DEPARTAMENTO DE TEORÍA DE LOS LENGUAJES Y CIENCIAS DE LA COMUNICACIÓN

CONSTRUCTING MEANING AND KNOWLEDGE ACQUISITION FROM EXPOSITORY TEXTS THROUGH SELF-REGULATED READING ACTIVITIES IN A SECOND LANGUAGE

DAVID PERRY

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Constructing Meaning and Knowledge Acquisition from Expository Texts through Self-Regulated Reading Activities in a Second Language

Tesis doctoral
Presentada por: David Perry
Dirigida por: Dra. Ana Gimeno Sanz
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Abstract

The underlying objective of the research reported in this thesis is to find an effective means of improving our students reading comprehension of expository texts written in English, and thereby provide them with the resources and the self-confidence necessary to make more productive and autonomous use of the vast quantities of information now available for their own academic professional and cultural purposes.

After a general overview of the main issues, the thesis examines the current situation of foreign language learning in higher education in Spain, noting the reasons for the acknowledged importance of English in its role as an international language, and defining the sorts of knowledge and skills that are considered to be involved in 'knowing' a language and how these can be assessed, with particular reference to reading. From there, it goes on to explore some of the cognitive and knowledge variables involved in the reading process, and discusses some of the difficulties native Spanish readers may find in each of these areas, especially when reading expository texts. Following that, the results of a study carried out into the use and awareness of comprehension strategies by Spanish university students when reading expository texts in Spanish and in English are presented. The aim of this study is to identify the comprehension strategies employed in both languages in the context of specific reading tasks, and thus add to our knowledge of how students go about processing texts. Finally, the thesis investigates whether groups of native Spanish

university students with a low-intermediate level of English can be trained to engage in self-regulated constructive reading activities when reading expository texts written in English, with a view to (i) enhancing their comprehension of such texts, and (ii) improving their long-term learning of the subject content of the texts. Self-regulated constructive reading activities are operationalised as self-explaining, note-taking and asking questions, and the group training takes place as normal classroom procedure.

Constructing Meaning and Knowledge Acquisition from Expository Texts through Self-Regulated Reading Activities in a Second Language

Resumen

El objetivo de base de la investigación recogida en esta tesis es encontrar un método efectivo para mejorar la comprensión lectora en nuestros estudiantes de textos expositivos escritos en inglés, y, con ello, equiparlos con los recursos y la autoconfianza necesaria para hacer un uso más productivo y autónomo de la ingente cantidad de información disponible en la actualidad para sus fines académicos, profesionales y culturales.

Tras ofrecer una visión de conjunto de los principales aspectos de interés, la tesis examina la situación actual del aprendizaje de lenguas extranjeras en la educación superior en España, destacando las razones de la reconocida importancia del inglés en su papel de lengua internacional, y definiendo los tipos de conocimientos y aptitudes que se consideran implicados en el hecho de "saber" una lengua, y cómo pueden estos ser evaluados, especialmente en relación con la lectura. A partir de ahí, la tesis continúa con la exploración de algunas de las variables cognitivas y de conocimiento relacionadas con el proceso de lectura, y estudia algunas de las dificultades que los lectores cuya lengua nativa es el español pueden encontrar en cada una de esas áreas, en particular cuando leen textos expositivos. A continuación, se presentan los resultados de un estudio realizado sobre el uso y la toma de conciencia de estrategias de comprensión por parte de estudiantes universitarios españoles al leer textos expositivos en español y en inglés. El objetivo de este estudio es

identificar las estrategias de comprensión empleadas en ambas lenguas en el contexto de tareas específicas de lectura, y, de este modo, avanzar en nuestro conocimiento acerca de cómo se enfrentan los estudiantes al procesamiento de los textos. Finalmente, la tesis investiga si se puede entrenar a estudiantes universitarios cuya lengua nativa es el español con un nivel intermedio-bajo de inglés para que se impliquen en actividades de lectura constructiva y auto-regulada cuando leen textos expositivos escritos en inglés, con la intención de (a) mejorar su comprensión de dichos textos, y (b) intensificar su aprendizaje a largo plazo del contenido de la materia de los textos. Las actividades de lectura constructiva y auto-regulada se 'operacionalizan' en forma de auto-explicación, toma de apuntes y planteamiento de preguntas, y la instrucción del grupo tiene lugar como un procedimiento normal de aula.

Constructing Meaning and Knowledge Acquisition from Expository Texts through Self-Regulated Reading Activities in a Second Language

Resum

L'objectiu de base de la investigació arreplegada en aquesta tesi és trobar un mètode efectiu per a millorar la comprensió lectora en els nostres estudiants de textos expositius escrits en anglés, i, amb això, equipar-los amb els recursos i l'autoconfiança necessària per a fer un ús més productiu i autònom de la ingent quantitat d'informació disponible en l'actualitat per als seus fins acadèmics, professionals i culturals.

Després d'oferir una visió de conjunt dels principals aspectes d'interés, la tesi examina la situació actual de l'aprenentatge de llengües estrangeres en l'educació superior a Espanya, tot destacant les raons de la reconeguda importància de l'anglés en el seu paper de llengua internacional, i definint els tipus de coneixements i aptituds que es consideren implicats en el fet de "saber" una llengua, a més de com poden aquests ser avaluats, especialment en relació amb la lectura. A partir d'ací, la tesi continua amb l'exploració d'algunes de les variables cognitives i de coneixement relacionades amb el procés de lectura i estudia algunes de les dificultats que els lectors la llengua nativa dels quals és l'espanyol poden trobar en cada una d'aquestes àrees, en particular quan lligen textos expositius. A continuació, es presenten els resultats d'un estudi realitzat sobre l'ús i la presa de consciència d'estratègies de comprensió per part d'estudiants universitaris espanyols en llegir textos expositius en espanyol i en anglés. L'objectiu d'aquest estudi és identificar les estratègies de comprensió

