5	3	0.048	0.143	0.112	17.89		-0.095	-0.255	-2.33	-0.169	-1.51	12.1
	D	2	9	3	0.095	0.143	0.175	16.78		-0.048	-0.117	-1.04	-0.086	-0.76	13.6
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
4	A	5	12	4	0.238	0.190	0.262	15.58		0.048	-0.064	-0.57	-0.050	-0.44	14.1
	B	0	1	8	0.000	0.381	0.112	17.89		-0.381	-0.619	-6.96	-0.409	-3.96	8.7
	C	2	8	4	0.095	0.190	0.175	16.78		-0.095	-0.187	-1.68	-0.138	-1.23	13.0
	* D	* 14	17	5	*0.667	0.238	0.450	13.54	*	0.429	0.511	5.25	0.409	3.96	* 16.8
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
5	A	5	6	4	0.238	0.190	0.188	16.59		0.048	0.186	1.67	0.139	1.24	16.0
	B	1	13	10	0.048	0.476	0.300	15.14		-0.429	-0.411	-3.98	-0.324	-3.03	12.0
	* C	* 11	13	2	*0.524	0.095	0.325	14.86	*	0.429	0.414	4.02	0.326	3.05	* 16.9

	D	4	6	5	0.190	0.238	0.188	16.59		-0.048	-0.201	-1.81	-0.150	-1.34	12.9
46.88															
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00															
6	A	4	14	11	0.190	0.524	0.363	14.45		-0.333	-0.374	-3.56	-0.297	-2.75	12.5
46.06															
	* B	* 17	15	4	*0.810	0.190	0.450	13.54	*	0.619	0.597	6.58	0.478	4.81	* 17.2
55.29															
	C	0	0	4	0.000	0.190	0.050	19.62		-0.190	-0.563	-6.01	-0.294	-2.71	8.0
37.20															
	D	0	9	2	0.000	0.095	0.138	17.41		-0.095	-0.135	-1.20	-0.091	-0.81	13.4
47.72															
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00															
7	A	6	23	10	0.286	0.476	0.488	13.17		-0.190	-0.163	-1.46	-0.130	-1.16	13.8
48.67															
	B	4	8	5	0.190	0.238	0.213	16.23		-0.048	-0.007	-0.07	-0.006	-0.05	14.5
49.89															
	C	1	2	5	0.048	0.238	0.100	18.17		-0.190	-0.338	-3.17	-0.222	-2.01	11.1
43.33															
	* D	* 10	5	1	*0.476	0.048	0.200	16.41	*	0.429	0.459	4.56	0.335	3.14	* 17.9
56.69															
	ERROR	0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00															

MEAN ITEM CRITERION	RESP-	NUMBER RESPONDING			DIFFICULTY INDICE				DISC.INDEX	CORRELATION COEFFICIENTS BISERIAL		POINT-BISERIAL		
NO. T-SC	ONSE	UPPER	MIDDLE	LOWER	UPPER	LOWER	TOTAL	DELTA		RBIS	t	RPB	t	SCORE
8	A	8	11	6	0.381	0.286	0.313	14.99	0.095	0.205	1.85	0.163	1.46	15.8
52.42														
	* B	* 8	14	1	*0.381	0.048	0.287	15.28	* 0.333	0.374	3.57	0.292	2.70	* 16.9
54.60														
	C	1	4	4	0.048	0.190	0.112	17.89	-0.143	-0.314	-2.92	-0.207	-1.87	11.6
44.18														
	D	4	9	10	0.190	0.476	0.287	15.28	-0.286	-0.403	-3.89	-0.315	-2.93	12.0
45.05														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
9	* A	* 9	13	6	*0.429	0.286	0.350	14.58	* 0.143	0.272	2.49	0.217	1.97	* 16.0
52.96														
	B	8	19	11	0.381	0.524	0.475	13.29	-0.143	-0.172	-1.54	-0.137	-1.22	13.8
48.56														
	C	4	6	4	0.190	0.190	0.175	16.78	0.000	-0.126	-1.12	-0.093	-0.82	13.5
47.99														
	D	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
10	* A	* 13	20	3	*0.619	0.143	0.450	13.54	* 0.476	0.419	4.08	0.336	3.15	* 16.4
53.71														
	B	5	5	15	0.238	0.714	0.313	14.99	-0.476	-0.306	-2.84	-0.244	-2.22	12.7
46.38														
	C	0	1	2	0.000	0.095	0.038	20.16	-0.095	-0.547	-5.77	-0.278	-2.56	7.3
35.90														
	D	3	12	1	0.143	0.048	0.200	16.41	0.095	-0.003	-0.03	-0.002	-0.02	14.5
49.95														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
11	A	4	12	10	0.190	0.476	0.325	14.86	-0.286	-0.370	-3.51	-0.291	-2.69	12.4
45.80														
	B	1	3	2	0.048	0.095	0.075	18.80	-0.048	-0.062	-0.55	-0.039	-0.34	13.8
48.64														
	* C	* 16	20	7	*0.762	0.333	0.538	12.58	* 0.429	0.476	4.79	0.381	3.64	* 16.3
53.53														
	D	0	3	2	0.000	0.095	0.063	19.18	-0.095	-0.303	-2.81	-0.178	-1.60	11.0
43.09														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
12	A	0	12	4	0.000	0.190	0.200	16.41	-0.190	-0.264	-2.42	-0.192	-1.73	12.6
46.15														
	B	0	2	4	0.000	0.190	0.075	18.80	-0.190	-0.392	-3.76	-0.243	-2.22	10.2
41.45														
	* C	* 17	22	5	*0.810	0.238	0.550	12.46	* 0.571	0.529	5.50	0.423	4.13	* 16.5
53.83														
	D	4	2	8	0.190	0.381	0.175	16.78	-0.190	-0.248	-2.26	-0.183	-1.64	12.5
46.03														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
13	* A	* 21	34	18	*1.000	0.857	0.913	7.54	* 0.143	0.563	6.02	0.336	3.15	* 15.1
51.04														
	B	0	2	2	0.000	0.095	0.050	19.62	-0.095	-0.498	-5.07	-0.260	-2.38	8.8
38.67														
	C	0	2	0	0.000	0.000	0.025	20.88	0.000	-0.146	-1.30	-0.064	-0.56	12.5
46.03														
	D	0	0	1	0.000	0.048	0.013	22.01	-0.048	-0.759	-10.30	-0.254	-2.32	3.0
27.40														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
14	A	0	2	4	0.000	0.190	0.075	18.80	-0.190	-0.497	-5.06	-0.309	-2.86	9.0
39.16														
	* B	* 20	31	9	*0.952	0.429	0.750	10.26	* 0.524	0.639	7.34	0.490	4.96	* 16.0
52.83														
	C	1	5	6	0.048	0.286	0.150	17.18	-0.238	-0.395	-3.79	-0.284	-2.61	11.1
43.25														
	D	0	0	2	0.000	0.095	0.025	20.88	-0.095	-0.435	-4.26	-0.189	-1.70	8.5
38.18														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														

ITEM NO.	RESPONSE	NUMBER RESPONDING UPPER	MIDDLE	LOWER	DIFFICULTY INDICE UPPER	LOWER	TOTAL	DELTA	DISC.INDEX	CORRELATION COEFFICIENTS BISERIAL RBIS	t	POINT-BISERIAL RPB	t	MEAN CRITERION SCORE T-SC
15	A	0	7	8	0.000	0.381	0.188	16.59	-0.381	-0.511	-5.26	-0.382	-3.65	10.5 42.04
	B	5	9	5	0.238	0.238	0.237	15.90	0.000	-0.030	-0.27	-0.023	-0.20	14.3 49.59
	* C	* 16	20	6	*0.762	0.286	0.525	12.71	* 0.476	0.522	5.41	0.417	4.05	* 16.5 53.97
	D	0	2	2	0.000	0.095	0.050	19.62	-0.095	-0.433	-4.24	-0.226	-2.05	9.5 40.15
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
16	* A	* 16	21	5	*0.762	0.238	0.525	12.71	* 0.524	0.516	5.32	0.412	3.99	* 16.5 53.92
	B	4	17	12	0.190	0.571	0.412	13.92	-0.381	-0.400	-3.85	-0.320	-2.99	12.6 46.18
	C	0	0	3	0.000	0.143	0.038	20.16	-0.143	-0.496	-5.04	-0.253	-2.31	8.0 37.20
	D	1	0	1	0.048	0.048	0.025	20.88	0.000	-0.002	-0.02	-0.001	-0.01	14.5 49.95
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
17	A	0	5	2	0.000	0.095	0.087	18.46	-0.095	-0.136	-1.21	-0.084	-0.74	13.1 47.29
	B	4	18	8	0.190	0.381	0.375	14.31	-0.190	-0.226	-2.05	-0.181	-1.63	13.3 47.66
	* C	* 13	13	8	*0.619	0.381	0.425	13.80	* 0.238	0.266	2.44	0.214	1.93	* 15.8 52.49
	D	4	2	3	0.190	0.143	0.112	17.89	0.048	0.027	0.24	0.018	0.16	14.8 50.50
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
18	A	0	10	1	0.000	0.048	0.138	17.41	-0.048	0.045	0.39	0.030	0.27	14.9 50.75
	B	3	12	9	0.143	0.429	0.300	15.14	-0.286	-0.275	-2.53	-0.217	-1.97	12.8 46.68
	* C	* 17	14	2	*0.810	0.095	0.412	13.92	* 0.714	0.613	6.85	0.491	4.98	* 17.5 55.86
	D	1	2	9	0.048	0.429	0.150	17.18	-0.381	-0.595	-6.54	-0.428	-4.18	9.3 39.82
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
19	A	6	11	6	0.286	0.286	0.287	15.28	0.000	-0.063	-0.56	-0.049	-0.43	14.1 49.23
	B	2	3	6	0.095	0.286	0.138	17.41	-0.190	-0.324	-3.03	-0.219	-1.98	11.7 44.51
	* C	* 8	16	5	*0.381	0.238	0.363	14.45	* 0.143	0.268	2.46	0.213	1.93	* 16.0 52.83
	D	5	8	4	0.238	0.190	0.213	16.23	0.048	-0.016	-0.14	-0.012	-0.10	14.4 49.78
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
20	* A	* 19	31	9	*0.905	0.429	0.738	10.42	* 0.476	0.459	4.57	0.357	3.37	* 15.6 52.13
	B	2	5	1	0.095	0.048	0.100	18.17	0.048	-0.040	-0.35	-0.026	-0.23	14.1 49.22
	C	0	2	8	0.000	0.381	0.125	17.64	-0.381	-0.492	-4.99	-0.328	-3.07	10.1 41.32
	D	0	0	3	0.000	0.143	0.038	20.16	-0.143	-0.420	-4.09	-0.214	-1.93	9.0 39.16
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
21	* A	* 9	4	2	*0.429	0.095	0.188	16.59	* 0.333	0.438	4.30	0.327	3.06	* 18.0 56.82
	B	5	16	5	0.238	0.238	0.325	14.86	0.000	-0.011	-0.10	-0.009	-0.08	14.5 49.88
	C	4	15	9	0.190	0.429	0.350	14.58	-0.238	-0.248	-2.27	-0.199	-1.79	13.1 47.29
	D	3	3	5	0.143	0.238	0.138	17.41	-0.095	-0.124	-1.10	-0.084	-0.74	13.5 47.90
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00

PILOT36 ITEM ANALYSIS

ITEM NO.	RESPONSE	NUMBER RESPONDING UPPER	MIDDLE	LOWER	DIFFICULTY INDICE UPPER	LOWER	TOTAL	DELTA	DISC.INDEX	CORRELATION COEFFICIENTS BISERIAL RBIS	t	POINT-BISERIAL RPB	t	MEAN CRITERION SCORE T-SC
22	A	1	10	9	0.048	0.429	0.250	15.74	-0.381	-0.282	-2.60	-0.218	-1.97	12.6 46.22
	B	5	8	2	0.238	0.095	0.188	16.59	0.143	0.161	1.44	0.120	1.07	15.8 52.50
	* C	* 15	13	5	*0.714	0.238	0.412	13.92	* 0.476	0.389	3.73	0.312	2.90	* 16.4 53.72
	D	0	7	5	0.000	0.238	0.150	17.18	-0.238	-0.414	-4.01	-0.297	-2.75	10.9 42.92
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00
23	A	0	1	5	0.000	0.238	0.075	18.80	-0.238	-0.632	-7.20	-0.392	-3.77	7.5 36.22
	* B	* 20	23	9	*0.952	0.429	0.650	11.42	* 0.524	0.494	5.01	0.394	3.79	* 16.0 52.89
	C	0	7	6	0.000	0.286	0.162	16.97	-0.286	-0.391	-3.75	-0.285	-2.62	11.2 43.54
	D	1	7	1	0.048	0.048	0.112	17.89	0.000	0.097	0.86	0.064	0.57	15.4 51.80
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0 0.00

24	* A	*	5	7	3	*0.238	0.143	0.188	16.59	*	0.095	0.194	1.75	0.145	1.30	* 16.1
53.02																
	B		0	3	2	0.000	0.095	0.063	19.18		-0.095	-0.303	-2.81	-0.178	-1.60	11.0
43.09																
	C		11	18	7	0.524	0.333	0.450	13.54		0.190	0.118	1.05	0.094	0.83	15.1
51.04																
	D		5	10	9	0.238	0.429	0.300	15.14		-0.190	-0.167	-1.49	-0.132	-1.17	13.5
47.99																
	ERROR		0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00																
25	A		0	6	2	0.000	0.095	0.100	18.17		-0.095	-0.251	-2.29	-0.165	-1.48	12.0
45.05																
	B		2	13	10	0.095	0.476	0.313	14.99		-0.381	-0.346	-3.26	-0.276	-2.53	12.4
45.91																
	* C	*	18	8	6	*0.857	0.286	0.400	14.05	*	0.571	0.634	7.24	0.506	5.19	* 17.7
56.20																
	D		1	11	3	0.048	0.143	0.188	16.59		-0.095	-0.243	-2.21	-0.181	-1.63	12.6
46.22																
	ERROR		0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00																
26	A		0	2	3	0.000	0.143	0.063	19.18		-0.143	-0.389	-3.73	-0.229	-2.08	10.0
41.13																
	B		0	1	3	0.000	0.143	0.050	19.62		-0.143	-0.369	-3.50	-0.192	-1.73	10.3
41.62																
	* C	*	21	31	13	*1.000	0.619	0.813	9.41	*	0.381	0.519	5.36	0.382	3.65	* 15.5
51.84																
	D		0	4	2	0.000	0.095	0.075	18.80		-0.095	-0.317	-2.95	-0.197	-1.77	11.0
43.09																
	ERROR		0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00																
27	A		1	3	4	0.048	0.190	0.100	18.17		-0.143	-0.351	-3.31	-0.230	-2.09	11.0
43.09																
	B		0	11	6	0.000	0.286	0.213	16.23		-0.286	-0.291	-2.68	-0.215	-1.95	12.4
45.86																
	* C	*	19	23	5	*0.905	0.238	0.587	12.08	*	0.667	0.630	7.16	0.505	5.16	* 16.7
54.23																
	D		1	1	6	0.048	0.286	0.100	18.17		-0.238	-0.462	-4.61	-0.304	-2.82	9.9
40.88																
	ERROR		0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00																
28	A		1	4	5	0.048	0.238	0.125	17.64		-0.190	-0.247	-2.25	-0.165	-1.48	12.3
45.64																
	B		5	5	1	0.238	0.048	0.138	17.41		0.190	0.319	2.97	0.215	1.95	17.3
55.39																
	C		0	8	12	0.000	0.571	0.250	15.74		-0.571	-0.597	-6.57	-0.461	-4.59	10.4
42.01																
	* D	*	15	21	3	*0.714	0.143	0.488	13.17	*	0.571	0.452	4.47	0.361	3.41	* 16.4
53.70																
	ERROR		0	0	0	0.000	0.000	0.000	0.00		0.000	0.000	0.00	0.000	0.00	0.0
0.00																

PILOT36 ITEM ANALYSIS

MEAN ITEM	RESP-	NUMBER RESPONDING			DIFFICULTY INDICE				DISC.INDEX	CORRELATION COEFFICIENTS BISERIAL		POINT-BISERIAL		
CRITERION NO.	ONSE	UPPER	MIDDLE	LOWER	UPPER	LOWER	TOTAL	DELTA		RBIS	t	RPB	t	SCORE
T-SC														
29	A	11	11	4	0.524	0.190	0.325	14.86	0.333	0.215	1.94	0.169	1.52	15.8
52.44														
	B	0	0	3	0.000	0.143	0.038	20.16	-0.143	-0.344	-3.23	-0.175	-1.57	10.0
41.13														
	C	0	6	7	0.000	0.333	0.162	16.97	-0.333	-0.501	-5.11	-0.364	-3.46	10.3
41.73														
	* D	* 10	21	7	*0.476	0.333	0.475	13.29	* 0.143	0.222	2.01	0.177	1.59	* 15.5
51.86														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														
30	A	3	15	4	0.143	0.190	0.275	15.43	-0.048	0.089	0.79	0.068	0.61	15.1
51.11														
	B	4	6	5	0.190	0.238	0.188	16.59	-0.048	-0.142	-1.26	-0.106	-0.94	13.4
47.79														
	C	0	3	6	0.000	0.286	0.112	17.89	-0.286	-0.502	-5.12	-0.331	-3.10	9.8
40.69														
	* D	* 14	14	6	*0.667	0.286	0.425	13.80	* 0.381	0.291	2.69	0.234	2.12	* 15.9
52.72														
	ERROR	0	0	0	0.000	0.000	0.000	0.00	0.000	0.000	0.00	0.000	0.00	0.0
0.00														

PILOT36 TEST SUMMARY

TEST STATISTICS

	MEAN	MIN	MEDIAN*	MAX	STD DEVN	VAR
TEST SCORES	14.525	3.000	14.500	26.000	5.099	25.999
DIFF. INDEX	0.484	0.188	0.550	0.913	0.514	0.265
DELTA	13.144	7.537	12.062	16.587	2.043	4.175
DISC. INDEX	0.427	0.143	0.429	0.714	0.175	0.031
BISERIAL RBIS	0.460	0.194	0.473	0.751	0.144	0.021
POINT-BISERIAL RPB	0.359	0.145	0.367	0.590	0.114	0.013

KUDER-RICHARDSON RELIABILITY STATISTICS

KR20 =0.772 SEM20 = 2.432
KR21 =0.736 SEM21 = 2.618

CRONBACH ALPHA RELIABILITY STATISTICS

ALPHA =0.772 SEM-ALP = 2.432

SPLIT-HALF RELIABILITY STATISTICS

RTT =0.654 SEMTT = 3.001

* APPROXIMATE MEDIANS,
IF THE DISTRIBUTIONS ARE NOT NORMAL.

PILOT36 DISTRIBUTION OF DIFFICULTIES
PLOTTED OVER 20 EQUAL INTERVALS OF 0.036

MIN							MEDIAN*												MAX
0.186	0.260	0.333	0.405	0.478	0.550	0.623	0.695	0.768	0.840	0.914									
*	0.224	0.296	0.369	0.441	0.514 *	0.586	0.659	0.731	0.804	0.876 *									
7	0	8	5	9	3	17	4	28	11	1	27	23	2	0	14	0	26	0	13
21	0	0	0	19	25	18	6	0	12	0	0	0	0	0	20	0	0	0	0
24	0	0	0	0	0	22	10	0	15	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	30	29	0	16	0	0	0	0	0	0	0	0	0	0
COL 3	0	1	1	2	2	4	4	1	4	1	1	1	1	0	2	0	1	0	1
TOTALS																			

** IF ANY INDEX IS ZERO,
ITS ITEM NO. IS NOT PLOTTED.

PILOT36 DISTRIBUTION OF DISCRIMINATIONS
PLOTTED OVER 20 EQUAL INTERVALS OF 0.031

MIN							MEDIAN*												MAX
0.094	0.157	0.219	0.281	0.343	0.405	0.467	0.529	0.590	0.652	0.715									
*	0.126	0.188	0.250	0.312	0.374 *	0.436	0.498	0.560	0.621	0.683 *									
24	9	0	0	17	0	1	8	0	26	4	0	10	14	0	3	6	0	27	2
0	13	0	0	0	0	0	21	0	30	5	0	15	16	0	12	0	0	0	18
0	19	0	0	0	0	0	0	0	0	7	0	20	23	0	25	0	0	0	0
0	29	0	0	0	0	0	0	0	11	0	22	0	0	0	28	0	0	0	0
COL 1	4	0	0	1	0	1	2	0	2	4	0	4	3	0	4	1	0	1	2
TOTALS																			

** IF ANY INDEX IS ZERO,
ITS ITEM NO. IS NOT PLOTTED.

PILOT36 DISTRIBUTION OF POINT-BISERIALS
PLOTTED OVER 20 EQUAL INTERVALS OF 0.022

MIN							MEDIAN*												MAX
0.144	0.190	0.234	0.279	0.323	0.367	0.412	0.456	0.501	0.545	0.591									
*	0.167	0.212	0.256	0.301	0.345 *	0.390	0.434	0.479	0.523	0.567 *									
24	29	1	9	0	0	8	22	5	20	11	4	12	0	6	14	3	0	0	2
0	0	0	17	0	0	0	0	7	28	26	23	15	0	0	18	25	0	0	0
0	0	0	19	0	0	0	0	10	0	0	0	16	0	0	0	27	0	0	0
0	0	0	30	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0
COL 1	1	1	4	0	0	1	1	5	2	2	2	3	0	1	2	3	0	0	1
TOTALS																			

** IF ANY INDEX IS ZERO,
ITS ITEM NO. IS NOT PLOTTED.

PILOT36 DISTRIBUTION OF BISERIALS
PLOTTED OVER 20 EQUAL INTERVALS OF 0.028

MIN							MEDIAN*												MAX
0.193	0.250	0.306	0.361	0.417	0.473	0.528	0.584	0.640	0.696	0.752									
*	0.222	0.278	0.334	0.389	0.445 *	0.501	0.556	0.612	0.668	0.723 *									
24	1	9	30	0	0	8	5	10	7	11	4	12	13	6	3	0	0	0	2
29	0	17	0	0	0	0	22	21	20	23	15	0	0	0	14	0	0	0	0
0	0	19	0	0	0	0	0	0	28	0	16	0	0	0	18	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	25	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0
COL 2	1	3	1	0	0	1	2	2	3	2	4	1	1	1	5	0	0	0	1
TOTALS																			

** IF ANY INDEX IS ZERO,
ITS ITEM NO. IS NOT PLOTTED.

THE ITEM ANALYSIS IS SUCCESSFUL

Appendix E

Strategy questionnaire

QUESTIONNAIRE

READING STRATEGIES OF SECOND LANGUAGE LEARNERS

Name: [redacted]

[redacted]

[redacted]

[redacted]

How long have you been studying English? _____

____ Less than 8 years ___✓__ 8-10 years _____ 11-13 years _____ 14 years or over

am conducting a study to find out more about how Thai students use their strategies when reading English xts. Please indicate how often you do the following activities when reading an English text. There is no right wrong answer. Everyone has their own strategies.

y completing the following example, you will understand how to fill out the questionnaire. Look at the xample statement below.

ask the teacher for an explanation if I don't understand.
ou may always, often, sometimes, seldom or never do this activity.
you always do this activity make a (X) in the space under number one.
you often do that make a (X) in the space under number two and so on.

ways	Often	Sometimes	Seldom	Neve
1	2	3	4	5

	1	2	3	4	5
ask the teacher for an explanation if I don't understand.					

you choose the wrong number, make parallel lines on it (~~X~~) and make a cross in the space under the numbe u meant to choose.

u will all complete this questionnaire at different speeds. Do not worry if you are amongst the first or the las finish. What is important is that you answer every question. When you have finished please check that you ve answered all the questions and wait in silence until the teacher collects the questionnaires. Ask your cher now for help if you do not understand.

ank you for your help.

following statements are about the kinds of activities you may or may not do when you read texts in lish. Please indicate how often you make use of the following strategies.

ays	Often	Sometimes	Seldom	Never
	2	3	4	5

When reading an English text,	1	2	3	4	5
I read the title and find out what the passage is about.		X			
I read every word.			X		
I use figures (1,2,3...) to show the step or process of the text.			X		
I give up and stop reading if I don't understand something.			X		
I am interested in what I'm reading.	X				
I translate into Thai.			X		
I summarise the content of the text.			X		
I decide what my purpose is before I read.			X		
I try to predict what will come next.			X		
I take notes.			X		
I find the text is boring.		X			
I draw a diagram to help to understand the content of the text.			X		
I skip unimportant parts.		X			
I read ahead to find the whole idea of the text.		X			
I look up words in the dictionary.		X			
I skip the parts that I don't understand.			X		
I keep on reading if I don't understand something.			X		
I re-read the problematic part if I don't understand.		X			
I use the illustration to help to understand the content of the text.		X			
I check through the story to see if my understanding is correct.			X		
I look for further information about the text in other books.			X		
I ask questions about the text.			X		
I underline important parts of the text.		X			
I use my prior knowledge and experience to understand the text.		X			
I identify grammatical categories of words to help me to understand.		X			
I try to recognise the difference between main points and supporting details.			X		

Always	Often	Sometimes	Seldom	Never
1	2	3	4	5

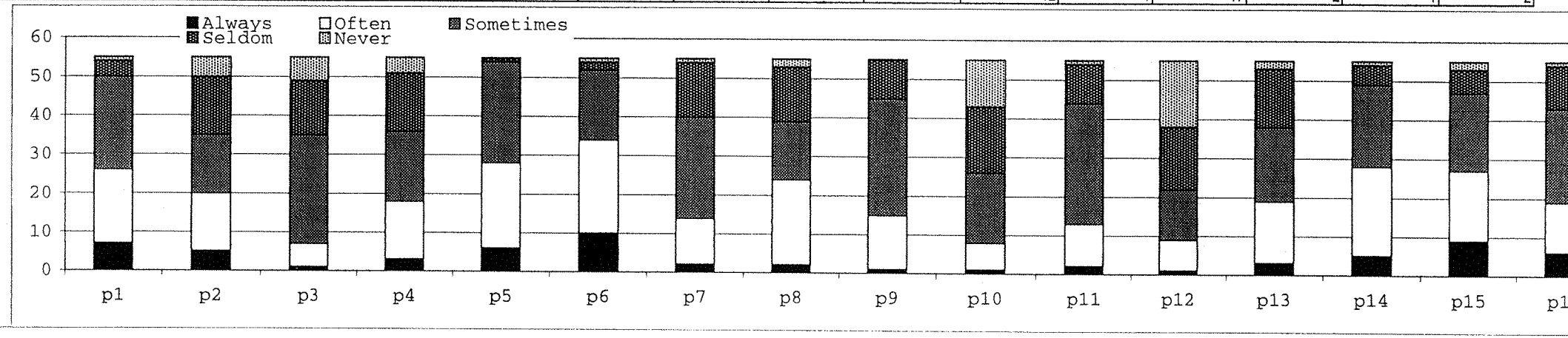
		1	2	3	4	5
27.	I guess the meaning of unknown words from context.			X		
28.	I write down an asterisk (*) to show that the statement contains an important idea.					X
29.	I always remember the main idea of the text in mind while I read.			X		
30.	I am pleased when I find that what I am reading makes sense.			X		
31.	I use word formation (*prefix, suffix, root*) to understand unknown words.		X			
32.	I am confused by what I read.			X		
33.	I relate new information which comes next to the previous paragraph			X		
34.	I imagine or draw a picture of the story in my mind.				X	
35.	I find the text is easy.			X		
36.	I use marker words (*and, but, however*) to help to understand the text.		X			
37.	I find the text is difficult			X		
	My Difficulty					
38.	I understand all the words but cannot get the whole idea of the text.			X		
39.	I can translate the sentences but I don't understand the text			X		
40.	I have difficulty with the grammatical structure.			X		
41.	I have difficulty with vocabulary.			X		
42.	I have difficulty in getting overall meaning of the text.			X		
43.	I have difficulty in guessing the meaning of unknown words.			X		
44.	I have difficulty in grasping the organisation of the text.			X		
45.	I have difficulty in relating the text to what I already know.			X		

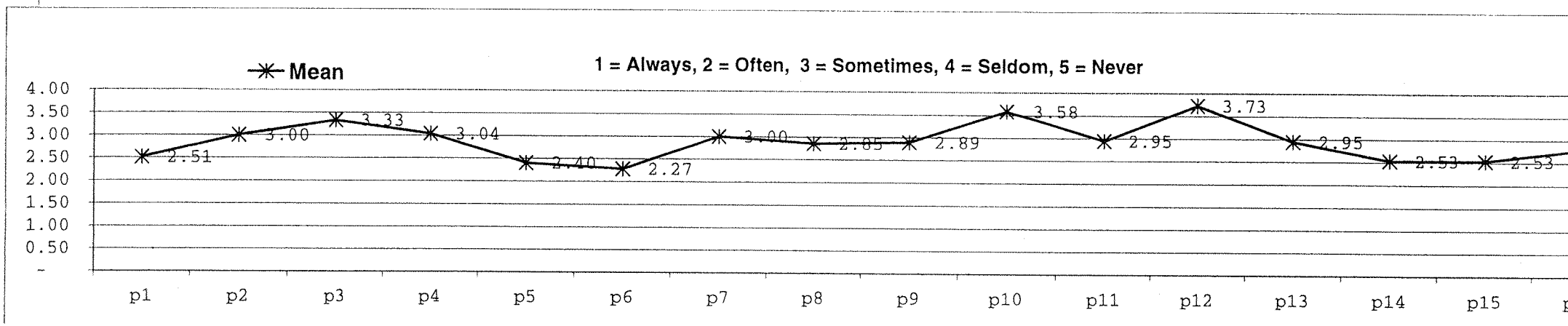
THANK YOU FOR YOUR HELP.

Appendix F

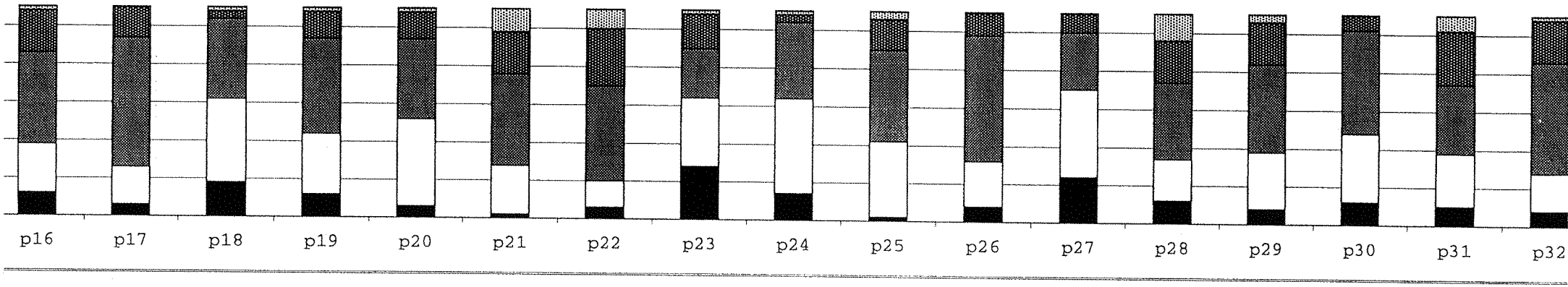
Reliability analysis of the questionnaire

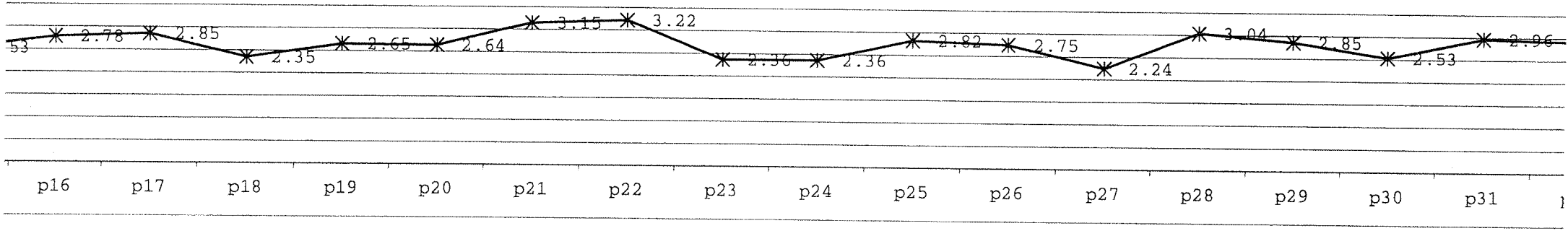
	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	p13	p14	p15
Mean	2.51	3.00	3.33	3.04	2.40	2.27	3.00	2.85	2.89	3.58	2.95	3.73	2.95	2.53	2.53
Always	7	5	1	3	6	10	2	2	1	1	2	1	3	5	9
Often	19	15	6	15	22	24	12	22	14	7	11	8	16	23	18
Sometimes	24	15	28	18	26	18	26	15	30	18	31	13	19	21	20
Seldom	4	15	14	15	1	2	14	14	10	17	10	16	15	5	6
Never	1	5	6	4	0	1	1	2	0	12	1	17	2	1	2



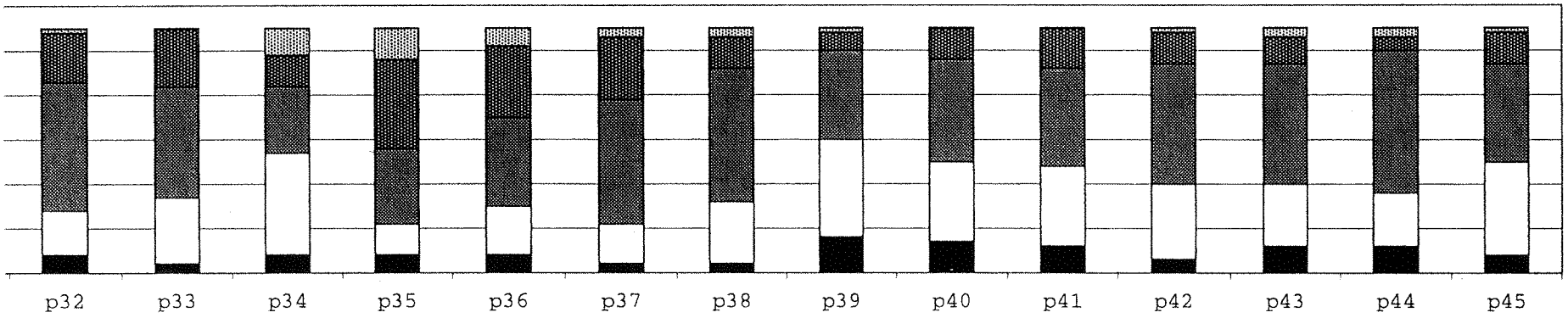


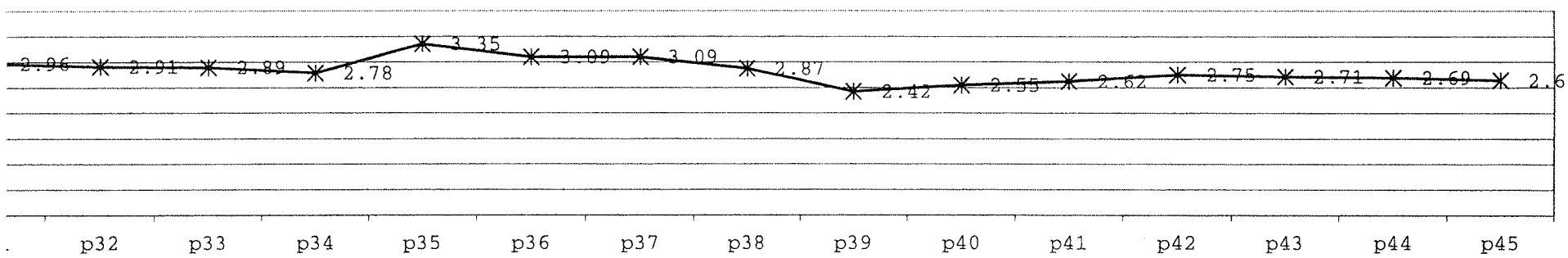
p16	p17	p18	p19	p20	p21	p22	p23	p24	p25	p26	p27	p28	p29	p30	p31
2.78	2.85	2.35	2.65	2.64	3.15	3.22	2.36	2.36	2.82	2.75	2.24	3.04	2.85	2.53	2.96
6	3	9	6	3	1	3	14	7	1	4	12	6	4	6	5
13	10	22	16	23	13	7	18	25	20	12	23	11	15	18	14
24	34	21	25	21	24	25	13	20	24	33	15	20	23	27	18
11	8	2	7	7	11	15	9	2	8	6	5	11	11	4	14
1	0	1	1	1	6	5	1	1	2	0	0	7	2	0	4





p32	p33	p34	p35	p36	p37	p38	p39	p40	p41	p42	p43	p44	p45	Total(1-45) MEAN	(1-39) MEAN
2.91	2.89	2.78	3.35	3.09	3.09	2.87	2.42	2.55	2.62	2.75	2.71	2.69	2.64	2.81	2.83
4	2	4	4	4	2	2	8	7	6	3	6	6	4	always	
10	15	23	7	11	9	14	22	18	18	17	14	12	21	often	
29	25	15	17	20	28	30	20	23	22	27	27	32	22	sometimes	
11	13	7	20	16	14	7	4	7	9	7	6	3	7	seldom	
1	0	6	7	4	2	2	1	0	0	1	2	2	1	never	





Reliability

****** Method 2 (covariance matrix) will be used for this analysis ******

RELIABILITY ANALYSIS - SCALE (ALPHA)

N of Cases = 55.0

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.8097	2.2364	3.7273	1.4909	1.6667	.1092

Item Variances	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.8531	.5037	1.3690	.8653	2.7179	.0494

Analysis of Variance

Source of Variation	Sum of Sq.	DF	Mean Square	F	Prob.
Between People	232.7451	54	4.3101		
Within People	2104.6222	2420	.8697		
Between Measures	264.3127	44	6.0071	7.7557	.0000
Residual	1840.3095	2376	.7745		
Total	2337.3673	2474	.9448		
Grand Mean	2.8097				

Reliability Coefficients 45 items

Alpha = .8203 Standardized item alpha = .8258

Appendix G

Think-aloud texts

Muck into medicine

Soil bacteria could be turned into a chemical goldmine

GUIDED BY the maxim that where there's muck there's money, a Canadian biotechnology company says it has found a way to raid the treasure trove of potentially useful compounds made by soil-dwelling microorganisms. It also plans to extract drugs from lichens.