emprades en ambdues llengües en el context de tasques específiques de lectura, i, d'aquesta manera, avançar en el nostre coneixement sobre com s'enfronten els estudiants al processament dels textos. Finalment, la tesi investiga si es pot entrenar estudiants universitaris la llengua nativa de la qual és l'espanyol amb un nivell intermedi-baix d'anglés perquè s'impliquen en activitats de lectura constructiva i autoregulada quan lligen textos expositius escrits en anglés, amb la intenció de (a) millorar la seua comprensió dels dits textos, i (b) intensificar el seu aprenentatge a llarg termini del contingut de la matèria dels textos. Les activitats de lectura constructiva i autoregulada ‘s'operacionalitzen’ en forma d'autoexplicació, presa d'apunts i plantejament de preguntes, i la instrucció del grup té lloc com un procediment normal d'aula.

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Constructing Meaning and Knowledge Acquisition from Expository Texts through Self-Regulated Reading Activities in a Second Language

Table of contents

List of tables

Chapter 5

Chapter 7

Chapter 8

Chapter 9

List of figures

Abbreviations used

ACTFL	American Council on the Teaching of Foreign Languages
ALTE	Association of Language Testers in Europe
BOE	Boletín Official del Estado
CEF	Common European Framework of Reference for Languages
ETSID	Escuela Técnica Superior de Ingeniería del Diseño
L1	First language or native language
L2	Second language. Any non-native language
QPT	Quick Placement Test
TL	Target language: a language being learned
UCLES	University of Cambridge Examinations Syndicate
UPV	Universidad Politécnica de Valencia

Note on the spelling of English words

British spelling has been used throughout, except in the following cases:
1) In citations from publications written in American English. In these cases the original spelling has been maintained.
2) In the examples of students' original work, which have been included as they were written.

English terms for Spanish institutions

For the first three Spanish terms in the Table below, we have used the English equivalents which appear on the BOE website at: <http://www.boe.es/g/eng/organismo/contenidoBoe.php>.

For the remaining two institutions we have used the English equivalents which can be found on the website of the *Universidad Politécnica de Valencia* at <http://www.upv.es>.

Spanish name	*English name*
Boletín Official del Estado	Official Spanish Gazette
Ley Orgánica	Organic Law
Real Decreto	Royal Decree
Universidad Politécnica de Valencia	Polytechnic University of Valencia
Escuela Técnica Superior de Ingeniería del Diseño	School of Design Engineering

Part I

Chapter 1

Introduction

When a child learns to talk its mother tongue, its first language, it isn't normally taught explicitly how to speak or how to listen or what to say in each and every situation. Of course, adults may offer help at times so that words like 'hurted' or 'drawed' or 'mouses' give way to adult forms, but in the normal course of development the child's language system and the ability to communicate vocally evolve naturally through social encounters and experiences, so that ultimately the child's speech conforms in usage to that of the language community in which it lives. Reading, on the other hand, is not a 'natural' development in the way that speaking is. Reading is "the product of cultural rather than biological evolution" (McShane, 1991: 283), and is a skill that must be taught and learned.

The subject of this dissertation is the research and classroom procedures we have carried out with Spanish university students reading in English, with the aim of teaching them to regulate their reading of expository texts and thereby enhance (i) their reading comprehension, and (ii) their long term learning of the content knowledge contained in the texts.

1.1 A definition of reading comprehension

Definitions of what reading is range from complex models, such as the Structure Building Framework (Gernsbacher, 1990), the Construction-

Integration model (Kintsch, 1988, 1998), Verbal Efficiency theory (Perfetti, 1985, 1988) the Event-Indexing Model (Zwaan, Langston & Graesser, 1995) or the Landscape Model of Reading (van den Broek, Young, Tzeng & Linderholm, 1999), to fairly general, and somewhat inconclusive, statements. Indeed, despite (or perhaps because of) the vast amount of research on reading and reading comprehension in both first language (L1) and second language (L2)[1] contexts, many authors find the task of capturing what reading is in a single concise statement problematic, and feel a need to provide further explanation. Urquhart & Weir (1998: 14), for example, admit that they have “some difficulty” defining reading. Their

[1] A distinction is sometimes made between ‘foreign’ and ‘second’ languages and between ‘foreign’ and ‘second’ language teaching. One sense refers more to the status of the language, while the other is used principally in study contexts. Thus, a ‘foreign language’ can refer to a language which is used outside one’s own national boundaries, while a ‘second language’ may have official status or a recognised function within a country (Stern, 1983). In study contexts, ‘foreign’ is taken to refer to teaching/learning environments where the study of a language (the target language or TL) is just one more subject in a broader curriculum; for example, in a school. ‘Second’ language study, on the other hand, refers to those situations where the language learner has some contact with the target language outside the classroom. An example of this would be where a person has emigrated to another country and is learning the language of that country through formal instruction, while at the same time being exposed to the language outside the classroom situation. Second language might also refer to "[…] the chronology of language learning; a second language being any language acquired after the native" (Stern, 1983: 12).

Ellis (1984) argues that the ‘foreign/second’ distinction is not an especially useful one. Many students who are studying a ‘foreign’ language at school may have some exposure to it – through television, cinema or music, perhaps, or by spending part of their summer holidays studying in the country where the TL is spoken – while ‘second’ language learners may have virtually no contact with the speech community for which the language is the primary means of communication (cf. Swain, 1981) and so may hardly ever use the TL in natural settings. A more useful distinction, suggested by Ellis (1984) might be between ‘pure’ and ‘impure’ classroom second language development. In the former, the learner is entirely dependent on formal instruction, while in the latter the learner may additionally experience some degree of exposure to the target language outside the classroom. In this dissertation, we do not intend to contrast ‘foreign’ language teaching/learning with ‘second’ language teaching/learning. In common with what is now widely accepted practice, the terms ‘second language’ and ‘foreign language’ are used generically to refer to any language which is being learned (other than the native language). In this sense, the term ‘second language’ could, in fact, be the learner’s third or fourth language.

initial definition states that reading is: “dealing with language messages in written or printed form”, a view which echoes somewhat Widdowson’s (1979) definition as “the process of getting linguistic information via print”. However, Urquhart & Weir (1998: 22) then take their first, provisional definition a little further, finally settling for:

> Reading is the process of receiving and interpreting information encoded in language form via the medium of print.

Moreover, they emphasise the fact that reading, dealing as it does with “processing language messages” (p. 15), makes considerable demands on linguistic competence. This may seem an obvious point but it has important consequences. It means, for example, that an adult first language reader; i.e., a reader reading in his or her L1, already has available a major component of reading; namely, substantial knowledge of the linguistic properties (e.g. orthographic, phonological, lexical, syntactic, and discoursal) of the language – although this may have to be activated. Such knowledge may not be available to the second language reader to the same degree or depth.

Underwood & Batt (1996: 2) also seem to have difficulty providing a concrete definition of reading:

> The closest that we can come to defining reading is by use of a generality, by suggesting that it is a form of problem solving that is directed at the integration of words in an attempt to recover the writer’s ideas.

By describing reading as problem solving Underwood & Batt (*ibid.*) recognise that they have “used one mysterious activity to describe another”, however, they are not the first to describe reading as problem solving. Almost ninety years ago Thorndike (1917) likened reading to mathematical problem solving, Britton & Black (1985) view reading as active problem solving, while both Olshavsky (1977) and Sarig (1987) see reading as a problem-solving process. Neisser (1967: 136), by describing reading as externally guided thinking, seems to equate reading with reasoning.

However, according to Kintsch (2005: 125), although characterising reading as problem solving may sometimes be appropriate, especially “for the struggling novice reader” – and which, by extension, we might apply to readers in a second language who are often thrown back to an earlier stage of development (Urquhart & Weir, 1998) – for Kintsch (*ibid.*) “fluent adult reading is more akin to automatic perception than deliberate analysis”, and it is only when normal comprehension breaks down that the reader applies strategic problem solving operations.

For our purposes, we shall use Snow’s (2002: 11) definition of reading comprehension as:

> [...] simultaneously extracting and constructing meaning through interaction and involvement with written language.

A view which is, in fact, rather similar to Urquhart and Weir’s above. The idea of *extracting meaning* stresses the importance of the text as one of the factors influencing reading comprehension, while that of *constructing meaning* indicates that the text is not the only determining factor and that the reader is also actively involved in getting meaning from the text. A text provides input to the reader who is thus induced to activate information. Indeed, as, Linderholm, Virtue, Tzeng & van den Broek (2004: 167) point out, “if in a specific instance a text does not affect – implicitly or explicitly – the activation [of information] in a ‘reader’ then the person is not actually reading”. Thus, although one commonly held view is that a text contains a certain amount of information which is accessible to all readers and that comprehension consists of extracting this meaning, there is another widely held view that comprehension is the process of giving meaning to a text (Samuels & Kamil, 1988) and that the reader interacts with a text in various ways in order to construct the meaning. If we didn't somehow construct the meaning, and normally the process is very rapid, when we read the sentence:

> Estudió derecho ante la imposibilidad de estudiar sentado debido a los azotes de su progenitor
> Source: *El País Semanal*, Nº. 1374, January 26, 2003, p. 462.

first, there would be no conflict between the meaning we initially give to 'Estudió derecho' and the rest of the phrase, and second, we would be unable to resolve the ambiguity. The following newspaper headline, cited by Reah (1998: 19), which appeared during World War Two, is another interesting example of ambiguity which the reader must resolve: "8th Army push bottles up Germans".

Clearly, then, in order to capture the ideas behind the words which make up a text some kind of processing seems necessary. As Paul Kolers points out in his Introduction to Huey's book *Psychology and Pedagogy of Reading*, republished in 1968:

> What the reader understands from what he has read is the result of a construction he makes and not the result of a simple transmission of the graphic symbols to his mind.

1.2 Overview and hypotheses

According to Bernhardt (1991a: 174), it is often assumed that reading in a second language "is just a slower form of first language reading". One reason for slower reading is simply that it may take a second language reader longer to recognise words and access their stored meanings (Alderson, 2000; Segalowitz, Poulson & Komoda, 1991). Perfetti's (1985)

Verbal Efficiency theory suggests that readers who have automatic, attention-efficient and accurate word recognition skills are able to dedicate more attentional resources to comprehension than those readers whose relatively poor word identification skills requires them to focus more time and cognitive resources on working out the meanings of words. Thus, if word recognition is slow and effortful it may adversely affect comprehension (Serra & Oller, 2001; Wolf & Bowers, 1999). Recognising words, however, is not the only skill involved in reading. Reading comprehension is a highly complex task (e.g. Artelt, Schiefele & Schneider, 2001; Bell & Perfetti, 1994) which involves the reader drawing on long-term knowledge and skills (Kintsch, Healy, Hegarty, Pennington & Salthouse, 1999) and engaging in many different processes, at different levels of analysis, ranging from basic linguistic processing to knowledge integration (Kintsch, 2005). If we accept the now generally agreed view that all these operations and processes are highly interactive (e.g. Rumelhart, 1977; van den Broek, Rapp & Kendeou, 2005), problems in just one area "may have a knock-on effect in other areas of the reading process" (Urquhart & Weir, 1998: 189).