Every handful of soil contains up to 5000 species of bacteria, but research into their potential to produce antibiotics and industrial enzymes has been hampered by their stubborn refusal to grow in the laboratory. Only 1 per cent of soil microorganisms can be cultivated artificially.

Now, TerraGen Diversity of Vancouver has sidestepped this problem by chopping the DNA of the microorganisms into larger chunks than has previously been possible—and then transplanting them into hosts which are easy to cultivate, such as the bacterium *Escherichia coli*.

The company is also using the method to extract novel compounds from 15 000 lichen species—combinations of algae, bacteria and fungi—which have also defied attempts at laboratory cultivation.

At present, TerraGen will only reveal the bare outlines of its technique. First, soil or lichen samples are put through a series of centrifuges to separate the microorganisms from inanimate debris. Samples are treated chemically to destroy soilborne substances, such as humic acid, that would hamper analysis.

Once the live organisms have been isolated, TerraGen treats them with restriction enzymes to break the microbial DNA into manageable chunks. After these chunks have been spliced into hoops of DNA called plasmids—which are the way organisms exchange genes naturally—the microbial genes can be transplanted into their hosts. The hosts might be *E. coli*, fungi or strains of bacteria that make antibiotics.

Similar techniques, of expressing alien genes in host bacteria or fungi, are nothing new to the biotechnology industry. Typically, microbiologists transplant chunks containing around 40 000 of the nucleotide bases that form the DNA alphabet. TerraGen claims to have broken new ground by devising a way to transplant especially large strands of bacterial DNA that may contain dozens of genes. The company routinely transplants chunks containing 100 000 nucleotides, and has even inserted chunks of up to 300 000 bases, which account for as much as 5 per cent of a bacterium's genome.

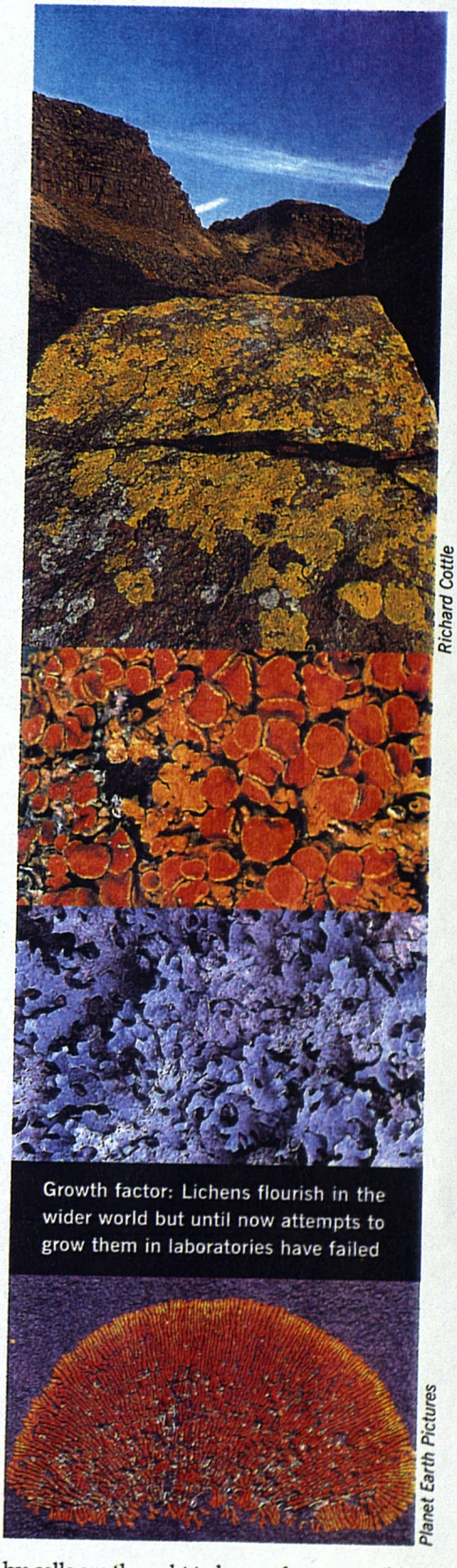
The large size of the chunks is important, says Joe McDermott, research director at TerraGen, because it means that several new proteins are likely to be produced in the host. The chunk could even be an entire biochemical production line for a substance that could not be produced if only a couple of genes were transplanted.

Searching for the new compounds and proteins is also made easier by TerraGen's transplant method. Because the company is already familiar with the chemicals normally produced by the host, it only has to look for a handful of novel chemicals in each search. "Because we're dealing with the same genetic background time after time, it's easy for us to tell what's native and what's novel," says McDermott.

The company has already produced new antibiotics, created by stitching alien genes into the *Streptomyces* bacteria already used to make antibiotics. It has also isolated chemicals that can influence the way cells respond to messages from their environment. Inadequate or exaggerated responses by cells are thought to be partly responsible for diseases such as cancer and diabetes.

TerraGen has also extracted 16 new xylanase enzymes which could find a role in the pulp, paper and textile industries for breaking down and bleaching natural fibres.

Andy Coghlan



Richard Cottle

Growth factor: Lichens flourish in the wider world but until now attempts to grow them in laboratories have failed

Planet Earth Pictures

REVIEW

Island havens

◆ *Islands make good prisons. That's why the only one of dozens featured in the* Natural History of the Islands of California *that most will have heard of is Alcatraz. But islands are also good prisons for wildlife, keeping natives apart from alien species and humans alike. Much of the California that has disappeared beneath freeways lives on there. By Allan A. Schoenherr and others, published by University of California Press, $45, ISBN 0520211979.*

Other Edens

◆ *Gold rushes transformed California and Australia within a few years in the mid-19th century. Millions of Argonauts and diggers came to rip their fortune from the land. It was not a pretty sight. But with them, as Ian Tyrrell records in* True Gardens of the Gods, *came landscape gardeners anxious to recreate Eden in these temples to greed. Published by University of California Press, £35/$45, ISBN 0520213467.*

Body parts

◆ *The beauty of bones and the link between art and anatomy are displayed in the Wellcome Trust's exhibition The New Anatomists (Two 10 Gallery, 210 Euston Road, London NW1 2BE, until 16 July). Particularly gripping are a rotating interactive skeleton that makes our insides look metallic and eerily abstract, and Ian Breakwell's death mask-like thermal images of his face breaking into a laugh. Visit.*

Cloth of ages

The Mummies Of Urumchi by Elizabeth Wayland Barber, Macmillan, $20, ISBN 0333730240

Reza/Sygma

TANTALISING glimpses of remarkable archaeological finds in Western China, of peoples said to be Caucasian in origin, have appeared in the press in the past five years. Who were these people—and what do the finds say about early connections between China and the West, still a politically sensitive issue?

In the 1970s, Chinese archaeologists excavated several mummies, many fully preserved in clothing that retained its original bright colourings, in the Tarim Basin area of what is now Xinjiang Autonomous Region. The mummies were conserved and put on display in the regional museum in Urumchi. There they languished until 1987, until "discovered" by Victor Mair, a professor of Chinese studies at the University of Pennsylvania.

Mair returned to examine the finds in 1995, accompanied by one of the original archaeologists and two textile specialists—one of whom was Elizabeth Wayland Barber, a professor at Occidental College, Los Angeles, known for her work on prehistoric weaving. In *The Mummies Of Urumchi*, she tells the story of this visit and what she found.

Earlier this century explorers, including Marc Aurel Stein, passed through the Tarim Basin in the foothills of the Himalayas and uncovered similar burials. They either took away artefacts or described the burials as best they could. Most people concluded that because these people were very tall, large-nosed, with blonde hair and, possibly, blue eyes, they must have been strays from the West. Wherever these people actually came from, they lived in the Tarim Basin between about 2000 and 1000 BC. Their graves, dug in salt beds, are all that now remain of them. Small-time agriculturists, they were herders of small flocks and had bronze but not iron. They buried the dead fully clothed, with other garments piled on top of them and hats and baskets at their sides.

Barber was shown only about a fifth of the material in Urumchi, which made it impossible for her to sort the typical from the unusual. But the omission of details she did have is puzzling—surely they would interest the lay reader too? Some small technical detail of the burials such as the source of dyes, width of looms, stitching and seaming techniques, size of clothes, details of woven baskets or the leather footwear might spark off a response in a researcher's mind. With luck, this might lead us to clues about the origins of these people. Unfortunately, Barber provides few such details. Two-thirds of the book covers background issues, including older burials in the region, the activities of early explorers, and what can be gleaned from the languages of peoples to the north. On the basis of the roots of words for textile technology, Barber concludes that weaving was brought from the West by the people who left the Tarim burials, but that they probably picked up felt-making locally.

And she perceives close links with the Celts, based on the "tartan" appearance of the clothes buried with the mummies. She devotes her last two chapters to speculations about the origins of the people who made these burials and the reason for their settlement so far to the east.

The mummies and their textiles are exceptionally fragile. Damage and decay have already begun. Authoritative reporting is urgently needed, with plentiful, good illustration. Sadly, Barber's is a hastily conceived and executed work. The colour plate references in the text are incorrect, and execrable line drawings—scribbles, to be accurate—take the place of photographs published elsewhere. It is full of tiresome colloquialisms, from "apemen", for example, to "kick the bucket". Whether such dumbing down was perpetrated by the author or an editor, it introduces doubt about the academic reliability of the arguments.□

Kay Staniland **is a dress historian with a special interest in the medieval and prehistoric periods**

Get stuck in

Reshaped studs could give players a head start

FOOTBALLERS should be able to get off the mark faster thanks to boots equipped with a new type of stud.

The new boots, launched this week by sportswear maker Mitre, have pyramid-shaped studs with a flat edge perpendicular to the toes. Mitre claims the studs give the boot a better grip than conventional round studs and can increase acceleration over the first five metres of a player's run. This could give players a crucial edge when they are racing to get to the ball. The stud, which is made of moulded plastic, has a hexagonal metal head that can be gripped by a spanner to screw it into the sole of the boot.

The new stud was the brainchild of biomechanics expert Jenny Mitchell, a member of Mitre's research team. She realised that traditional cone-shaped studs lack grip when players drive themselves forward. "Round studs are the worst you can have," she says. Because soft ground is essentially fluid, the studs cut through the soil with the minimum of drag, she explains. And drag equates to grip. "So we looked at putting in a flat edge to increase the drag," she says.

Mitre has shaped the stud so that it only increases grip when players are going forwards. Too much grip on the outside edge of the boot could lead to players twisting their ankles when turning, Mitchell says.

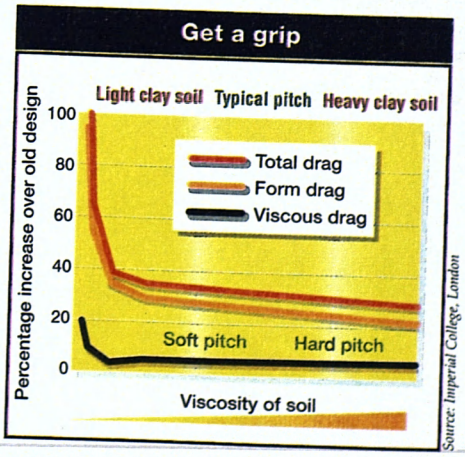
Initial tests with amateur players showed that the studs improved acceleration by an average of 13 per cent, equivalent to a half-metre head start over the first five metres, Mitre says. The company then commissioned engineers at Imperial College, London, to conduct an independent investigation into the studs' performance. Peter Lindstedt and Fred Marquis modelled the forces acting on the studs using computational fluid dynamics.

There are two main components of the force affecting an object in a fluid: form drag, which depends on the shape of an object, and viscous drag, which depends on its surface area or size, says Lindstedt. "The new stud produced a much greater form drag," he says. The engineers spent two weeks modelling the behaviour of the studs over a range of pitch conditions. They found that Mitre's design could theoretically boost initial acceleration by up to 40 per cent. "The softer the pitch the greater the improvement," says Lindstedt (see right).

Mitre has patented the design, which has been accepted by football's governing body, FIFA, and English Premier League referees. However, Steve Haake, an engineer in the sports engineering group at the University of Sheffield cautions that new boot designs may not have a significant impact on player's performance. "The fact that conventional studs have been around for 40 or 50 years means there is not much wrong with them. All you can really do is tinker with the design," he says. "Player testing is the key."

Matt Walker

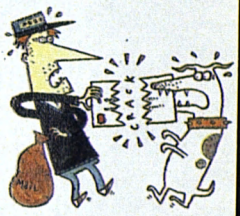
Speedy boots: the flat edge of the stud gives players a better grip when they are running forward



PATENTS

Cracking idea

Ivan Taylor's recently published British patent application (GB 2 325 866) gives Christmas card and cracker makers a novel product for the next festive season. The idea is to combine cards with crackers so that they can be sent through the post in a plain envelope. The cracker comes as two flat panels, separated by a folded card. Explosive cracker snaps are glued through the middle. When the card is pulled, the snaps explode and the centre section pops out, like an origami decoration, to reveal a Christmas greeting, silly joke or flat-packed toy.



Standardised noise

British employers with noisy premises are legally obliged to check sound levels with a sound pressure level meter. The meters must be accurately calibrated and checked every two years. The Association of Noise Consultants in Royston, Hertfordshire, has been working on a system that lets employers calibrate meters without sending them all off to a specialist laboratory (GB 2 326 478). Their calibration CD contains 69 test tracks of fixed level and plays on an ordinary CD player. An interface unit connects the CD player to the sound level meter, amplifying the signal from the CD so that it always delivers a standard level to the meter.

Straight to the point

The next VCRs from Philips could help people who fill their video tapes and then cannot find anything they have recorded (WO 98/55942). The new device records an index of thumbnail images in the first minute or two of tape. It does this by running the tape through an analyser that searches for every scene change or cut in a picture sequence. The cut point images are digitally compressed to create a sequence of low-resolution pictures that are just clear enough to give a clue to content. When you select an image, the video fast-forwards the tape to that point.

Barry Fox

Word power

Without speech, we can't add up

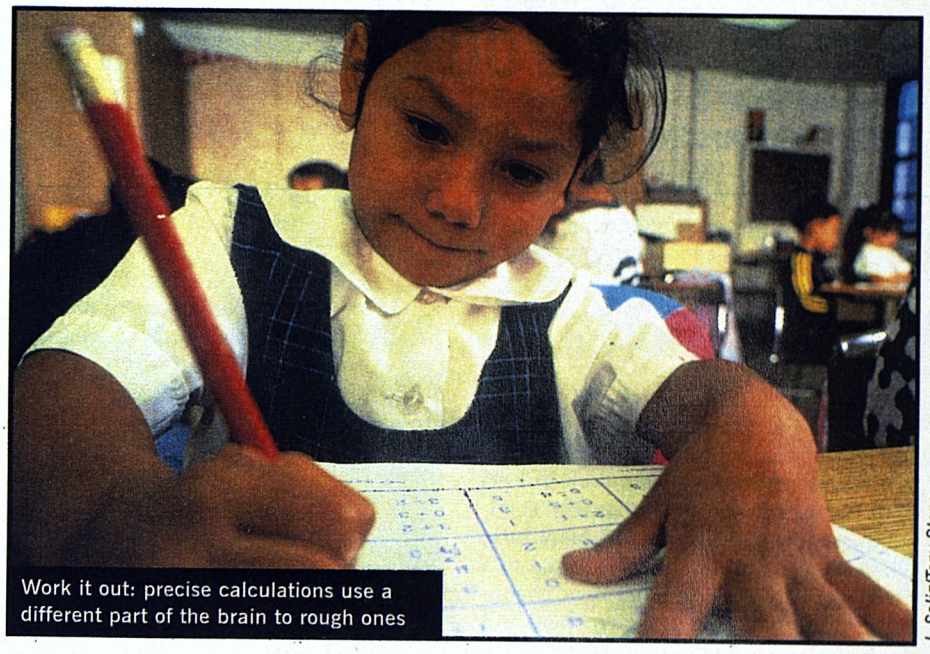
OUR brains can make rough mathematical calculations without language, but exact calculations need language skills, a new study suggests. The discovery may point to better ways of teaching maths.

Scientists have long wondered to what extent language is required for maths. Despite their lack of language skills, even monkeys and five-month-old infants have some ability to understand numbers. They gape in surprise when they see someone put two dolls behind a screen and then raise the screen to reveal only one doll ("It all adds up", *New Scientist*, 7 March 1998, p 42).

Also, the brain centres that process numbers seem to be different for exact and approximate calculations. Some patients with strokes or brain damage have severe difficulty with language and exact calculations, while their ability to estimate remains intact.