The characteristics of texts and the characteristics of readers are not the only factors which influence comprehension and learning from written materials. Other variables include the task or the purpose of reading and the context or reading situation (Kintsch, 1998; Otero, 1998; Snow, 2002). These factors influence the kind of reading processes and strategies which are carried out by the reader. In this research, the readers are in their first or second year of undergraduate study at the School of Design Engineering (hereinafter referred to by its Spanish acronym of ETSID – *Escuela Técnica Superior de Ingenieria del Diseño*) of the Polytechnic University of Valencia (*Universidad Politécnica de Valencia* or UPV), studying Technical Industrial Engineering in one of four major disciplines; Chemical Engineering, Electrical Engineering, Electronic Engineering or Mechanical Engineering.

The reading texts used are authentic materials (i.e., not simplified) of the informational, expository type, written in English. The material to be learned includes information contained in the texts, and the reading situation is the lecture hall, classroom or computer laboratory. It needs to be emphasised from the beginning, however, that this research is *not* primarily about teaching (or learning) the English language, although inevitably several issues related to the teaching and learning of second languages, and to English as a second language in particular, will be considered. The main focus, rather, is on how students can be trained in strategic reading; in other words, how (and whether) the appropriate skills and strategies for dealing with authentic, expository English texts can be developed and enhanced in university students whose native or first language (L1) is Spanish and whose proficiency level in English (their second language, or L2) is, to use the descriptive labels employed by the Association of Language Testers in Europe (ALTE)[2], 'elementary' or 'lower intermediate'. What this means is that, by some definitions, the students have an arguably insufficient level of second language proficiency to cope with the sort of text they are required to read. This is an issue we take up further in Section 2.4.3.

1.2.1 Reading, learning and self-explaining

In her survey of L2 reading research, Bernhardt (1991a: 173) observes that:

> Research has not yet firmly established how to teach comprehension (or for that matter whether it is teachable).

[2] The Association of Language Testers in Europe (ALTE) is an association of providers of European foreign language examinations within Europe. One of its principal aims is to clarify how qualifications in different languages correspond to each other so that these qualifications may be recognised internationally. Currently, there are 28 members, representing 24 European languages. The *Instituto Cervantes* is a member of ALTE. There are 6 common levels of proficiency within the ALTE Framework (Breakthrough, 1, 2, 3, 4 and 5).

> Neither has research provided substantial insights into the process of second language learning.

Despite Bernhardt's observation, within the field of teaching reading in English as a second language, and especially within the area of English for academic purposes, asking learners to verbalise what they understand as they read has long been recognised as (a) aiding comprehension, and (b) helping learners understand the processes involved in reading. For example, some of the comprehension exercises in Munby's *Read and Think* published nearly four decades ago in 1968 did not require just one correct answer but were designed to stimulate debate between the students. A series of two books on reading for academic purposes published in 1979 and 1980 (*Reading and Thinking in English* edited by Henry Widdowson and *Skills for Learning* edited by Elaine Morais) both included tasks which required the students to read and discuss what they understood in small or whole class groups. In fact, reading and talking about reading was one of the design principles behind many of the tasks in these, and later, books; the objective being to get students to think about what, and how, they understood. Many of the current textbooks written to prepare students for the Reading Papers in the Cambridge First Certificate, Advanced, and Proficiency examinations contain activities designed to encourage the learner to 'interrogate' texts in order to go beyond their superficial features in order to understand the development of the ideas and opinions in them.

A little more recently, several L1 studies have also shown that learning from texts; that is, learning in the sense of integrating new information with existing knowledge, is more effective when students talk about or explain written materials to themselves (Ainsworth & Loizou, 2003; Chi, Bassok, Lewis, Reimann & Glaser, 1989), and that readers construct better mental models of the situation represented in the text (Chi, Deleeuw, Chiu & Lavancher, 1994; Magliano, Trabasso & Graesser, 1999).

The original Chi et al. (1989) study concerned learning procedural knowledge in order to solve a problem from a physics textbook, but the self-explanation effect has been found to occur in other problem-solving domains ranging from computer programming (Bielaczyc & Recker, 1991; Pirolli & Recker, 1994) to chess (de Bruin, Rikers & Schmidt, 2004). Self-explanations are also effective when used to learn declarative knowledge from expository text (Chi, Deleeuw, Chiu & Lavancher, 1994; Coté, Goldman & Saul, 1998; Pressley, Wood, Woloshyn, Martin, King & Menki, 1992). Moreover, students can be taught to self-explain (Bielaczyc, Pirolli & Brown, 1995), and do so when prompted by their tutors (Chi et al., 1994) and by electronic tutors; i.e., computer programmes (Aleven & Koedinger, 2002). Chi et al. (1994) carried out a study with 13-14 year-olds who were not given any extensive training in self-explaining but "merely asked [prompted] to self-explain after reading each line of a passage on the human circulatory system" (Chi et al., 1994: 439). The prompted students scored higher on a posttest of the topic than the control students who had simply read the text twice without being prompted to self-explain.

There seem to be degrees of self-explaining activity with some students generating more self-explanations than others. This does not mean that all readers who are low self-explainers or non-explainers do not understand, however, according to Chi et al. (1994), the high-explainers in their study learned with greater understanding than the low-explainers, which suggests that high self-explainers encode information in different ways.

We can illustrate self-explaining activity by our own students when reading both English (L2) and Spanish (L1 texts). As part of this study, and with the aim of gaining a better understanding of some of the "learning limitations" (Ramírez Verdugo, 2004: 92) of our students, we investigated the comprehension strategies our students employed when reading expository texts in English and in Spanish (the resuts are reported in Chapter 7). Participants were required to read a text and, after each sentence (which, following Olshavsky (1977) had been separated by red dots) say what they did in order to understand the text. Some students *spontaneously* generated self-explanations in order to understand the text while others did not. The possibility of these latter engaging in covert self-explanations can be ruled out, as during the subsequent interviews the students who had not shown any self-explaining activity confirmed that they had, for example "leido el texto sin más"[3], while the high self-explainers reported that when they read a text they always tried to relate the information in the text to what they already knew. Like Chi et al. (1989) we found that the students who spontaneously self-explained what they read were also better comprehenders.

Below are a total of six extracts from the think-aloud protocols of three of the students who participated in that research into comprehension strategies. We refer to the students as Subject #2, who is a high self-explainer, Subject #3 and Subject #5, who are both low self-explainers. There are two extracts from each subject: one referring to an English text and one to a Spanish text. The first 3 extracts below (numbers [1] - [3]) refer to the opening lines of the English text which described the Rosetta Spacecraft Project[4], a mission whose objective is to gather scientific data from Comet 67P/Churyumov-Gerasimenko, in 2014. The segment of text to which the extracts refer is shown below. The whole text is included in Appendix C3:

[3] Reported by Subject #4, February 2004.

[4] The Rosetta spacecraft is a European Space Agency (ESA) mission. The original mission goal was to rendezvous with comet 46P/Wirtanen. However, after postponement of the initial launch date from January 2003 to 2 March 2004 a new target was set. Rosetta will now aim at Comet 67P/Churyumov-Gerasimenko. It is expected to take 10 years to reach its target.

<u>*Rosetta Spacecraft Design*</u>

Introduction
The Rosetta mission is an interplanetary mission whose main objective is to rendez-vous with and make in-situ measurements of comet 46 P/Wirtanen, in August 2011. The spacecraft will also carry the Rosetta Lander (Surface Science Package) to the nucleus and deploy it onto the comet's surface. The Lander is provided by a German-led consortium of European institutes.
Source:
<http://www.estec.esa.nl/spdwww/rosetta/html/design.html>,
ll. 1-6

When the task of verbalising what they did to understand the English text was explained to the students, they were given the choice of carrying out the activity in English or in Spanish. All opted to do so in Spanish, thus the examples of high and low self-explanations which follow for both English and Spanish texts are in the students L1 (Spanish). Bensoussan & Rosenhouse (1990) note that, unless they have an advanced level of proficiency, second language learners tend to translate automatically into the L1 as they read. We, too, have found that with students of this level (low- to mid-intermediate), the activity of translating automatically (or *mental translation*) consists more of 'converting the idea' into the first language as one proceeds through the text. In the words of one of our students "Leo las palabras en inglés, pero entiendo en castellano"[5]. Whatever we call this activity, however, it is perhaps why all the students verbalised their thoughts in Spanish.

[5] Subject #2, reported in February 2004 during an informal interview after having completed several self-explaining reading sessions. See also Section 7.4.1.

Extracts from the protocols for the text in English [6].

Subject #2

[1] <<Bueno .. *The Rosetta* .. ok, pues a ver, el principio .. *Rosetta* es el nombre del de la nave que van a mandar para allá, interplanetaria misión interplanetaria, cuyo principal objetivo es *to rendez-vous*, eso es francés .. *and make in-situ, in-situ* es en el momento .. *measurements of comet ..rendez-vous* en este caso será yo creo, puede ser, no tengo ni idea, por el contexto, eh .. encontrarse, al ser *with* es con algo, entonces puede ser, el objetivo es encontrarse, o sea, llegar y.. y hacer medidas sobre el cometa tal que viene .. medir la velocidad que lleva, su tamaño y todo esto, y todo eso será en el 2011. La nave, que también llevará el Rosetta Lander, 'lander' es .. *surface science package* eso .. bueno, claro, después, después de leer esto yo .. creo que *rendez-vous* sí debe ser encontrarse, porque .. los *landers* son que aterrizan, *landing* es aterrizaje, *to land* es aterrizar en tierra, entonces esto es un .. *surface science package* debe ser .. un dispositivo para hacer un estudio sobre la superficie del mismo cometa, igual que en .. no lo sé *to the nucleus* eh .. entonces esto quiere decir que la nave llevará también al .. al esto de aterrizaje Rosetta, que se situará sobre la superficie, y lo llevará al.. núcleo .. y *deploy*, *deploy* no sé lo que es, que será dejar. Lo llevará hasta la superficie del cometa.

The Lander is provided el *lander* .. el *lander* en este caso llaman a la nave que aterrizó en la tierra, en la superficie, ha sido provisto, o sea, lo han llevado a cabo un consorcio de alemanes .. de la .. del instituto europeo, o sea, que lo han hecho los alemanes, pero .. eh.. en conjunto con la .. con los institutos europeos de .. de .. astronautas, vale.>>

[6] The transcription notation we have used here and throughout this paper is based on Jeffersonian Transcription Notation as described in Atkinson & Heritage (eds), 1984: ix-xvi, although with some modifications. Original or source text, whether in English or in Spanish, is italicised and placed in a box. The readers' introspections (reflections or explanations), are placed between carrots (<<...>>). In accordance with the transcription notation used, two suspension points (..) indicate a pause in the tape of more than 3 seconds. Three suspension points enclosed within square brackets ([...]) indicate that a portion of the reader's reflections has not been cited (as it contributes nothing to the point in question). In addition, all extracts from student protocols are numbered in square brackets.

Subject #3

[2] <<La primera frase, lo que quiere decir lo entiendo, aunque no entiendo la palabra *rendez-vous*.
De la segunda frase, *spacecraft* no .. supongo que por deducción, por descomposición de la palabra *space* que es espacio, puede ser una nave espacial o algo así, por deducción.
De la siguiente frase, *German-led*, ese *led* no sé lo que significa, pero tampoco considero importante saberlo para entender realmente lo que la frase expresa.>>

Subject #5

[3] <<Este punto .. se entiende bien.
Este punto, lo tengo que leer dos veces para entender todo el significado.
Este punto lo entiendo bien.>>

We should make it clear that Subject #2 is not a high-explainer because his level of English is greater than Subjects #3 and #5 or, conversley, the latter are not low-explainers because they do not understand the text – although with respect to second language knowledge (as well as domain knowledge) it must be the case that a reader would need to understand enough of the text (language *and* content) in order to go beyond it. Rather, Subject #2 *naturally* generates to himself an explanation of what he is reading. The differences between high-explaining and low-explaining are also apparent in the think-aloud protocols for the Spanish text where, again, we can see how Subject #2 relates the information in the text to his existing knowledge and also anticipates what the text will say, while Subjects #3 and #5 seem to accept what they read without thinking further about the ideas contained in the text.