Elizabeth Spelke and Sanna Tsivkin of the Massachusetts Institute of Technology investigated the role of language in maths by enlisting eight adults who spoke Russian as their native language and were fluent in English. To mimic the process children go through as they learn maths, the researchers taught the subjects complex arithmetic and unfamiliar approximations. Some exercises were taught only in English, others in Russian. The teachers wrote numbers out as words rather than using Arabic numerals.

Spelke and Tsivkin then tested the students by giving them problems to solve in both languages. When asked to make exact calculations (does 53 plus 68 equal 121 or 127?) the students took about a second longer to come up with the answer if the question was not asked in the language they had been taught in (*Science*, vol 284, p 970). But there was no language-dependent time lag when they were asked to approximate (is 53 plus 68 closer to 120 or 150?).



Work it out: precise calculations use a different part of the brain to rough ones

J. Selig/Tony Stone

As part of the same study, Stanislas Dehaene and his colleagues at the French medical research organisation INSERM and Frédéric Joliot Hospital in Orsay looked at brain images of people doing calculations. Exact calculations increased the activity of speech-related areas of the brain's left frontal lobe, while estimates increased activity in the left and right parietal lobes. These regions help control hand and finger movements and, perhaps, counting on fingers. "I was amazed that the association could be so sharp," says Dehaene.

The findings may have implications for maths teaching. "If a child begins learning arithmetic in one language, is there a cost if the language is switched later on?" asks Spelke. Dehaene adds that even if children have severe language problems, they could still develop their numeracy by concentrating on approximate calculations.

Brian Butterworth at University College London, who studies how the brain handles mathematics, says the results are fascinating. However, he suspects the verbal and nonverbal parts of the brain don't work alone, but interact in complex ways. People often break down exact mathematical tasks, for example, turning nine plus seven into ten plus six. "There would be big overlaps," Butterworth predicts. **Nell Boyce**

Plants call in the pest control

SPIDERS scare off insects and help plants boost seed production in exchange for dollops of sugary nectar, say scientists in New Jersey.

Many species of plant produce enticing nectar bonuses known as extrafloral nectaries (EFNs). The EFNs attract ants which defend the plant against leaf-eating insects in return for the sweet treats. Some tropical tree species can die without the ants' protection.

Only a few spiders are known to take an interest in EFNs. To find out more, Steven Handel and Scott Ruhren from the State University of New Jersey in New Brunswick studied the interactions between jumping spiders from the genera *Eris* and *Metaphidippus*, and a yellow-flowered legume (*Chamaecrista nictitans*) common to the eastern US.

Greenhouse experiments showed the spiders jumped onto plants with active EFNs six times more often than those without, and regularly ate the extra nectar. The plants also benefited from the spiders' presence in the field, where seed production rose by 8 per cent (*Oecologia*, vol 119, p 227). "This is the first evidence that spiders can increase plants' fitness in terms of seed production," says Handel. "It's a completely unexpected link in nature."

Most spiders sit and wait for their prey, says Handel, but jumping spiders move around and are aggressive—just like the ants that protect trees. Handel suspects the spiders play as vital a role as ants in protecting plants. "Most people hate spiders. Now there is finally one reason to like them," he says. Matt Walker

On guard: spiders play a vital role in protecting plants

DRK

Fiendish fungus

A hybrid blight is running amok in Europe's woodlands

AN UNNATURAL union between two fungi has created an aggressive new disease that is felling hundreds of thousands of alder trees along Europe's rivers. Two species of *Phytophthora*, relatives of the potato blight, have hybridised to create lethal offspring that destroy the bark around the base of the trees, eventually killing them.

So far, the disease has claimed around 10 per cent of the alders in southern England and Wales, and is steadily killing up to 2 per cent of the population each year. The blight has also had a catastrophic impact in parts of Sweden, France and Holland, and is spreading in Germany and Austria.

Forest researchers warn that this might be the first of a rash of new pathogens to strike as the world trade in plants accelerates the evolution of new species. "I'm concerned that there's a lot of this going on," warns Clive Brasier of the Forestry Authority Research Station in Farnham.

Epidemics of fungal diseases are usually caused by introduced pathogens, which make short work of native species with no resistance to them—as with Dutch elm disease in the 1970s. But until now, there has been no evidence that introduced fungal species were exchanging genes with either resident fungi or other exotic fungi.

When the alder disease first struck in 1993, Brasier and his colleagues at the Scottish Crop Research Institute in Invergowrie tried to identify the fungus by sequencing a region of its DNA called the internal transcribed spacer, a stretch of genes that provides a signature of the species. They were surprised to find signatures from two different species, suggesting it was a hybrid. "That's very unusual," says Brasier.

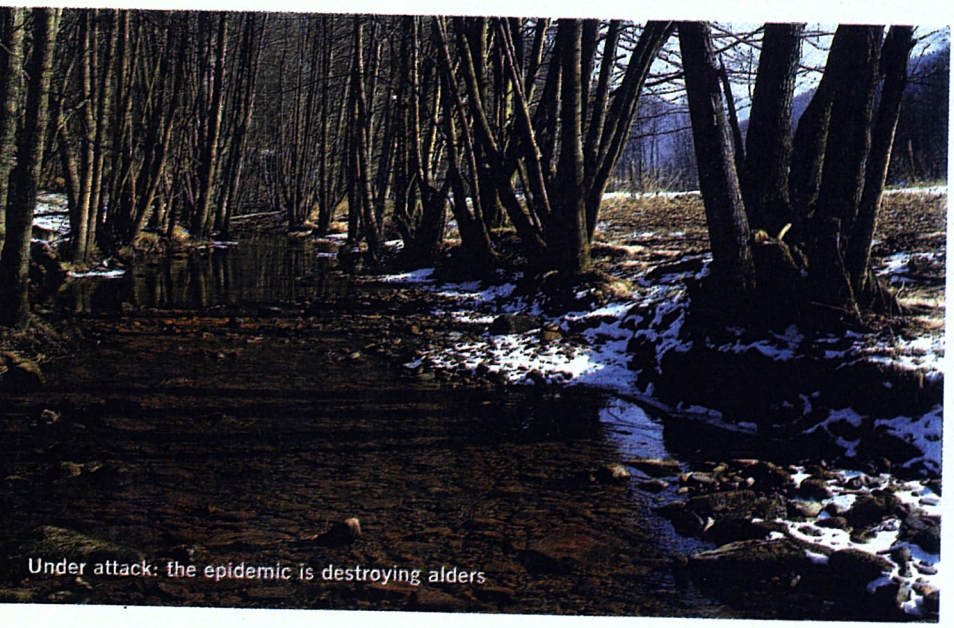
Fungi rarely hybridise in nature, because species that live in the same environment have evolved barriers to prevent it. "But fungi that are geographically isolated don't accumulate barriers to reproduction. So if you bring them together there is more risk of hybridisation," says Brasier.

Further studies have identified one parent as *Phytophthora cambivora*, which infects some trees, but not alders. The other parent is close but not identical to *P. fragariae*, a blight of strawberries and raspberries (*Proceedings of the National Academy of Sciences*, vol 96, p 5878). Both species have been introduced to Europe.

The hybrids of these species found in different parts of Europe vary greatly in structure and behaviour and often have reproductive abnormalities. This suggests that the pathogen is a very recent creation and is still evolving. "It hasn't stabilised into a single entity yet," says Brasier. "We don't know where selection will take it."

Alders are a key species in wetlands and along rivers, where they stabilise the banks, says John Gibbs, who has surveyed the damage in Britain for the Forestry Authority. If the fungus reaches the US, which has many native alder species, the losses could be immense. "We don't know yet if the American species are susceptible," adds Brasier. **Stephanie Pain**

H. Reinhard/Oxford Scientific



Under attack: the epidemic is destroying alders

No more needles

PILLS containing a chemical from a tree mould may one day replace insulin injections for people with diabetes. In diabetic mice, the chemical reduces high blood sugar levels to normal.

Diabetics need insulin to prevent their blood sugar rising to a dangerously high level. Because insulin is broken down in the stomach, it can't be taken orally. So diabetics often need several unpleasant injections of the hormone each day.

SPL

To try to find an alternative, biochemist Bei Zhang and her colleagues at Merck Research Laboratories in Rahway, New Jersey, screened 50 000 natural and synthetic compounds for one that would mimic insulin. One compound, from an extract of the tree fungus *Pseudomassaria*, activated the insulin receptors in cultured cells.

It also enhanced the effect of insulin itself. When fed to obese mice with symptoms of diabetes, the chemical did not break down in the stomach and reduced the amount of glucose in the animals' blood almost to normal levels (*Science*, vol 284, p 974).

Several years ago, Chris Orvig of the University of British Columbia in Vancouver helped develop a drug containing the metal vanadium that amplifies the effects of insulin. The drug is now in clinical trials. This kind of drug would be most useful for types of diabetes in which some natural insulin still circulates in the body, Orvig says.

In contrast, by mimicking insulin, the Merck compound might be useful in all types of the disease. "It's very promising," says Orvig.

Zhang cautions that while the new compound works in rodents, this does not mean it will work in people. "We are still in the early stage of preclinical studies," she says. "I can't say how this will play out in the end." Jonathan Knight

That's us stuffed then

People living near turkey farms harbour drug-resistant bacteria

EVIDENCE from Dutch turkey farms has reinforced claims that bacteria resistant to antibiotics can spread to humans from farms where animals are fed with antibiotics to make them grow faster. The new findings, published in the *New England Journal of Medicine* (vol 337, p 1158), will strengthen calls for a permanent ban on avoparcin—a growth promotor manufactured by Hoffman-La Roche that has already been banned temporarily on European farms because it resembles an antibiotic.

Last Christmas the European Union suspended the use of avoparcin on the grounds that it might promote resistance to vancomycin and teicoplanin. These antibiotics are the last line of defence against methicillin-resistant *Staphylococcus aureus* (MRSA), a strain of bacteria that is resistant to all other antibiotics. Because avoparcin works in the same way, bacteria that become resistant to it are likely to be equally resistant to both vancomycin and teicoplanin.

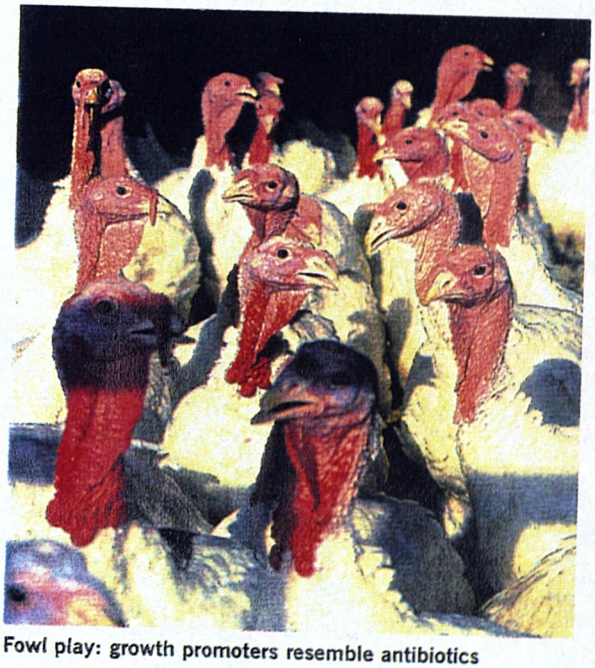
Now studies on 47 Dutch Turkey farms by Anthony van den Bogaard and Ellen Stobberingh from the department of medical microbiology at the University of Maastricht have confirmed that bacteria resistant to vancomycin are much more common in stool samples from turkeys fed with avoparcin. They also demonstrated how easy it is for these resistant strains of bacteria to infect farm personnel and, most surprisingly, people who merely live in the neighbourhood of the farms.

In the stool samples they took from turkeys on the 12 farms where no avoparcin was used, only 8 per cent tested positive for *Enterococcus faecium* bacteria resistant to vancomycin. This compared with 60 per cent on the remaining farms, where the turkeys had been given avoparcin. "This was a much higher prevalence of vancomycin-resistant enterococcus than we expected," says van den Bogaard. In all, half the samples from turkeys were positive. Some 39 per cent of the farmers tested positive, as did 20 per cent of the samples from staff responsible for slaughtering the birds.

But the shock result was that 14 per cent of stool samples from people living in the neighbourhood of the farms tested positive. "This was much higher than expected," says van den Bogaard. "In countries like Sweden, where avoparcin is not used, you find that nobody carries vancomycin-resistant bacteria," he says.

The Dutch researchers, working with Lars Bogo Jensen at the Danish Veterinary Laboratory in Copenhagen, also used genetic fingerprinting to show that one of the farmers was infected with the same strain of vancomycin-resistant enterococci as his turkey. They say this proves that the farmer must have caught the infection from the turkey.

"These people have demonstrated that one farmer out of 47 was contaminated with the same organism as found in one of his turkeys," says David Beighton, head of the infectious diseases research group at King's College London. He says the clinical significance of such an isolated finding is not clear.



Ardea

Fowl play: growth promoters resemble antibiotics

Tony Mudd, technical manager at Roche, says the resistant bacteria could have spread from the farmer to the turkey.

The current European suspension of avoparcin is only temporary, and protagonists on each side of the divide have until May 1999 to furnish the European Commission with new evidence to support their case.

Andy Coghlan NS+

NEWSWIRE

Cutting cancer

Screening women regularly for breast cancer before they reach 50 can almost halve deaths from the disease, a new Swedish study shows.

Women are traditionally advised that breast X-rays are unnecessary before the age of 50. But in a study of 26 000 women aged between 40 and 49, researchers at Sahlgrens University Hospital in Gothenburg found that the death rate among women who had a mammogram every 18 months was 45 per cent less than that of those who had just one X-ray at the end of that period. Better screening could save the lives of 5000 women in Western Europe and 7000 in the US, the researchers say. The results are published in *Cancer* (vol 80, p 2091).

Landmine detector

The campaign to eradicate landmines has received a boost from the European Commission, which last week earmarked £10 million for the development of safer technologies for removing land mines.

Alois Sieber, technical coordinator of the project at the commission's joint research centre in Ispra near Milan, says the programme will focus on developing better hand-held detectors.

Just awards

There is no gender bias in awarding research grants in Britain, say two reports out this week covering the internal audits of the research councils and the Welcome Trust.

Alarm bells sounded earlier this year when two researchers found that to get the same grants from Sweden's medical research council, women had to be 2·5 times as productive as their male counterparts.

Blow up

Four bombs exploded last week outside facilities owned by BioChem Pharma, the Canadian company that developed the anti-HIV drug 3TC. Staff at the sites in Montreal and Laval were evacuated. There is speculation that antivivisectionists may be involved. If so, this would be the first time a Canadian pharmaceuticals company has been targeted.

Best of both worlds

A new kind of rice puts weeds in the shade and trebles yields

MILLIONS of poor rice farmers in Africa may soon be trebling their yields at no extra cost thanks to hybrid plants especially suited to African conditions. The hybrid combines in a single plant the hardiness of a long-forgotten native African strain with the high-yielding qualities of widely grown Asian plants, say rice breeders at the West African Rice Development Association's (WARDA) laboratories in Bouake, Côte d'Ivoire.

The hybrid was made by combining two rice species—*Oryza sativa* and *Oryza glaberrima*. To cross two types of rice that would not normally interbreed, the researchers used a technique called anther culture. They took pollen-producing anthers from individual plants and grew them into tiny plantlets containing a single set of chromosomes.

Treating the plantlets with special mixtures of chemicals makes them generate twin sets of the same chromosomes in each cell, a condition called double haploidy. Once equipped with two sets of chromosomes, the plants are no longer infertile and can form both pollen and ovules. To generate hybrids, these "double haploid" varieties can be crossed repeatedly with either of the parents until plants with the desired set of traits are produced.

Early trials have produced crops that yield 3 tonnes per hectare where only 1 tonne is usually harvested. Improved husbandry can boost yields to 5 tonnes per hectare.

Upland rice farmers in West Africa produce 40 per cent of the continent's rice; the remainder is grown on rainy or irrigated lowlands. The upland farmers usually grow the high-yielding Asian rice *O. sativa* which grows bolt-upright. But the leaves of the plant do not cast much shade, allowing weeds to grow, limiting yields.

Top crop: hybrid grains return a bumper harvest

Ron Giling/Panos

WARDA researcher David Johnson, working with colleagues Monty Jones and Michael Dingkuhn, solved the weed problem by crossing *O. sativa* with its obscure African cousin *O. glaberrima*. This species has been long abandoned by African farmers because it produces such low and variable yields. What *O. glaberrima* has in its favour is the ability to generate profuse, droopy foliage extremely rapidly. This acts as a canopy, creating shade under the plant which limits the growth of weeds. Unfortunately, as the plants develop, they collapse under the weight of their own foliage and the rice turns mouldy on the ground. Also, its grains are fragile and tend to shatter.

When Johnson and his colleagues crossed the two, they generated hybrids which have the African parent's early spurt of foliage and droopy leaves, added to the high grain yields of the Asian parent. Also, the hybrid has the Asian forebear's strong stem, which prevents the plant from collapsing. Most importantly, as far as the farmers are concerned, the weed control comes at no extra cost. "If the shadowing comes free, that really helps," he says.

Jones presented the latest data this week in Malacca, Malaysia, at a rice biotechnology conference organised by the Rockefeller Foundation. **Andy Coghlan** NS+

Outwitting a deadly duo

PLANT biotechnologists have struck a major blow for rice farmers with a genetically engineered strain of the cereal that can resist rice tungro disease. Epidemics of this viral infection can destroy up to 90 per cent of a crop.

Two viruses are needed to transmit rice tungro disease from plant to plant, and epidemics only occur when plagues of leaf hoppers are around. The symptoms of the disease are caused by the DNA-containing rice tungro bacciliform virus. But unless the RNA-containing rice tungro spherical virus is also present, the leaf hoppers cannot produce a protein they need to pick up the infection and pass it on.

"Our goal has been to block either virus, knowing that this should prevent transmission between plants," says Roger Beachy, leader of the International Laboratory for Tropical Agricultural Biotechnology based at the Scripps Research Institute in La Jolla, California. Scripps collaborated with researchers from France and Malaysia on a 10-year project to produce the tungro-resistant rice strain.

The researchers equipped rice plants with copies of viral genes that allow them to make the same proteins the viruses do. In a virus, these genes make the infectious agent's protein sheath or a protein that helps it to replicate.

Rice plants containing these viral genes are resistant to tungro. As soon as the viruses encounter viral proteins or strands of viral RNA in the rice, they stop replicating, says Beachy, though no one is yet sure why this happens.

Researchers at the Malaysian Agricultural Research and Development Institute in Kuala Lumpur have been growing the altered plants in greenhouses, and have exposed them to leaf hoppers carrying the virus three times within a month. Many of the plants remained healthy, while normal rice died. "The best plants resisted all three waves of attack," says Beachy. NS+

Sensor sensibility

Control that computer with a wave of your hand

WHO needs computer mice or data gloves cluttering up our desks, asks a team at MIT's Media Lab. Instead, they have created a "sensory tabletop" that keeps track of your hand as you move it around. But rather than being limited to two dimensions, the table can accurately detect the motion of your hand in three dimensions.

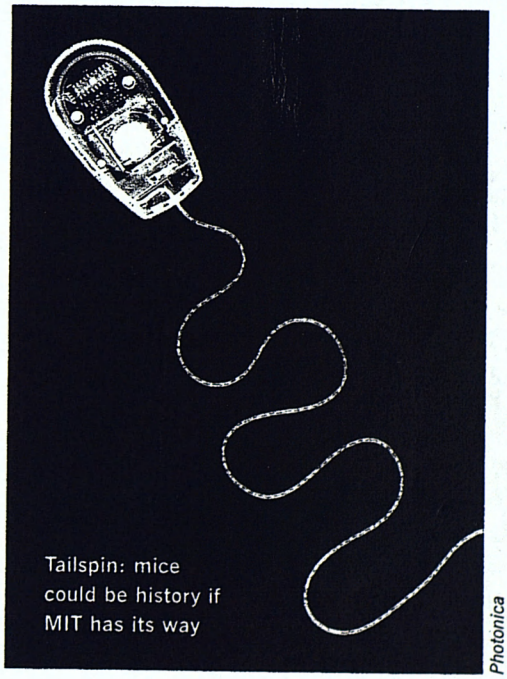
Physicist Neil Gershenfeld wants computer users to enjoy their technology built into attractive furniture. "So instead of it being your job to find the mouse, it's the table's job to reach out and find you," he says.

Gershenfeld developed the new system with the help of his former student Josh Smith. Electrodes build into the surface of the table induce tiny currents of the order of nanoamps in your hand. Your hand in turn, induces detectable currents in the coils embedded in the table top.

From the distribution of current in coils across the table, mathematical algorithms calculate where your hand must be in 3D space to create such currents. In this way, the technology could be used to control 3D special effects or computer-aided design software.

The technique mirrors one used by geophysicists, who face a similar problem—but the other way up. By sending electric or acoustic pulses into the ground, they can then measure the pulses that return and attempt to use these to describe the matter beneath the surface. But it's no easy task. "Supercomputers grind away for weeks on these problems," explains Gershenfeld.

But the MIT team have refined their algorithms so the table sensor works on low cost computers. Their next step is to develop the system so that the sensor table can generate a 3D computer image of the hand above it. **Duncan Graham-Rowe**, Boston



Tailspin: mice could be history if MIT has its way

Photonica

Clear and present danger?

MYSTERY surrounds the alleged hijacking of a military communications satellite. Computer hackers are said to have held one of Britain's five Skynet craft to ransom. The Ministry of Defence denies any such attack took place—yet computer fraud detectives at Scotland Yard confirm that they are investigating the matter.

Given that much of Britain's military intelligence at such global troublespots as Kosovo comes via the Skynet network, military officials would see such an attack as a dangerous breach of security. A Scotland Yard spokesman told *New Scientist*: "Officers from the Metropolitan Police Force Fraud Squad are investigating an allegation of a hacker who is believed to be targeting several different international sites some of which may include military installations."

But the MoD is dismissing the story, published in this week's *Sunday Business* newspaper. "All our satellites are on course and we've had no problems at all," says an MoD spokesman. The encrypted radio commands that control the satellite are uncrackable and part of a closed control system, not linked to the outside world, he adds.

The fifth Skynet craft was launched last Friday, and its manufacturer, Matra Marconi Space, says it has anti-jamming features that let it survive "in the harshest of electronic warfare environments". But three of the satellites are over 10 years old, calling into question the effectiveness of their security features.

TECHNOFILE

News hungry

Want to read the news over lunch but find newspapers awkward? Never fear—you could soon be reading the news on fruit, vegetables, nuts or cheese crackers. Researchers at MIT have come up with a way to combine news consumption with food consumption by etching the headlines onto foodstuffs. Their tool is a modified laser cutter that's normally used for etching plastics. The researchers say fruit could be made more fun for kids by engraving pictures on it—and that wasteful packaging could be reduced by having bar codes and sell-by information placed directly on the food. See what it looks like at *http://dsmall.www.media.mit.edu/people/dsmall/food/index.html*.

You've got mail

Want to send e-mail but haven't got a computer? BT has an answer for Britain. This month, the firm will launch a keyboard and phone with LCD display that lets people send and receive e-mail. The Easicom 1000 costs £180, and has an LCD screen and small Qwerty keyboard. Owners get five e-mail addresses without subscribing to an Internet service. Instead, they pay 25p per minute to connect. If messages are prepared, it takes around 30 seconds to send and receive a couple of messages. The unit also works as an ordinary phone with calls charged at normal rates.

Pass the earplugs

The University of Leeds has developed a way of making drumsticks that are noisier and longer-lasting. A solid blend of polypropylene and polyethylene is drawn through a metal die at a temperature below its melting point. This aligns the molecules in long chains to produce drumsticks that bounce as stiffly as hickory, but which can be struck harder because they are three times as strong and yet last five times as long. Canadian company Tech-Triangle is to license the British process for a new range of sticks.

Dave Ellis/Redferns

THIS WEEK

Elixir of youth

What stops us growing old? Brewer's yeast points to some possible answers

A PROTEIN that keeps people youthful also wards off the ravages of old age in a single-celled yeast, American scientists have found. They suggest that such "longevity factors" may have come into being early on in evolution and still be common to a wide range of species.

The researchers think that the protein prolongs life by protecting a compartment in the cell called the nucleolus, where critical pieces of ribosomes—the protein factories of the cell—are copied from chromosomes. "This seems to be the Achilles heel of the cell," says the leader of the team, Leonard Guarente of the Massachusetts Institute of Technology near Boston.

J. Cotier/Tony Stone Images

Ravages of time: a missing protein leads to premature ageing of cells

Guarente's work was inspired by studies of Werner's syndrome, a disease caused by a rare defect in a human gene called *WRN*. Patients without a working copy of *WRN* turn grey-haired in their twenties, their skin wrinkles, and they develop diseases usually associated with the elderly, such as cataracts and osteoporosis. Most die before the age of 50.

Last year, researchers sequenced the *WRN* gene and discovered that it codes for a helicase, an enzyme that unwinds the double helices of DNA or RNA. Since then, researchers have been keen to understand how *WRN* fends off ageing in healthy people, since it might give some clue to the normal ageing process.

Meanwhile, Guarente's team had been studying how the humble brewer's yeast, *Saccharomyces cerevisiae*, grows old. This microorganism reproduces by budding, in which a large "mother cell" sprouts a daughter cell containing a copy of its chromosomes. A healthy mother cell can produce a few dozen buds before perishing.

The researchers wanted to know if the yeast's version of the Werner's gene, known as *SGS1*, was also involved in ageing. They used standard genetic tricks to disrupt the *SGS1* gene in yeast and followed mother cells to see how many times each budded before dying. Without a functional *SGS1* gene, the cells produced an average of 9·5 daughter cells. But yeast with a healthy gene lived twice as long, budding 24·5 times.

Guarente's team has also found some hints to how the SGS1 protein slows ageing. First the researchers showed that the protein was concentrated in the nucleoli of yeast cells. When the gene for SGS1 was disrupted, the nucleolus broke into pieces as mother cells neared the premature end of their lives. Intriguingly, cells with normal *SGS1* also had fragmented nucleoli as they neared the end of their days (*Science*, vol 277, p 1313). That suggests to Guarente that SGS1 stalls ageing by unwinding and stabilising DNA inside the nucleolus. Sooner or later, however, the cells die when the nucleolus is smashed to pieces.

"This is first-rate science, beautifully executed," says George Martin of the University of Washington in Seattle, part of the team that cloned and sequenced *WRN*. He adds that the work is sure to focus attention on the nucleolus's role in ageing. But he warns that even though human *WRN* and yeast *SGS1* are similar, it is still unclear whether their function is the same. "The jury is still out on even that basic question," he says.

Guarente's group is planning to close the gap between mammals and microorganisms by seeing if nucleolar changes accompany the ageing of cells in Werner's syndrome patients.

Philip Cohen

TECHNOLOGY AND BUSINESS

GEORGE LEPP Tony Stone Images

DRUG FACTORY OF THE FUTURE? Corn can be mutated to make human anticancer proteins.

BIOTECHNOLOGY

PLANTIBODIES

Human antibodies produced by field crops enter clinical trials

Down a country road in southern Wisconsin lies a cornfield with ears of gold. The kernels growing on these few acres could be worth millions—not to grocers or ranchers but to drug companies. This corn is no Silver Queen, bred for sweetness, but a strain genetically engineered by Agracetus in Middleton, Wis., to secrete human antibodies. This autumn a pharmaceutical partner of Agracetus's plans to begin injecting cancer patients with doses of up to 250 milligrams of antibodies purified from mutant corn seeds. If the treatment works as intended, the antibodies will stick to tumor cells and deliver radioisotopes to kill them.

Using antibodies as drugs is not new, but manufacturing them in plants is, and the technique could be a real boon to the many biotechnology firms that have spent years and hundreds of millions of dollars trying to bring these promising medicines to market. So far most have failed, for two reasons.

First, many early antibody drugs either did not work or provoked severe allergic reactions. They were not human but mouse antibodies produced in vats of cloned mouse cells. In recent years, geneticists have bred cell lines that churn out antibodies that are mostly or completely human. These chimeras seem to work better: this past July one made by IDEC Pharmaceuticals passed scientific review by the Food and Drug Administration. The compound, a treatment for non-Hodgkin's lymphoma, will be only the third therapeutic antibody to go on sale in the U.S.

The new drug may be effective, but it will not be cheap; cost is the second barrier these medicines face. Cloned animal cells make inefficient factories: 10,000 liters of them eke out only a kilogram or two of usable antibodies. So some antibody therapies, which typically require a gram or more of drug for each patient, may cost more than insurance companies will cover. Low yields also raise the expense and risk of developing antibody drugs.

This, Agracetus scientist Vikram M. Paradkar says, is where "plantibodies" come in. By transplanting a human gene into corn reproductive cells and adding other DNA that cranks up the cells' production of the foreign protein, Agracetus has created a strain that it claims yields about 1.5 kilograms of pharmaceutical-quality antibodies per acre of corn. "We could grow enough antibodies to supply the entire U.S. market for our cancer drug—tens of thousands of patients—on just 30 acres," Paradkar predicts. The development process takes about a year longer in plants than in mammal cells, he concedes. "But start-up costs are far lower, and in full-scale production we can make proteins for orders of magnitude less cost," he adds.

Plantibodies might reduce another risk as well. The billions of cells in fermentation tanks can catch human diseases; plants don't. So although Agracetus must ensure that its plantibodies are free from pesticides and other kinds of contaminants, it can forgo expensive screening for viruses and bacterial toxins.

Corn is not the only crop that can mimic human cells. Agracetus is also cultivating soybeans that contain human antibodies against herpes simplex virus 2, a culprit in venereal disease, in the hope of producing a drug cheap enough to add to contraceptives. Planet Biotechnology in Mountain View, Calif., is testing an anti-tooth-decay mouthwash made with antibodies extracted from transgenic tobacco plants. CropTech in Blacksburg, Va., has modified tobacco to manufacture an enzyme called glucocerebrosidase in its leaves. People with Gaucher's disease pay up to $160,000 a year for a supply of this crucial protein, which their bodies cannot make.

"It's rather astounding how accurately transgenic plants can translate the subtle signals that control human protein processing," says CropTech founder Carole L. Cramer. But, she cautions, there are important differences as well. Human cells adorn some antibodies with special carbohydrate molecules. Plant cells can stick the wrong carbohydrates onto a human antibody. If that happens, says Douglas A. Russell, a molecular biologist at Agracetus, the maladjusted antibodies cannot stimulate the body into producing its own immune response, and they are rapidly filtered from the bloodstream. Until that discrepancy is solved, Russell says, Agracetus will focus on plantibodies that don't need the carbohydrates. Next spring the company's clinical trial results may reveal other differences as well.

—W. Wayt Gibbs in San Francisco

Appendix H

Example of think-aloud protocol

(one student)

1. Muck into Medicine

Student: B1

S: I've known only a part of biology. This article seems to be out of my depth (difficult). Actually I have no idea about it, but the picture's colour is beautiful. The headline, Muck into Medicine, is also unknown to me. I know this soil bacteria and think that it might make money. Firstly, from the first paragraph I did not know the word 'maxim' but when I kept on reading I thought that it should be the company's name that did an experiment about the bacteria. It said in the paragraph that 'guided by the maxim that...., a Canadian biotechnology company says it..... .

T: You have never heard the word 'maxim'?

S: 'The maxim that where...' is a place? Oh, it's a proverb. It said that where there was muck, there was money or medicine. I think 'muck' might be bacteria because it said about money or something with a big amount that they got and they called it 'compound'. The story said that 'useful compounds made by soil-dwelling microorganisms'. I think firstly they found compounds, secondly, they extracted medicine from lichens. In my view, lichens should be one kind of microorganism or it might be a kind of plant.

T: Have you ever heard of 'lichens'?

S: I've heard this word but I can't remember what it is.

T: This is a picture of lichens.

S: Oh, they grow on the stone and the earth, do they?

T: Yes, have you ever seen them before?

S: Yes, but I'm not sure about the real ones.

T: They are the same as the ones in this picture.

S: Yes, from the paragraph they said that they would make use from lichens and some kind of substance from microorganisms in soil. Then, there had been a problem.... In the third paragraph, it said that ' ...has sidestepped this problem....'. So, this made me look back to see whether it was as I had thought before. They said there was a problem while in my view everything was going well.

T: When you saw it, you went back to the second paragraph?

S: Yes, I did. But I had stopped at the last sentence saying that there was only 1% of soil microorganisms...I am not sure whether the 1% in this sentence represented

positive or negative outcome in their senses. Because from the third paragraph when they had known the problem they used a chopping method with the DNA to get the following results as said in the next sentences. This third paragraph explained what they had done. The 'doers' should be a company, TerraGen. From the third, fourth, fifth and sixth paragraphs, they told us about the method they had used with DNA and the outcomes they got after that. I found the word 'novel chemicals' and I had no idea what it was. However, I reread this sentence " Because the company is already familiar with the chemicals normally produced by the host, it only has to look for a handful of novel chemicals.....". It said about which one was old. So, I guess that 'novel' means 'new'. They said that they had transplanted DNA from one place to another, then they used the results to produce antibiotics which is used for medicine. This was an innovation. I conclude that what they had tried to explain was about useless things had been produced to be a drug, analysing something to be a medicine. Finally, they also used this kind of method with fibre, paper and textile industries as well.

T: Do you always survey every paragraph?

S: Yes, it helps me to understand the whole idea of the text.

S: Do you understand the content details?

S: I can understand a little - not really in detail.

In the fourth paragraph they said that they could extract a new kind of substance from 15,000 species of lichens. These species had included algae, and also fungi. From 15,000 species, they said that TerraGen did it secretly but after that it revealed the bare outlines of its techniques from this I think that it meant no secret at all. Firstly, soil or lichens had to be separated out, or separate micro organisms from soil to see what kinds of substances it contained. I think that they might put something in the samples to destroy *soilborne substances* (she doesn't know these words), maybe acid in order to get only living microorganism.(reread) Why they used the word 'once'- it seems that they wanted to describe something in the past. Then, when the microorganisms had been separated, they would be treated by a kind of substance putting in, to break away DNA in groups. Actually, I am not sure what this 'chunk' means. I've seen it in a book and made me feel that it should mean groups.

T: Have you heard anything relevant to the picture before?

S: No, I haven't. But I think it is in our body. Just that – that's all I know. After the DNA were separated into groups, they stopped doing the same process and called the groups plasmids. I think that it was about exchanging genes. Organisms were exchanging genes. What were organisms? (The student reread)
'The microbial genes can be transplanted into their hosts'- I'm not sure about this word, transplant. (She translated into Thai)

T: How can you know this vocabulary?

S: I seem to have heard this word before. Trans means to move from some place to another place and plant is plant or lichens. This means move from this place to that place. It was to exchange between hosts and there was 'transplant between hosts and organisms'. It might be gene exchange and the hosts might be E.coli or fungi.

T: Have you heard this word, E.coli?

S: Yes, it is in water causing bad health if we consume it. This exchange created antibiotics in the hosts. After the exchange, this same technique...(reading) ' this alien gene'...I guess it means from other planets- I've heard that before. Genes transplanted from old DNA to the hosts turned into alien genes- they said this was not a new. (pause)
It is this.. 'are nothing new'. The alien genes being created by transplants in the hosts was not new. They, biotechnology something, might have known this before. DNA alphabet...

T: Have you heard this word before?

S: No, I know alphabet.

T: And you also know DNA.

S: Well, it is a genetic substance in our body and can transfer. I think it was about some genetic transfer from those diseases to the hosts. After receiving the diseases, hosts were creating antibiotics in their bodies. Finally, they would extract those antibodies to make some drugs or to use in any industry.

T: Have you heard how to make antibiotics from lichen before?

S: No, I haven't. I've heard some but not from lichen. I've heard about injecting disease into a horse and we can get serum from the horse to inject into our body. Never heard of fungi.

T: Have you never heard about penicillin before?

S: Oh, yes, how can I have forgotten it, penicillin? I think it should be the same. They gave much more details. That's it. They use lichen because there is a lot of lichen in our world. Yes, they make a useful thing from the useless.

The problem in the story was that it could not grow in the laboratory. They solved the problem by chopping the DNA of the microorganisms into chunks. Then they gave us a lot of details.

From this, I had to read very slowly because I could not imagine it.

Actually I could imagine some, but some verbs I could not imagine how they did them especially the clear process because I've never been in a laboratory before. I've never known any laboratory equipment. I've talked with someone who studied biotechnology and I have read their books. But I can't imagine what the equipment is.

T: Do you usually imagine what you read?

S: Yes, but in the documents they use technical terms, put these chemicals into that one at the amount of some quantity which is very difficult for me to understand.

T: In this article they started by putting soil in centrifuges. Can you imagine it?