The Spanish text comes from the electronic version (i.e., the webpage) of the *Futuro* supplement of the Spanish newspaper *El País*. Again, it is followed by extracts from the protocols of the same three subjects.

El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta

Pero, ¿no es Plutón mismo un planeta? En los años noventa, esta pregunta pareció lo bastante importante como para que la Unión Astronómica Internacional (IAU, siglas en inglés) revisase su definición. El dictamen, emitido en 1999, determina que un planeta es "un objeto en órbita alrededor de una estrella, que sea más pesado que Plutón y más ligero que la estrella más pequeña". Se trata, evidentemente, de acabar con la polémica salvaguardando la condición planetaria de Plutón, pero descalificando a todos los cuerpos menores que él, descubiertos o por descubrir.
Source: <http://www.elpais.es/suple/futuro/>, ll. 44-50.

Extracts from the protocols for the text in Spanish.

Subject # 2

[4] <<Vale, ahora van a .. estoy seguro, convencido, de que van a empezar con lo de que cuando se descubrió Plutón unos decían que no era, otros que si era .. entonces van a ver, si Plutón es un planeta, porque Quaoar no, supongo. Vale, aquí está tratando de responder a la pregunta, lo que quiere decir que en los años 90, al descubrir Plutón aparecieron muchos problemas porque había gente supongo que diría que era un planeta, y habría otra gente que no, entonces se remitieron a las normas que habían impuesto como condiciones mínimas para ser planeta, y se revisó su definición.

Vamos a ver lo que es un planeta 'un objeto en órbita alrededor de una estrella, o sea, en nuestro caso el sol, que sea más pesado que Plutón y más ligero que la estrella más pequeña', que sea más pesado que Plutón y más ligero que la estrella más pequeña, esto lo encuentro un poco una tontería, porque se trata de medirlo con respecto a Plutón, bueno, sería como en química, como el Hidrógeno, pero bueno. Bueno, esto es una norma que han puesto para ver si llega a ser un planeta, o llega a ser un satélite etc.>>

Subject #3

[5] <<La siguiente frase es una pregunta que es bastante sencilla.

La siguiente frase es corta y sencilla de entender.
La siguiente frase también es sencilla.
Lo mismo con la siguiente.>>

Subject #5

[6] << Este punto tiene una pregunta, pero no tiene ninguna complicación.
Este punto no tiene ninguna dificultad.
Este punto no tiene .. con leerlo se entiende bien.
El siguiente punto está bastante claro, no tiene dificultad ninguna.>>

1.2.2 The benefits of self-explaining

It seems clear from these extracts, as well as from the research findings, that readers who self-explain develop richer representations (situation models) which go beyond the information in the text. They link the ideas in the text to their existing knowledge or experience, or to other parts of the text and elaborate on the information. Elaboration allows students better access to their knowledge and triggers that knowledge in a way which is not available to poor- or non-explainers (Chi et al. 1989: 168). These latter may simply paraphrase the text (Ozgungor & Guthrie, 2004) or accept what is written without further analysis. They appear to look only at the surface features of a text and seem to be satisfied with a shallow understanding.

Various reasons why self-explaining improves comprehension and learning can be found in the literature. For VanLehn & Jones (1993), verbalising what is understood during reading results in learners processing the material in a more deliberate way, leading them to identify gaps in their knowledge which they subsequently try to fill. As VanLehn & Jones (1993: 1038) put it, "self-explanation causes readers to discover their ignorance and do something about it".

Neuman & Schwarz (2000) make the point that self-explanations aid learning because they support and encourage the use of existing problem-solving strategies already possessed by the learner. As we have already noted, we assume our students do indeed possess (at least some) such strategies in their L1 although they may only employ them when prompted to do so. While Chi et al. (1994) argue that by generating self explanations, the process of integrating new information into existing knowledge is facilitated and students develop a deeper understanding of the subject-matter.

According to Chi et al. (1994: 441) self-explaining is a constructive inferencing activity where “*any form of constructive activity* [our emphasis] may be beneficial to some degree, even diagram drawing”. Reimann & Neubert (2000: 318) too, in a study of learning to use computer software from worked examples, took self-explaining activities in a broader sense to mean: “monitoring one's understanding as well as engaging in knowledge construction in order to overcome self-diagnosed problems of understanding”.

Thus constructive activities, such as self-explanation, take readers beyond what is simply stated in the text and encourage them to take an active role in interpreting and processing the information in the reading materials.

1.2.3 Hypotheses and research questions

Applying this to reading L2 texts, we hypothesise that by self-explaining a text, or by engaging in some other constructive activity, readers will produce richer, more elaborated understandings. They will be more likely to associate the information in the text with what they already know and retrieve from long-term memory (LTM) relevant background knowledge or examples which will be used to create a richer situation model. As we have shown with Subject #2.

Most of the research into self-explaining has been carried out using individual tutoring; i.e., one-on–one sessions (e.g. Ainsworth & Loizou, 2003; McNamara, 2004) and, moreover, has focused on procedural knowledge and problem-solving. We are concerned here with developing our students skill in reading in a second language as well as improving their learning from written texts, thus, our focus is on the acquisition and enhancement of the procedural skills involved in self-regulated reading of expository texts in a second language, and also on exploring ways of developing and enhancing the long-term learning of declarative knowledge, the understanding of concepts, and the construction of richer mental models of the text topic. This study, moreover, has been carried out with classes of approximately thirty students who are taught *as a group* and not on an individual basis.