S: No, I can't. But I think that it is important. I will not underline where I think it's not important. But for this, I could not imagine, I did not know them and I guessed they should be kinds of containers. Firstly, I didn't know what 'series' was, but I thought that it should be 'more than one'. It might be many items. Because I'd seen 'series', but....

T: Why did you circle 'it's'?

S: Firstly, I was not sure whether 'it's' meant TerraGen's technique. But after keeping on reading, I thought it was because they started from here telling what they had done and how it had been done.

T: Do you understand after rereading or continuing reading it?

S: I read only once but it's an intermittent reading, that is, read over and over the sentences which I didn't understand. And the vocabulary is very difficult. I read the whole story only once because I thought that it's useless to reread since I didn't understand it.

T: Do you find the vocabulary difficult?

S: Yes, I normally guessed because I had no idea about it, for eample., alien, from other planets.

I'm not in this field. This is what I do not know. Is it correct?

T: Yes, it also means something strange. And do you know the word 'host'?

S: I think I know it. Just like a tree, when there is a parasite on the tree we call the tree a host.

T: Do you pay much attention to the specific names, such as., TerraGen?

S: Oh, no, not really. I think that they were scientific names. I guess from the Italic print. Some of them might be diseases' names. Italic fonts are always used for specific names. I did not know them. If the scientists had read this article they should have known what those names were because they came from Latin words.

T: The picture can not help you at all?

S: It is beautiful with bright colour. I still don't know whether they were in real soil or from a laboratory. I've never seen them before. Are the real ones as same as this?

T: Have you never seen the real ones before?

S: No, I've not.

T: I've heard that you like to travel in the forest.

S: I've seen them as a small green cluster on the ground surface, not as many colours like this. Firstly, I thought that it's a picture of coral.

2. Cloth of Ages

Student: B1

S: Firstly, after seeing the topic I thought that it was about mummy's wrapping cloth that told us the mummy's age. But after reading for a while, I thought it was about beautiful dressing of the mummy wrapped with cloth. Also there were something buried with the mummy. In conclusion, the article was to criticise an author namely Barber. At first I didn't think it was about criticism.

T: How do you know?

S: The article told us who was doing what. There was a discovery of mummies in Urumchi. During my reading I thought that the story told us about what was going on after the discovery, and what was discovered from the mummies. Then, there was a sentence saying ' what do the finds say about early connections between china and the West, still a politically sensitive issue?' which I thought it should have been about a political issue, but it wasn't.

From the first paragraph it should have been like that. But from the second paragraph, they told us where the mummies were found and where they were kept,

which is, in the museum. Then, someone named, Mair, returned there to study with Barber. After that, Barber had written a book telling about what she had found. I had found a lot of 'burial'. Firstly, I didn't understand what it meant. Finally, I thought about 'bury' and these two words should be relevant with each other. 'Burial' should mean what they have buried.

T: Do you guess from what you have read?

S: Yes, I do. Firstly, I forgot what 'bury' means. But after reading for a while I was sure what it was. Then, I reread from the underlined 'burial'. I didn't know the meanings of all words. I started having a problem (about vocabulary) from the fourth paragraph. I didn't know what 'explorer' meant. I was not sure it was about discovering or discoverer. When I found the name 'Marc Aurel Stein' I realised that it should be a discoverer. They explored a mountain of the Himalayas and 'uncovered'. I was not sure about this word. It might mean 'not found'? They tried to explain what they had found during exploration. 'Most people', this word meant the mummies because there was no context prior to this. And then the word 'burial', this should mean things that were buried together with the mummies. However, after reading further, I was not sure that 'those people' were 'these people' and whether the mummies were large-nosed, with blonde hair and blue eyes or not; and where those people came from to live in Tarim basin. When I saw 'their graves' I concluded that the people were the mummies. They were tall mummies and they were buried. After that the story told us about their dressing. The next paragraph said that 'Barber was shown only a fifth of the material in Urumchi...'. This meant that during the excavation they found a lot of things . They wrote here 'number, number fifth'...only one.

T: Do you understand clearly?

S: I am not sure whether this number fifth was the thing they discovered. This is the paragraph that I could not understand clearly.

T: Then, what will you do?

S: I tried to finish the whole paragraph but still got stuck. I started to understand that this was a book criticism. When I found 'two-thirds of the book', I realised that it was her book. Around 3-4 lines from this paragraph that I was not sure what Barber told us about. (she reread) I could understand what they had found, sizes of clothes, but... I thought that they tried to explain a basket, shoes, and so on. 'Sparkle ' meant lightening, but 'spark off' meant 'turn off', isn't it? That made

what she had studied failed. Then, the story told us that it was lucky that we could find something. Oh, unfortunately again that Barber explained little details, only two-thirds. The story told us about background, then, about the book again. This background told us what the mummies were after the study of the things that had been discovered, they were telling about root of words for textile technology. Then, Barber had concluded that the weaving was brought from the Western people who used to live in Tarim basin. Oh, I couldn't understand the last sentence. What does this mean 'felt-making locally'?

T: What would you do when you do not understand?

S: I tried to reread but I still could not guess. So I skipped.(Reread) I think they were the people who used to live there, the local people. Actually, I don't know the word 'felt' but when I saw the word 'tartan' which I thought I had seen it before. It reminded me about fluid for covering the mummies' cloth. And this word 'close link' might mean 'belong to the mummies'. Yes, linking to the technique, weaving technique. I think it should be the same or nearly the same but I'm not sure.

T: Do you know 'Celts'?

S: It was a capital letter so it should be a specific name but I have never heard it before. I have seen only the word 'tartan'. It might mean that mummies of Italian, English used to be wrapped with the same technique as these mummies. Then, Barber told in her 2-3 last chapters that from the findings it might be concluded on the settlement of those people.

T: You say you have heard 'tartan'. Where have you heard this word?

S: I have read it in a comic about Pharos's curse. It told me how to make mummy. I also have heard this word 'fragile', but I can't remember from where. But I think it should be relevant to textile.

T: 'The mummies and their textiles are exceptionally fragile.'

S: I have seen this but I can't remember. It doesn't mean a disease?

T: No.

S: I have seen this word.

T: From where? On a box?

S: A glass box, easy to break.

T: Firstly, what did you guess?

S: I didn't guess at the first time. When I continued reading I could not understand so I stopped. I nearly understood but I could not. They told us about damage and

decay. It was a report about authoritative...(long pause).They needed clear and complete pictures, a finding report with clear pictures. They talked about Barber .....But Barber did not do it thorouhly .It was incorrect colours. The line drawings, meant drawing on clothes, did not show how it was made. They said it might come from bad publishing. Actually 'colloquialisms' means 'to be familiar with', isn't it? Also this 'kick the bucket' I didn't know what it was. I still doubt that how the author knew that the colour was wrong or he had the real one to compare. Or the author guessed, I didn't know because I didn't understand the whole story. (she reread) The author tried to tell us about the incomplete of the work resulting in the academic reliability, I am not sure.

T: You said you still do not understand. This is because of vocabulary or because of something else?

S: I tried to find subject and verb but some vocabulary I did not understand.. I think it because of incorrect colours and pictures. But I didn't know how the author could know or he compares with the real ones. Maybe this, 'it is full of tiresome..'. But I could not translate all so I didn't know what it was about. The author told us many paragraphs about Barber's work and only told about the problems in the last one.

T: Do you see the link between each paragraph?

S: Well, they told us continuously what had been found. It's a way of writing to increase more details who were studying, what were found after the study and more explanation.

T: How do you feel when reading this text?

S: I was not sure whether the story ended. I don't know why the author started an introduction like this but he did not continue his story. Firstly, I expected to see more than this but I could not find it.

T: Do you pay more attention in any specific names, e.g., Urumchi or something like that?

S: I tried to think whether I had heard this word before. I thought that it was one town in China. So they named a museum after it. By the way, what does 'tantalising' mean?

T: Can you guess?

S: This is what the archaeologists expected before they found something, isn't it?

T: Did you see the picture?

S: Yes, I did. Firstly, I didn't think it's a picture of Western man but it looked like an old Chinese.

T: Do you understand the story well?

S: Yes, but I am not sure whether I understood the whole story. What did 'colloquial' mean? It meant 'familiar'? The author also stated barber's work as 'hastily'. Yes, he said that 'Sadly, Barber's is a hastily conceived and executed work'. I didn't know the words 'conceived' and 'executed' but could guess that they were all negative. What does 'conceive' mean, doubtful? The whole sentence means her work is incomplete and needed to be continued.
Oh, the price is $20.

3. Get stuck in

Student: B1

S: I could understand but not in detail. Some words I had never seen before. It was about football boots which I had never paid attention before. However, I knew that they were called a stud and were used in a game that needed a grip to the ground, for example, football. The story told us that there was a new launch of new stud with a different design from the old one, a cone shape. There might be a development to become a pyramid shape with a thin flat edge that could increase or reduce something. They used plastic which is a mixture between metal and plastic to make the underside of the stud and they also made thin flat edge boots. What is it? Wait, wait, and what made it better, then?

T: Take it easy.

S: I reached this part where a lady tried to explain why the thin edge ones were better. Yes, the thin edge of the boots could help dragging, which I think in this case, it was leg dragging or running, to be better. I didn't know actually that how good the stud was. But during playing game there was stepping. It was impossible to stay put and grip to the ground. We should change our position. So, the studs together with the thin flat edge boots could help for better movement. I was not sure what this 'fluid' meant. Maybe it was about fluid dynamic or something else, which I thought that it might result in the newly designed boots. This might decrease a chance to get less ankle injure during our movement. The old style boots might not be able to grip well in soft ground or they might slip easily. The new boots were

said to be better in gripping. However, the story said in the final paragraph that the conventional boots had been used for 40-50 years and there was nothing wrong with them, so, the player was the one to judge it.

T: Did you read ahead to the last paragraph?

S: Yes. But I started at the first paragraph to get the idea. The first paragraph told us about the launching of the new boots and told us how they were better than the conventional ones, from what the studs, were made.

The second paragraph, the research team told us about the weak points of the conventional boots comparing to the strong points of the newly designed boots. They said the new boots were better in gripping the ground, no matter what the ground condition was, e.g., soft. The conventional ones might not be good at soft ground grip.

The third paragraph, they said that the stud would give good grip when the player was moving forward. But with too much grip, he might be injure. I thought that the new stud might be suitable and might not give too much grip or something like that.

T: Do you survey every paragraph?

S: Yes. The next paragraph told us that there were tests after the design for its quality. I didn't understand what 'acceleration' was. I had seen this word before but I couldn't remember. '13 %, equivalent to a half-metre head start over the first five metres'. I didn't know why it was good. I didn't understand why 'the first five metres' start was important with this stud. I didn't understand the first part of this paragraph, but I knew the end. They designed this stud by using a so-called 'computational fluid dynamic'. I didn't understand this..(reread) 'there are two main components of the force affecting an object in a fluid..' I guess that they might use fluid dynamic in the stud design. There were 'form drag' and 'viscous drag' (she does not know their meanings). This stud was mainly relevant in 'form drag'. (She reread)

T: During your reading, do you try to analyse the sentences?

S: Yes, I did but I got stuck in some vocabulary. Yes, vocabulary is my problem and I couldn't imagine why they did the tests. When I got stuck in some paragraphs, I would get stuck in the following ones. I knew that there were tests about the stud's quality but I didn't understand what the average 13% result was. (she reread) They said about the first five-metre start, didn't they?

T: Yes.

S: But they didn't tell us what the result was. They said that in the initial test by amateur players, the stud could improve acceleration. What was acceleration?

T: Could you guess?

S; I guess it was a good point of the stud. How is it good? It's not a speed. This means the new stud had 13% improvement in acceleration which was equivalent to a half metre heading for the first five metre when comparing to the conventional one. Equivalent means equal?

T: Yes.

S: 'Peter and Fred modeled the forces acting on the studs using computational fluid dynamic.' This 'model' meant 'design a stud'? I am not sure what 'object' was. Actually I didn't understand starting from 'fluid dynamic'. I am not sure whether it meant the direction of fluid or not.....I think it used a theory of Fluid Dynamic together with a computer. It was also told that one main component of force affecting an object was form drag. It meant the way we pulled (dragged) our legs to the left and to the right? It depended on the shape of the object. The object's shape would affect its movement. The shape of the object affected a direction of its movement. But another drag component depended on the surface where we dragged the object through and this object was a shoe, right?

T: Well, it's a theory saying that the movement depended on a shape and the surface.

S: That was the way the new stud had been designed. It concentrated mainly on the movement. They said that after an experiment...'they found that Mitre's design could theoretically boost initial acceleration by up to 40%'.

T: Yes.

S: (Reread) 'The softer the pitch the greater the improvement'. Let's look at the chart. The graph told us two types of soil, soft and hard. It said the harder the soil the greater the acceleration. That is for the harder soil the new stud was better. The new stud could get a better grip and it was accepted but I didn't know what would be going on because it said the conventional stud also had been used for a long time and nothing was wrong with it. That's it.

T: Before you started what did you do first?

S: I looked at the heading first, 'Get stuck in'- I didn't know what it meant. Then, I looked at the picture. It was a shoe called a stud. I was not sure whether there was anything changed (read from the small heading) with studs. Also I didn't know

what 'a head start' meant. But I thought from 'head' that it should make something better, e.g., for a football player or for a runner. What was a head start?

T: You can imagine?

S: Yes, I've seen it in a movie 'The horse whispering'.

T: Then, go on please.

S: If there had not been any picture I might not have understood. I didn't look at a graph and the part relevant to it because I could not understand it. Then, I skipped to the following part. This is my habit in reading. I'll skip what I don't understand first and come back after reading other parts and try to connect the whole story with the known parts.

T: When you read the title and looked at the picture, have you got any idea?

S: At that time the answer was none. But after reading the first paragraph I thought it was the main idea because it could get along with 'reshape'. The paragraphs after that did not tell us more except that how it was made, what they had done, what the usefulness was. That's why I thought that it was the main idea.

T: Then, you read every paragraph orderly?

S: Yes, orderly except ones I couldn't understand so I skip and come back again after finished all.

T: What did you do with the difficult vocabulary?

S: I tried to guess by using a context. Sometime it's very difficult for me to guess, for example, acceleration. Here in the first paragraph, line sixth it said ' ...and can increase acceleration over the first five metre...' I could understand when a person ran for five metres and then, what's next? I couldn't find any context linking what acceleration meant. So, I skipped.

T: Did you read every word?

S: Not really every word. The paragraph which I could understand I would pass my eyes through it (skimming?). I would skip when I did not understand. But in a paragraph like 'Initial tests..', when I saw any word I couldn't understand, I would try to rearrange to understand it.

T: You also reread?

S: Yes, where I couldn't understand. If I still did not understand I would try to analyse the sentence where the subject was, where the verb was, etc. But I still couldn't understand (this paragraph). I didn't know why, maybe because of vocabulary or because I didn't know why they did this. I would get it (understand)

if I had used to know it or had done it before because I could know what the consequence would be. But in this case, I didn't know why five metres, why they had to run. Together with the word acceleration that made me not understand more. But I knew that they were going to test and the result was 13% better that I also couldn't understand. I knew what had been done but not in detail. I didn't understand some that I didn't know why they had to be done.

T: During your reading you also asked yourself some questions?

S: Yes, for example, why they did this or that. And what the conventional studs looked like because there was no picture. I also asked myself what the thin edge was and what was the difference between the new one and the conventional one.

T: This means you tried to imagine its picture?

S: Yes, I did but I have never touched it (stud) before in my life. First, I thought it was the one covering ankle which was a conventional one. The new one they said it would help protecting ankles. Maybe it made too much grip on the ground so the ankles might injure. And how they knew whether the soil was soft or hard. Was it suitable? I continued my imagination but mine was an old style boot.
I tried to imagine a football field but I had seen it from very far.

T: Anything else did you use to help you get more understanding apart from the imagination and the text?

S: Mainly, I tried to find the main idea. I tried to find out whether this company said about the conventional studs but I couldn't see it. The company told us about their new invention. It seemed to me that they also attacked themselves. I also tried to analyse what subject was, where the verb was, etc. But this part I read very few... Well, I had read it but skimming because I knew what it was about.

T: So, you paid less attention because you knew it.

S: Yes, I paid less attention because I knew it already.

T: You came to the graph lastly?

S: Yes, because the second sentence was the last sentence of this paragraph. So, I skipped and came back to see what the graph was later.

T: When you finished the whole story did you try to organise it?

S: Not yet. Firstly, I tried to understand what this part meant. Then, I reread the whole story to see what they were talking about. I could get the whole picture that how the boots were made, and what Jenny Mitchell, a researcher, talked.

T: O.K. Thank you very much.

4. Word Power

Student: B1

S: This time vocabulary was not a problem. The vocabulary was rather simple. During my first reading, I did not know what 'exact' and 'approximate' were. But when I continued reading I found something that made me know them, then I reread from the beginning.

T: What did you find?

S: I did not mark it. Oh, yes, I found it in a parenthesis saying that 'does 53 plus 68 equal 121....' and this one 'is 53 plus 68 closer to...' which meant a clear value while 'appropriate' was roughly or nearly. I felt that if I didn't know these two words I could not continue my reading. I was not sure so I had to go on reading until I was confident 'yes, it was'. I was reluctant to go on because I felt that I had to know their meanings. They should be important because there were lots of them in the story. However, I continued reading until I realised what they were. Then I start reading again. I looked at the picture, its heading, 'Word Power'. This made me understand that it should be about how to use a word without any speech to calculate. (she read- 'without speech, we can't calculate'.) And if we saw a number or a figure, a sign instead of an alphabet in the first sentence we could not do anything, could we? (she reread- 'our brain can make rough....') I thought that our brain actually could roughly calculate anything without help from the language. I realised that it might be about a picture instead. But 'exact calculation' needed a language to help. And I was not sure whether attached signs represented the word 'language'. When I continued reading they said that the scientists had long wondered whether the language was required for maths. Then, they had done many experiments. I did not understand the first experiment. I could not imagine what it was though I knew every word they said. I did not understand how the babies knew because they said that though they did not know the language or the 5-month babies who did not know the language but could understand the numbers. I understood that the following paragraph was a result and an explanation of the experiment in the above paragraph. It seemed to me that it was but finally I was not sure....I had no idea but I guessed that..... I guessed that it meant something showing a surprise when they or the babies saw someone put dolls behind the

'screen'...I guessed this meant a frame. Then, they raised something or the screen and there was only one doll left. I didn't understand how the babies knew the number. I also didn't understand the performance and other.