We hypothesised that modelling and instruction in self-explanation and other constructive activities would:

(i) raise students' awareness of the advantages of actively constructing the meaning of a text
(ii) improve readers' ability to self-regulate their reading
(iii) improve reading comprehension of expository texts
(iv) improve long-term learning.

Given that our overall objective was to develop students' reading comprehension and learning in specific academic and professional contexts, it seemed that one of the context-specific factors to take into account (apart from task requirements, background knowledge or L2 proficiency level) was what the students themselves brought to the reading process in terms of existing text-processing strategies. Without this information we can, according to Block (1986: 463-464), only guess at the problems or difficulties our students may have:

> Knowledge about the process, not just the product of reading, is needed if we are to move from head-scratching to designing programs which truly meet the needs of our students.

It was therefore decided that the most useful place to start would be to find out, on the basis of empirical observation, what text-processing strategies and operations students used, what mental processes they engaged in, as they carried out realistic reading tasks using L1 texts and to see how this compared with how they handled similar tasks using L2 texts. The first set of research questions explored in this study are then:

1) What comprehension strategies are used by readers reading expository texts in L1 and L2 while carrying out information-transfer type tasks?

2) Are the comprehension strategies used by the readers when reading in their L1 similar or different to those used when reading in their L2?

3) Are the readers aware of the strategies they use while reading and do they have control over these strategies?

It was felt that an answer to these issues would provide an insight into the processing strategies and operations which students in our teaching-learning situation already employed, and allow us some understanding of the conditions in which they used them. The second set of research questions was derived from the desire to know the sorts of constructive activities which might be most effective in achieving our objectives:

4) Can the benefits of self-explaining texts be extended to students with an elementary/lower-intermediate level of English as a second language, reading expository texts in English?

5) Can readers with this level of English be instructed to self-explain L2 texts in a classroom situation as a group rather than individually, and will this group instruction improve the individual comprehension and learning of the participants?

6) Self-explaining can be operationalised in different ways. Are different forms of self-explaining; that is, different constructive activities, more, less, or equally effective in achieving the stated goals in our teaching-learning situation?

It should be noted that the primary concern was not that of developing second language knowledge, but rather with training our students to read more strategically and process texts more constructively in order to identify and extract relevant information in a text. The key objective was to explore ways of training groups of students in a classroom situation to read strategically. As Nuttall (1982: 21) explains it:

> The aim of the reading lesson is to develop the student's ability to extract the message the text contains [...] unlike a language development lesson, we are not trying to put something into his head, but instead we are trying to get him to take it himself.

This does not mean that second language development was ignored. In fact, the activities reported in this research were carried out together with other class activities aimed at developing general L2 proficiency, and at times certain linguistic features of the texts were explicitly focused on. This took place, however, quite independently of the sessions devoted to reading. It was also expected that some implicit learning of linguistic aspects, such as specific lexis (especially that related to the students' disciplines), grammatical patterns or even pronunciation (this latter, through listening to the researcher – at no point were students required to read aloud), would occur. Nevertheless, the principal objective was to explore different ways of enhancing readers' ability to understand, use and learn the information contained in unfamiliar, authentic, informational expository texts, and to equip them to become more independent learners.

1.3 Organisation of the thesis

The dissertation is structured into four parts. The purpose of Part I (Chapters 1 and 2) is to set the scene and describe the broad setting in which the research has taken place. Part II (Chapters 3-6) explores some of the knowledge and process variables involved in reading, while Part III (Chapters 7-9) reports first on the preliminary study carried out to compare the comprehension strategies students used when reading expository texts in Spanish and in English, and then describes the classroom procedures and interventions employed in order to train groups of students in self-regulated constructive reading activities, together with the results. The brief Part IV (Chapter 10) considers some areas for future research.

More specifically, Chapter 1 provides an overview of the reasons why we decided to carry out this research and states our objectives, hypotheses and research questions. Chapter 2 describes the context of the study. First, it discusses the current aims and objectives for foreign language learning in secondary and tertiary education in Spain as laid down by recent legislation, and notes the growing awareness of the importance of L2s in tertiary education. From there, it narrows down the area, discussing the importance of reading comprehension, especially with respect to what is now called ‘electronic literacy’ and to the emphasis placed on learner autonomy and lifelong learning. It then explores notions of second language proficiency in terms of *communicative competence*, drawing on recent work in Australia, the United States, and more especially Europe, where the *Common European Framework of Reference for Languages* (CEF) has been widely adopted. Chapter 2 then goes on to look at how these notions of communicative competence relate to English as a second language reading ability; that is, what learners can be expected to be able to do in reading tasks requiring real world communicative interaction in study contexts. The final part of Chapter 2 describes in general terms the L2 reading proficiency level of the subjects who participated in this study (leaving more specific details to the relevant sections in Chapters 7 and 9), and presents the case for devoting time and resources to developing the students’ strategic reading skills as opposed to concentrating exclusively on raising their level of general English.

Reading comprehension is highly complex, drawing on many different cognitive skills and areas of knowledge. The focus of the four Chapters making up Part II, therefore, is to describe some of these principal cognitive processes and knowledge factors. In Chapter 3, some general assumptions regarding comprehension processes, such as levels of representation, types of reading, the construction of meaning or the role of working memory, are discussed. Chapter 3 also discusses top-down and bottom-up processes, as well as the interactive nature of reading, and it examines two sample expository texts to see what may be involved in comprehending them.