T: You know what 'number' meant, didn't you?

S: Yes, I did. It's arithmetic amount.

Firstly when I read I thought it was arithmetic quantity but when reaching the experiment it might not mean quantity but it was 'thing'. The story did not tell how the babies knew it. I was not sure what 'raise the screen' meant. To lift the screen up, right? Firstly they told that the babies had seen 2 dolls behind the screen and then they saw only one doll left, right? They were surprised why only one doll left. This meant that they know that firstly there were two dolls. I also was surprised how they knew this. The scientists might observe from the babies' expression, right? The story did not tell us clearly how they observed. Maybe they used 'non-verbal' or something like that. I have read about an experiment which showed that a bird did not know number. It did not know whether any of its chicks was lost or existed if it still could hear their chirps. It could not count. Here,I could understand what they did but I felt that it was not continuously. It could not be concluded clearly that what and how things were done. Subsequently they talked about another experiment about the brain damage patients. Though they had problems with language and specific calculation, they could roughly estimate. The story told more about an experiment of Elizabeth and Sanna. They tried to teach maths with Russian native speakers who also could speak English. Though they (respondents) were adults, both researchers had copied a way they taught the children and used with them. This made me think that they taught maths by using the way they taught regular children, right? Or they might tried to study how the children studied...I was not sure. When they talked about ' process children go..', I thought that they might analyse the children's studying results from their teaching. I was not sure since the story told us only that the researchers taught in a complex way that might be difficult, right? When I came to 'unfamiliar approximations' I was not sure what it was. I knew 'unfamiliar'.(she translate correctly in Thai.) I still wondered either they might teach the students how to estimate an answer or this 'familiar' meant a technique which the students did not get used to. The story told us more that they did their lesson by teaching only English. There were many lessons but taught English only. Hang on, (she reread) some lessons were taught in English

while others were taught in Russian. 'Out as words' meant they wrote in words rather than in numbers. (She reread) This made me understand that they should be written in words rather than number, e.g., plus was used instead of + or multiply instead of x.....

Actually I felt that I was going to understand the whole story and I tried to conclude whether it was really cool. From the first time I read it and from the heading, I thought that they used words instead of numbers because they would like to know when we read a question and translated then solved it comparing with when we only looked at the numbers or signs then solved it, which one gave a better result. I thought that if I were the respondent I would find numbers and signs were easier than using a question. I continued reading and the story said the question given was about language. This might be because they taught in a language. Consequently, the question was written in words instead of in numbers and signs.....

No, they were in two languages, i.e., Russian and English to make 'exact calculation'. For example, if the questions were given like this (if they were asked in the language they were taught), the students would spend more than one minute to find out the answers. .....Hang on, they were not asked in the language they were taught. Well, when I continued thinking about this. Suppose they taught three topics, A, B and C. A and C were taught in English, B in Russian. This meant that they asked topic A but used other language, right? Then, the story told us more that they found that there was nothing relevant to language if the question was asked to estimate and did not want an exact answer. There was the same experiment conducted by another organisation but they aimed at an activity of the brain emphasising on calculation. They found that the calculation that needed precision could make them know this behaviour. The brain's left frontal part was used while rough calculation both right and left part of the brain, i.e., parietal lobes, were used. I thought that when we do exact calculation we used one part of the brain while we do approximate calculation we would use another part of the brain. In the part of the brain used for the exact calculation, when it was used it also could activate a language part as well. When I reached 'these regions...', firstly I was not sure whether 'these' meant the whole brain or only parietal lobes. Finally, I guessed that it should be only parietal lobes and it might be about counting on fingers. There was only one 'approximate' up there. They also

doubted that...the word 'association' might mean that that part of the brain could work sharply. If we used it, it could stimulate a language matter as well.Stimulate area or stimulate activity? Activity of what?

Activity of that part of the brain which was relevant to language and speech. As already said when reaching 'these regions..' I was not sure whether it was the whole brain or only parietal lobes. Finally, I thought it should be parietal lobes because I was taught that if it was 'referred' it should be close with each other. I had a problem that this lobes with 's' and that lobe- no 's' and another 'these'. Finally, I guessed that 'these' should mean only parietal lobes that also used for movement of something. But 'count on fingers' was found only at that place (in the text). This was a sentence which I was not sure (she reread). This researcher also was not sure. The word 'association' I was not sure what it meant. It might be the brain activity which was correct and sharp. 'Findings' with 's' might implied the maths teaching. They asked themselves..very difficult to conclude. Was it good if the children were taught maths in one language and then they were moved to study another language or were taught in another language? They gave more examples that though the children had severe language problem, but they could do exact calculation. The last paragraph..I wondered what would be the conclusion. Someone who studied how the brain handled maths concluded that our brain actually did not work only on 'verbal' and 'non-verbal', there should be other things that interacted with it. This made us be able to do something and analyse something. (she reread). People tried to solve arithmetic problem. Well, I didn't know 'turning'. May be 'change'. 10+6 and 9x7 both gave the same answer. They said there might be overlaps. This meant a part of the brain, right? I still thought that study with words was torture. Why didn't they write in numbers. Maybe it depended on complexity of problems. If they were difficult and complex they should be written in words rather than using +, -, x, and /. I still believed that the problem with numbers and arithmetic signs should be easier.

T: Do you think you understand the text very well?

S: Yes, I find it very interesting.

5. No more needles

Student: B1

S: The heading stated clearly what they were doing. We might guess that they were doing something without needle. They also concluded in the first paragraph that what they were doing was to replace insulin injections for people with diabetes. They gave two examples. The first one located from the second paragraph, to the third and the fourth paragraph was the first pill with explanation what they could do. All of the following paragraphs were about the second pill. And there was a conclusion. Umm, there was no problem but I was not sure at 'because insulin is…' in the second paragraph. Here they said that the people with diabetes needed insulin to prevent their blood sugar rising to an abnormal level. They also said that insulin would be broken down in the stomach… it could not be taken orally. So they used injections instead and needed to do it every day. Well, I got stuck at one sentence about a new medicine. Was it the new one? Yes, here it told us that the new medicine was extracted from fungi from a tree. What was its name? They said 'it also enhanced the effect of insulin itself. When fed to obese mice ….' That was when they injected (she used 'inject' instead of 'feed') this medicine into diabetic mice it was not broken in their stomach. Rather it could decrease blood sugar level. Well, in conclusion the medicine was not broken in the stomach- I was not sure whether it was good or not. Because they tried to copy insulin from plant to decrease blood sugar in diabetic patients. But it was different from the previous insulin that it was not broken in the stomach. I still doubted whether they were the same and whether it worked or not though the story said that it could decrease blood sugar level. I was not sure because I saw this 'by mimicking insulin'. Apart from this I thought I could understand it all. But for the second medicine, they still had not concluded yet that it was perfect. It was during an experiment. I guessed from 'the drug is now in clinical trials'. Actually I did not understand this, but I guessed it was like trial and error which I had seen before. It should be the same but it was experiment in the clinic. Finally, I was astonished to see 'in contrast, by mimicking insulin, the Merck compound might be useful in all types of the disease.'. I thought that there might be many types of the people with diabetes and they said that Merck compound – the first medicine might be used with all types of diabetes. And 'it's very promising…'- this meant it might be really that way. Orvig

said this sentence and he was the one who made the second medicine. So, I was astonished why they praised the other who was in other organisation. Or I misunderstood something? People in the second organisation were still during their study. Actually I found some difficult vocabulary, e.g., insulin receptors in cultured cells. I did not know whether it meant a fungus cells that activate insulin or activated the cells to produce insulin. For the second medicine, I did not know 'metal vanadium', but I knew that it could expand the effects of the insulin. Actually I continued thinking that if we took this medicine after insulin injection it might be better. Or the medicine orally taken was already insulin because they said 'helped develop a drug containing'? The medicine with metal vanadium seemed to help to expand the effect of insulin that was taken. O.K. I thought that the first medicine that mimicked insulin might be possible but the second one seemed to be strange. It might need to take the first medicine and then inject the second one. The story did not tell us what to replace what and which to be used with what. Yes. And this guy praised the other guy in another organisation that 'it's very promising..'. Did it mean 'it should be like that' in Thai?

T: What do you think?

S: Well, I've to go back to see which one was in what organisation. Merck was above but Orvig was below here. One might start working from the results of the other. It might be. But they were in different organisations. Do you have more questions?

T: No. Do you understand clearly?

S: Well, I used to see 'pill' but I was not sure whether it was a tablet. Finally I thought it was.

T: You know how to cure diabetic patients?

S: I knew that they needed insulin injections. But I was not sure whether they needed it everyday. I wondered how they could know when their blood sugar was rising and they needed injections. I've heard that sometime they have to take sweet, lollipop. They must have a method to know when they need insulin injection and it must be terrible. From this point that is why the researchers try to find drug to replace insulin injections. Yes, most people do not like needles, though they were high technology. And was it good for insulin to be broken in our stomach?

T: No, it was not. That is why we can not take insulin orally.

S: Yes, our stomach might digest it completely. So insulin needs to be injected instead. And the new drug was good because it was not broken in our stomach.

They were still under experiments. Additionally, they had never been used with human. They might be good with mice but we still did not know their effect with human. The researchers made the mice infected. Poor mice!

6. That's us stuffed then

Student: B1

S: Horrible look, these turkeys. How can they eat them? First I read the title then I wondered what it was. So I asked myself what "stuff" was. In fact I heard this word before, but in general meaning. That stuff is a noun but stuff here is a verb. So I confused and asked myself because I don't get clear idea about it. Therefore, I kept on reading. After reading the topic sentence, I get clear idea that the author wants to talk about the turkey. Then in the first paragraph, there is no problem with the vocabularies, only "avoparcin". It is the first time I hear it, but this sign – what do you call it?

T: Hyphen.

S: Yes, this hyphen expands the meaning of " avoparcin". After I saw it I knew immediately that it was the meaning of the previous word. O.K. You did not want me to say about the content. Well, they were about two names; "vancomycin" and "teicoplanin". I paid attention to these two words and underlined here to show myself that there were important data. This one "Staphylococcus aureus" I heard it before but did not give much attention. It was only a bacterial name. They found in one turkey and the finding was not clear. They could not separate it. Maybe because they found only one turkey, right? This guy continued saying that it was possible that the bacteria with resistance to the medicine might spread out from the farm. Maybe it spread from human to turkeys. Human's bodies were carriers. This was a hypothesis of this guy. The last paragraph told us that suspension of Europeans currently…Well, I'd already found 'expend', now it was 'suspend'. I knew only suspender so I guessed it was expansion. Expansion of using avoparcin…hang on. 'Only temporary'…stop temporary. What stop temporary?The current of…wait, or it was 'at present'? 'Is only temporary suspension..'

T: What are you doing?

S: I tried to see what this " current" means The current before. Yes, it was.

Suspension of the Europeans at present...what did 'of' mean? This 'of' was only temporary. Actually, I knew protagonist. It was alike one word... Antagonist. Yes, antagonist, but I could not remember it. It was ridiculous...'on each side of the divide..'. Well, I could not really translate this last paragraph. But I guessed that it was about trying to find some evidences to support, to support the usage or to prohibit it? To allow temporary usage or permanent usage. What was 'protagonist'?

T: Can you guess?

S: Antagonist was an enemy. Yes. Latin vocabularies made me feel that it was difficult. If they were italic I would skip them. I really never knew them.

T: Why do you skip an italic type? You looked at a sign?

S: Yes, for my convenience. But in this case it was not italic and it was so important.

T: How did you know that it was important?

S: I felt. And I met it very often as if they tried to tell us something. Maybe because of the percentage that made me to reread. This story was continuously and if I could not catch up what it was about, I would not understand the whole story. While I was reading I tried to imagine that it should be like that or like this and what its effects were. And about MRSA, I told you that vancomycin and teicoplanin would resist to MRSA bacteria. This was the last way that they used. If there was not cured with this way it might be very difficult and created a problem. They tried to explain how the problem existed, where the bacteria were, what and how.

T: Could the diagram help you?

S: Every time when I got stuck I would look at the diagram. It was a post to cling on. I used it as a guide. When I knew that I wrongly translated, I would restart reading. When I found a problem while reading or it was a complex story I would write and draw and look. Then I would continue thinking how it went on. This made me continue my reading.

T: This helps you to comprehend the text?

S: Yes, I had to dig something out to be my clinging pole so I could go on.

T: Did you have any experience relevant to the story?

S: Actually I had never thought about experience relevant to the story because I paid much attention in reading and digging something out from it because I was nearly getting lost many times while reading. I could not go on if I could not dig it out.

Additionally, the vocabulary was rather difficult. Because the story went on continuously, so I had to separate it from each other to find out what was going on. If I did not try to understand each term I would not know what it was.

T: Do you understand it very well?

S: I think I can. Actually I had already separated it by half by my own signs. Firstly, they told about the problem, then how important avoparcin, vancomycin and teicoplanin were. From this part to this part, they did an experiment to show us that there was really a problem. They still talked about the problem they faced. No, not really. What they were doing? They were doing an experiment to support the whole issue. Then, finally they said they might ban something which still was not clear.

T: O.K. thank you.

7. Best of both worlds

Student: B1

S: Firstly I saw its heading 'both worlds', I didn't think about 2 continentals as said in the story. I wondered what the 'worlds' would represent. I translated 'A new kind of rice puts weeds in the shade and trebles yields' into Thai. It was about a new kind of rice that gave seeds under the shade (she misinterpreted weeds with seeds). I did not know 'trebles', and I was not sure the meaning of 'yield' when it was a noun. I knew only when it was a verb. When I saw a picture I felt that a child's hair was rather bad. 'Hybrid grains return a bumper harvest'- I knew 'hybrid' because I used to feed chickens, no..not that. I heard it since I was studying Agriculture. There were many breeds of animals, and 'hybrid' should be a result of breed mix. I thought that its meaning could be used here. It should be similar. It might be a mixing of rice species that came back. About 'bumper', I was not sure. I knew only a big bumper of a car. It might be about the harvest that came back in a big amount. There should have been a problem before this. After reading these two or three sentences, I'd started to read the story. Then I thought that the 'bumper' meant 'big'? Yes, It might be. I had no idea about its other meanings apart from a car bumper.

T: You got the answer from the meaning you knew or the meaning from the context?

S: I believed from what I knew first. If it did not match I would wait and continue reading till I found its real meaning from the story. About the story's organisation, from my first survey of reading it talked about a combination of two rice species; then it was about another two species. This made me think that the story lacked continuity. It should have been only one issue. However, when I came back to see italic again I found that I misunderstood.

T: Why did you think that you misunderstood?

S: I felt that if we did not notice that the italic were not the same we would misunderstand. Firstly, they talked about how they did with the two rice species and what the results were. Then, they talked about upland and its people on which I thought it was relevant to how to grow rice. Then, there was a problem and they brought new rice species. This made me wonder when the story still was not ended why they brought up the new issue. So, I reread and found that it was I myself who misunderstood. The italic was the same word. Well, I could conclude about the structure or the organisation of this story that they firstly told us about what and how they had done in details and what the results were; then, they talked about problems.

T: Do you understand more when you look at the text organisation?

S: Well, if I firstly had not misunderstood, I would have had given a better answer to you what was the problem here. But from my first misunderstanding ,where it came from (Note: she firstly thought that the italic was a different word so she thought that the story was discontinuous), I could not know where the problem was. I realised it later that it was the problem. They talked about how to solve the problem before what the problem was. I thought they it at the wrong place. To answer your question, if there was a person like me, that is, with carelessness while reading would face the same problem. And if he or she did not think while reading, he or she would not feel that the story was not strange. He or she would not know while the story could not be concluded. But if he or she continued reading she would find that the story lacked continuity. From the first part it was about how to combine two rice species, who grew rice- I myself was astonished why it was here in the middle part of the story and why this part was like this, etc. Finally, I realised that I was misunderstanding.

T: Why were you astonished?

S: Because the main idea should not be in this line ..this. Firstly, the story told us that the new rice giving better seeds under shade. That's it. Nothing about this after that. Then, here was what the rice possessed. So, I was astonished why they told us before (Note: she meant the sub-heading). Until I found 'O' point I could understand. I called it 'O' point. When I went on reading I found that I misunderstood so I went back and reread. I got stuck at some points but I could go on. Sometime I did not know vocabulary, especially below here. For example, husbrandy, fragile, etc. I tried to guess and did not have a big problem. I got stuck here- bolt upright, I could not guess. Another one here, I was not sure what it meant. It was about the rice species that one was Asian rice and...got stuck. Its leaves... 'do not cast much shade'.. I didn't know what it meant. I knew shade. Yes, I did. (she translated into Thai correctly) But I did not know its other meaning. I thought that it did not like shade. And its leaves didn't 'cast'. I knew that cast meant actor or actress.

T: And what was its other meaning? Casting.

S: Acting? If it was under shade it would give limited production.(read aloud) "...if it did not cast; then, it allowed weeds to grow". The seeds were growing? Rice. I knew whole-wheat. Allowing weeds to grow- weeds were not rice seeds, were they? No. What were weeds? And they limited yield. I still had no idea about yield but I guessed it should mean production.

T: How could you guess?

S: Normally I knew 'yield' as a verb meaning to show or to reveal or something like that. So it should be production. From this part..give more production to 5 tonnes per hectare. Yes, from this paragraph its meaning clearly was to produce. I got stuck here. I think I used to see 'weeds'. Apart from limiting yield, it should relate with shade as well, right?

T: Yes.

S: Put this under shade it would make triple yield. I know triple. And weed meant rice?

T: No.

S: New kind of rice put weeds under shade. No weed would make triple yield. I still have no idea. Bugs are not afraid of sun or shade. Plant disease? Some things in the paddle field which they had to control, right?: This story was about to control weeds from growing. When growing rice I will think about

temperature, soil or type of soil…Just like you grow vegetable. What will you do to grow it? Thing which we have to control to get triple yield. Thing which is not good for rice and it does not like being in shade, it needs sunlight……

S: Grass. Weeds.

T: Yes.

S: When we put rice under shade……No. Rice creates shade. Shade from rice would cover weeds. The rice should have big leaves that could create big shade so that weeds could not grow. From the story… 'do not cast much shade' might mean to create shade. Do not create much shade. The old species of rice could not create much shade. So weeds could grow and rice production was limited. The researchers had to combine two rice species. One was from Asia and another was from Africa which no one was interested because it gave low production. What was the meaning of 'variety'?

T: Do you know 'vary'?

S: Many kinds of them and not constant.

T: Correct.

S: So they combined two rice species together by 'double haploidy'.
O. sativa combined with African O.glaberrima. O.glaberrima had some weak points, e.g., it gave low production. And what was it strong point?
I was not sure about this vocabulary, profuse, droopy, foliage extremely rapidly. They should be perished rapidly. Droopy was 'perish'?
I think I have seen this word before but I can not remember its meaning. Hang on. I think this could be explained. 'This acts as a canopy, creating shade under the plant…'. This acted as a canopy and created shade which could limit weeds from growing. This was the strength of O.glaberrima.
But they said it's unfortunately because they collapsed. I had no idea about this 'collapse'. I guessed it should be 'bend and crack'.

T: You have never known this word before?

S: I know only 'collapse' used when two cars hit each other. I guessed it should be bend down because of its weight and then cracked because it said here that it turned on the ground. And this 'shatter' seemed to mean crack. I am not sure whether it seeds were fragile and easy to crack. Well, actually you have seen 'fragile' from other texts, e.g., 'Cloth of age'. In conclusion it had big leaves as strength but it was easy to crack because of its weight. So the researchers created a

new hybrid with strong stem rice species from Asia and it could give big leaves to cover weeds. What the farmers were worried about was to control....What to be worried by the researchers was the farmers. How to control weeds 'at no extra cost'..I don't know what they are.

T: How could you do to understand?

S: To be relevant to. This meant the farmers who were relevant to this issue, right? As far as the farmers are concerned or we could say as long as the farmers are concerned. As long as the farmers are concerned, the rice can control weeds without any cost, this is really help, O.K.? So, they did not spend much money, did they? They were poor people and it would be very useful if they could do their experiment without money.

T: Anywhere else you got stuck?

S: Only this point. I did not know what extra cost meant. Apart from this I could understand. And in paragraph 2 and 3.They explained their biological method how to cross theses two 'O's. They used pollen. I did not know what anther producing was. I believed that it was the way we took pollen from rice and mixed with ovules.

T: You can think about a kind of flower with a stamen and pistil with ovules below them.

S: From this it said that after this method 'the plants no longer infertile' because they could mix with each other in the same plant. Actually I did not know 'fertile' but I know 'fertilization'. It means to be born. So I thought that fertile should be its verb but with 'in' that is 'none' or no fertilization.

T: So what does it mean?

S: It would mean to be born as usual. Negative is used with negative.

8. Sensor sensibility

Student: B1

T: Shall we start now?

S: When I read the title I don't know what the passage about. So I looked at the picture and I guess it is about a computer technology, a mouse. Then I read the sub-title "Control that computer with a wave of your hand" and I can see that this mouse is working with wave from human body. So I asked myself "how".

T: Do you know the word "sensor"?

S: Yes, it's a kind of electronic device, sometimes it is called "electric eyes". In the first paragraph they said that they are going to create a mouse..no..a new table that can replace a computer mouse. It's new equipment.

T: Can you understand the text clearly?

S: Yes, I can get the main idea of the passage in the first paragraph and I can see how it works. It works by using a system creating a signal or currents that can be detected by the table replacing a mouse together with currents from human body. Then, sent to the tabletop, right? And how good is it? I asked myself. It said here in the fourth paragraph. It can create a 3D picture.

T: Did you read ahead again?

S: Yes, I want to know what is the advantage of this new technology ,so I tried to find in the passage. The first paragraph is a main idea telling us that this sensory tabletop, new equipment can replace a mouse. We can touch our hand on this table and move around. The difference is that the table can detect 3D while a normal mouse can do only 2D. The second paragraph tells us the inventor's name and what he aims is to invent new technology with much more convenience than a mouse, by using a table to replace the mouse. His co-inventor is a classmate. The table works by detecting human currents when the hand is moving. The third paragraph tells us about how he does it. Currents are induced in the table. Then, they use mathematical method to calculate where a hand is. The table will detect currents from the hand and build a 3D picture in a monitor. The fourth paragraph tells us that this technology have been used by physicists to find something beneath the ground. They send electric or acoustic pulses into the ground and then, by detecting the return pulses they can measure the depth or find things. It's not easy to do this when comparing with a supercomputer. It takes a long time and needs problem solving and more development. The fifth paragraph tells us that MIT still need to develop the system of this sensor tabletop to make it better workable and cheaper. They will develop a system for this table to create a 3D picture in a computer by using the hand.

T: Well, a lot details, then. Do you understand the whole story?

S: Yes.

T: How did you start at the beginning step?

S: I started by reading the title and then looked at the picture and the sub-title. It told us the important things in the story.

T: Did you read every word in the story?

S: Yes, every word , but I did not pay attention to every word. It's a short passage and since I got the main idea of the passage I did not have trouble reading it.

T: Did you find any difficult vocabulary?

S: Yes, I found many difficult vocabular . In the first paragraph I don't know "data gloves" but I guessed from the sentence "computer mice or data gloves", so "data gloves" must be a kind of computer mice. I don't know "cluttering up". Since it's a verb in this sentence I guessed it means "to place"

T: Are you sure whether they were correct?

S: I am not sure.

T: O.K. Have you heard about this story before, the sensor or the same method like this?

S: From the fifth paragraph, it's about sending the signal and measuring the return. They are used in many places. I cannot remember its name. It's about inducing currents at a computer monitor and touching with currents from our finger. It is controllable and can replace a mouse. It is an advertisement. They will write a software programme and allow us to use that programme....as a free test. But that one is two D not three D.

T: But it can be used as same as a computer mouse?

S: Yes, it is the same.

T: Do you think this article is interesting?

S: Yes, I do. I'd like to see the real one, to see what it looks like, its size, and whether it is bigger than a normal table.

T: Oh, you have a picture of this invention?

S: I can imagine. Here in the third paragraph it said "Electrodes built into the surface of the table.....induces detectable currents in the coils embedded in the table top". So I think it is a solid table top which must be special kind of substance. This substance can receive our wave and sends it to the coils. I don't know the word "embedded" but I guessed it must mean "hide". Yes, they have to put the coils in the place where the user cannot see. I think it is possible. It will be very expensive comparing with a normal computer mouse which is much more cheaper and available to buy. I think this sensor is very useful and convenience. Some time a

mouse can not be moved to some directions. Moreover, it can create a 3D picture. I think it can be used in medical science like ultrasound, e.g., sending ultra sound into something and then returning as a picture.

T: O.K. Do you want to add something more?

S: Nothing.

T: You know the word 'geophysicist'?

S: I chopped down this word. It comprises of 'geo', "physic" and 'cist' as a suffix and I know "geo " means earth. So, I guessed it means someone who studies about the earth surface. When I read this paragraph I was confused why it said about geophysics here I kept on reading and then I understand that it wants to explain how this table works. First I thought they put the mirrors in the table. I read again and found that "mirrors" here is a verb not a noun so it should mean "reflects". So I got the idea of this paragraph that it wants to explain this technique. And the last paragraph tells us what are they going to do to make it cheaper.

T: Do you know M.I.T.?

S: Yes, of course. It's very famous. I dream to further my study there.

9. Elixir of Youth

Student: B1

S: When I read the title, I think it's difficult. I don't understand the meaning of this 'elixir'. So, I read the sub-title up to now after I read the heading I know what this article is about, but still don't know the meaning of "elixir". But when I looked at the picture, still I didn't get the idea that the passage is about youth. Then, I kept on reading the sub-title .I do not want to be discouraged by not understanding. I ask myself a question " what stops us from growing old?" Why don't we grow old? Up to what I read here, oh, why? Then the sub- title tells us that brewer's yeast might help.

T: This is the way you ask yourself?

S: Yes. So, I know that this passage talks about a growth hormone or something like that. Just to make a prediction. In the first paragraph I underlined the key word such as "youthful", "ravages", "longevity factors". They are key words and important point. So I guessed that it's about youth. But for "ravages", I really don't know what it means. After trying to guess by rereading the same sentence I still

could not guess. I looked at the picture again, it said " ravages of time" under the picture of old hands so I guessed it means "damaged" but I'm really not sure, so I gave up and concentrate on the main idea "What stops us growing old?" Does that brewer's yeast point to some possible answers? You know brewer's yeast, don't you? They use yeast. So it is said that brewer's yeast points to some possible answers. Probably the yeast is something or something is similar to our growth, this is just a prediction. I think my prediction is O.K. It works. The author said that now they discovered the protein in the yeast. This protein can prevent people from growing old. They also discover the element that prevents people from getting old. This is in the first paragraph.

T: Go on please.

S: Now it is explaining how this protein prevents people from getting old. They said this. They say that this yeast protects a compartment in the cell called nucleolus. It is here (point at the second paragraph). In the second paragraph I underlined "the researchers prolongs life by protecting a compartment in the cell called the "nucleolus" I don't' know "compartment". I guessed it means "sub-cell". The word " nucleolus" I know it from biology class. I partly understand the content in paragraph two. It is not so clear, very difficult.

T: Do you understand "Achilles heel"?

S: No, I don't know. But it starts with capital letter. It must be a proper name. I know " heel", but still cannot guess the meaning of this word. They are copied from chromosome.....it is not clear. Now it says that, you know, in the cell there is a nucleus. In the nucleus there is nucleolus. In the nucleolus there is ribosome. This ribosome is a factory of protein, where the protein is made. Protein is an essential component part of human body and organism. The yeast is protecting this compartment in the nucleolus, This is what they try to explain. When I see this I know it from my prior knowledge. I know protein synthesis. There are some points that I don't understand, for example, Werner's disease, Werner's syndrome. Werner is a name of a person who discovered diseases. So, they call it Werner's syndrome. It is normally a medicine. This syndrome is named after the person who discovered it. When people get old, their hair will change its colour. I don't have much knowledge but I can understand by the words that this is a disease. I don't understand what really Werner's syndrome is. But it tries to explain here. I

understand this from the explanation here. It said what they have been done with this syndrome. Yes, they sequenced their gene of this Werner's syndrome.

T: Do you know 'helicase'?

S: Yes, it is also explained here which unwinds the double helices of DNA or RNA. I know how it unwinds according to my prior knowledge. It unwinds the double helices of DNA. Do you know DNA or RNA?

T: I know only DNA.

S: DNA is double-tran so it entangles and this comma, (after the term helices) I've to pay attention. Because I understand this, I know what this species are. Saccharomyces cerevisiae, I know it from my prior knowledge. When you try to study the disease you can not use people because our growth organism takes a long time to see, they have to wait for years. So, in order to study this gene that controls growth they try to use some animal or mouse. Here, they use yeast. Normally we use yeast in the lab because they grow very fast. I understand that from my prior knowledge. Here it is explaining how they discover that. This gene is possible for maintaining to prevent the growth organism. This gene works by unwinding or double-tran the DNA inside the nucleolus. I understand this from my prior knowledge.

T: Um, can I say that you understand this paragraph because you use your prior knowledge?

S: I can say so. Yes, because I know what they did from my prior knowledge. They still say that they are not sure if the gene in the yeast works exactly the same way in the organism of animal. And I underlined "WRN" to show that this abbreviation is a crucial part. It is a key word that the researchers want to study. Then I underlined the last sentence of the third paragraph.

T: Do you understand the content of the third paragraph?

S: Yes, I do since I have background knowledge in biology. However, there are two unknown words 'cataracts' and 'osteoporosis' but I understand the overall concept because the vocabularies are simple and the content is not difficult. The fourth paragraph, I put an asterisk at the beginning again to remind me that this part is interesting and important. Then, I underlined unknown words such as "helicase", "keen", " fends off". Before underlining I guessed first but it didn't work. So, I continued reading. I want to know how long I can tolerate or how much I understand the text if I only guess. However, I don't pay much attention. I try to

read on. I can't guess because I think that they are technical terms which I have to study them deeply to understand. Next paragraph, I marked again. The phrase 'the humble brewer's yeast Saccharomyces cerevisiae, I think this is also an important point. I'm not sure about the word 'budding' but I think it means spout or breed. I feel like I used to learn this word before but I'm not sure. I underlined this word because if I read it again I can open the dictionary immediately.

Next, 'perishing' is an unknown word so I guess from the context first. I'm not sure and I don't think it is right so I underlined it. If I need to present this paper, of course, I have to study some related materials. But here I just read so I don't bother. I think that open the dictionary is enough.

T: Then, you marked 'SGSI', what does it mean?

S: It is a key word. I think it connects with WRN, so I marked. Moreover, I highlighted the last two sentences of the sixth paragraph. I think they are significant points or important ideas. Then, I put an asterisk at the beginning of the seventh paragraph again since there is an important idea here. I also highlighted 'Guarente's team has an SGSI protein slow aging'. These terms are telling us that they can prolong aging process. Next, there are some unfamiliar words such as "disrupted", "intriguingly", "smash", so I guessed from the context but I still didn't know. At last, I gave up and kept on reading. I guessed 'smash' means break but I am not sure so I underlined it. The most important point in this article is in the eighth paragraph. Here you see, 'even though human', he says. However, I don't get clear whether it really works. I think they should continue their studies. Mostly when I read articles, I believe them. In addition, I think that the picture can help me. For example, I read the title and the sub-title first. Then, I looked at the picture before I read the content. The picture helps me get clear idea of the story. I can predict that they are going to talk about aging process.

10. Plantibodies

Student: B1

S: First, my strategy was interest, I mean 'motivation'. When I saw the picture, it was about corn. I asked myself why corn involved in this paper. I thought I liked it and wanted to read it. Then, I saw the title 'Plantibodies' that I never heard before but I felt familiar with it. You know why it was. Because of this one so I tried to chop the word into two parts. You see? Plantibodies-" plant "and "bodies". That it is. That is why I told you that I feel familiar with this word. After I chopped down, I can get the meaning. Then, you see this is a combination of two words, plant and antibodies. Then, I read the topic sentence, which modifies the whole paper. In fact you need not to read the whole paper. You just read the topic sentence and then, you get important ideas. Then, I highlight an important idea, such as this sentence- 'if the treatment work....'. I think this part is crucial to the story so I marked it. In addition, I also focus on this one, the author says- first, it tells us the step that I should follow.

T: This means that motivation helps you to understand. Is it correct?

S: If you like it then you can read it and remembers it quite well. It's quite interesting. I like it. Usually, antibody is a product from animal. But here they can plant it and by using corn. This is a new technology. What happens, I asked myself. About vocabulary, I don't have any problem because I find it's interesting. Regarding antibodies, protein, anticancer protein, or DNA, I understand them. I have read about this in the last passage. After reading the sub-title I can get the significant points right away. It shows exactly what the authors want to say. Actually I don't know much about this but there are not so many technical terms. So, I read and the first paragraph attracts me because they say that they plan to produce antibodies and this is useful for therapy in healing cancer. I think the whole paragraph is quite good.

T: Apart from interesting which strategies do you also use while reading?

S: I also pay attention to these terms such as soybeans, herpes simplex, and contraceptives. I think they are very important so I should know them. This paragraph tells the use of this product. But I did not read those companies' names. I don't have to know their names to understand the passage. I only know who did and what they made. While reading this paper, I need to question myself because I

find something that I did not expect. I say "how and what happened with antibodies". I think when I have questions I will have a guide when I read. Then I get more than answers. " What happens" I asked myself. The antibodies can be produced by crops. Unbelievable! in my brain I wonder how they do and here it shows me step by step. I wrote down " first " here to show the first step. I couldn't find the second so I continue reading but I still could not find the second step. I reread this part and previous idea again to see how they link. Here is protein. That protein is the.... Oh, much bigger than antibody. They can use anti-cancer protein to make medicine. I can understand what they are doing.

T: Is this the way to make you understand the passage?

S: Yes, when I read again it helps me. I know immediately that they are important parts. I need not to reread the whole paragraph. I just read the sentences or phrases I marked.

T: Why did you choose to highlight those parts?

S: What I highlighted is still the problem. Because I want to know what happens. According to my expectation, I want to know whether they can solve this problem. With this method there are still some problems needed to be solved in the future.

T: Don't you have problem with vocabulary?

S: Yes, but I can guess the meaning. Sometimes I can guess from the context and from the whole paragraph. About this word "pharmaceutical" I guess from the whole paper. I'm not sure if I'm right if I read only sentences. This article is talking about medicine and agriculture. So I guess it's about the medicine. I had to read the whole paper. I'm not sure whether my guess is right. If I want to make sure I have to look it up in the dictionary, but I don't bother. I can guess from the passage. And this word "glucocerebrosidsae" I skipped. I don't know this word and I cannot guess its exact meaning but I can guess it's a kind of enzyme in tobacco leave. I concentrated on the " caution" because it is warning which is more important than the other parts. This is the point that argues the whole paper. I try to make it clear because it is very important whether this technology is safe or not. Also the problems with pesticide and contaminants still worry me. This technology is very interesting but think of the corn, which contains blood in its ears, quite scary. And this word "discrepancy" I never heard before but I guessed it means problem because it said in the sentence "Until that discrepancy is solved".

Appendix I

Diary format

Date .....

Reading Materials	Duration	Problems	Solutions and Reading Strategies

The following published papers were included in the bound thesis. These have not been digitised due to copyright restrictions, but the links are provided.

N. Boyce. Word Power. Without speech we can’t add up. Journal Article published May 1999 p.p. 17 in New Scientist.

A. Coghlan. Best of both worlds. A new kind of rice puts weeds in the shade and trebles yields. Journal Article published Sept 1997 p.p. 17 in New Scientist.

A. Coghlan. Muck into medicine: Soil bacteria could be turned into a chemical goldmine. Journal Article published Oct 1997 in New Scientist.

A. Coghlan. That's US Stuffed then. People living near turkey farms harbour drug-resistant bacteria. Journal Article published Dec 1999 p.p. 5 in New Scientist.

P. Cohen. Elixir of youth. What stops us growing old? Brewer's yeast points to some possible answers. Journal Article in New Scientist.

D. Ellis Sensor sensibility. Control that computer with a wave of your hand. Journal Article published Mar 1999 p.p. 11 in New Scientist.

B. Fox. Get Stuck In. New studs could give players a head start. Journal Article published May 1999 p.p. 11 in New Scientist.

J. Knight. Fiendish fungus. A hybrid blight is running amok in Europe's woodlands. Journal Article published May 1999 p.p. 7 in New Scientist.

E. Wayland Barber. Cloth of Ages: The Mummies of Urumchi. Journal Article published May 1999 p.p. 456 in New Scientist.

W. Wayt-Gibbs. PLANTIBODIES : Human antibodies produced by field crops enter clinical trials . Journal Article published Nov 1997 p.p. 23 in Scientific American.