Chapters 4, 5 and 6 respectively, explore some of the word-level, sentence-level and discourse-level variables which bear on reading comprehension. Chapter 4 looks at three factors involved in word recognition; namely, decoding, phonological skills and vocabulary knowledge. Although these issues receive individual treatment, it should be noted that the recognition of individual words frequently depends on how they combine with other words around them. The Chapter discusses how ‘deficits’ in any one of these areas may be a source of difficulties for comprehension, with particular reference to readers whose L1 is Spanish and target language (TL) is English, and describes a small experiment which explored our students’ depth of knowledge of certain lexical items related to their area of study. Chapter 5 discusses the use of context at the level of the sentence and the role knowledge of syntax may play in constructing meaning. It also reports on the results of a small pilot study examining the effectiveness of translation as a means of testing comprehension and which suggests that partial comprehension of a text is often standard in second language reading. Chapter 6, the final chapter in Part II, explores the ‘higher-level’ processing variables of inferencing and comprehension monitoring, as well as knowledge of text structure. All of these are discussed with reference to expository texts, again focusing on some of the difficulties inherent in such texts for both L1 and L2 readers.

The starting point of the research study reported in Chapter 7 was the consideration that without knowledge of how students go about processing texts, it would be difficult to design effective instruction in reading strategies (cf. Block, 1986; Ramírez Verdugo, 2004). Chapter 7, therefore, describes the small, preliminary study carried out into the use of text processing strategies with a group of seven students who were asked to report on what they did to understand while carrying out information-transfer tasks based on expository texts in Spanish (their L1) and in English (their L2). This Chapter, then, presents the answers to Research Questions 1, 2 and 3.

Chapters 8 and 9 report on a much larger study carried out with a final total of 104 students divided into four groups of 26 students each. One of these groups was a control group, while each of the three experimental groups was trained in one of three different constructive activities; self-explaining, note-taking or asking questions. Chapter 8 discusses each of these and explains the reasons why they were chosen. Chapter 9, describes the main experiment itself and the training given to the students. This took place under standard, ecologically valid, classroom conditions; that is to say, the students were trained in the group to which they had been assigned and not individually. Chapter 9 also presents the answers to Research Questions 4, 5 and 6.

Finally, Chapter 10 looks ahead to our future research plans arising from the studies reported in this dissertation.

Chapter 2

The context of the study

Reading always takes place in a context. It is "[...] always situated in the sense that the readers, texts, tasks and setting influence the reading processes" (Elshout-Mohr & van Daalen-Kapteijns, 2002: 246). In this Chapter, we explore the broader setting of this study, beginning with a discussion of the current objectives for foreign language teaching in Spain and a look at some of the reasons why a knowledge of foreign languages is considered by many sectors of society as fundamental for today's graduates, professionals and researchers. From there we explain the importance of reading comprehension, which leads us to a description of the sorts of skills and abilities (or competences) which are currently widely regarded as characterising successful language use, both in general and with respect to reading in academic contexts. The final section in this Chapter looks in broad terms at the level of English language proficiency and at the reading behaviour of the students where this research was carried out, and develops further the argument for enhancing their reading skills.

2.1 Foreign language learning in secondary and tertiary education in Spain

In approximately the timespan of one generation the teaching and learning of foreign languages in Spain has undergone considerable changes. This can be seen especially in the objectives for the teaching of foreign languages, which "[...] han pasado de la competencia lingüística a la competencia comunicativa e intercultural en menos de tres décadas" (Trujillo Sáez, 2001: 1). Whether the content of classes (*what* is taught) or the methodology (*how* the language is taught), whether what Mateo Martínez (1999: 20) calls the "procedimientos pedagógicos individuales que se emplean en al aula", have had time to adapt themselves to these more communicative objectives, is not an issue we are concerned with. Suffice to say that, with respect to reading, most of our learners appear to be very similar to those described by Ramírez Verdugo (2004: 91) in that they "lack basic reading strategies and self-confidence in their reading skills".

2.1.1 Objectives for foreign language learning

Current objectives for foreign language learning in both compulsory secondary education, as well as those in the curriculum for 16-18 year-olds, have been established by a number of *Royal Decrees* passed within the last five years[7]. These *Royal Decrees* recognise the increasing importance of foreign languages in our modern society as a consequence of increased international relations, greater possibilities for working abroad, and wider access to new technologies and media. They regard knowledge of foreign languages as essential for the promotion of cultural, economic and technical collaboration, as a key element in the construction of a European identity, as well as a factor contributing to the free movement of people within Europe. Furthermore, they acknowledge the contribution a knowledge of foreign languages can make to the general intellectual development of the student, to social integration, and to the role they can

[7] The *Royal Decree 3473/2000* was published in the Official Spanish Gazette (*BOE*) of 16 January 2001 (BOE, 2001a). Subsequent modifications have taken place through the Organic Law *10/2002*, of 23 December 2002 (BOE, 2002), the *Royal Decree 832/2003*, of 27 June 2003 (BOE, 2003), and the *Royal Decree 117/2004*, of 23 January 2004 (BOE, 2004).

play in accessing information in the fields of science, technology and the humanities[8]. In short, they recognise that "the ability to understand and communicate in other languages is a basic skill for all European citizens"[9].

Indeed, it is the recognition of the important role foreign languages can play in cultural, educational, and work issues that has given an impulse to the learning of languages in secondary education in much of Western Europe, and in common with many other European countries, the Spanish Ministry of Education and Science (*Ministerio de Educación y Ciencia* or MEC) recommends that at the end of their secondary education at age eighteen, students should have developed the capacity to "Expresarse con fluidez en una o más lenguas extranjeras"[10]. The objective in secondary education is not for the students to attain 'native speaker' fluency, but rather to acquire "the essential core of skills that will serve them throughout a lifetime of language learning … with the emphasis on effective communicative ability: active skills rather than passive knowledge"[11].

As regards tertiary education, up until very recently considerably fewer resources have been dedicated to the teaching of foreign languages to non-language students; that is, to students not following language degree courses. The low priority the teaching of foreign languages has been given

[8] See, for example, the description for Foreign Language I and II (*Lengua Extranjera I y II*) from the *Royal Decree 117/2004* of 23 January 2004, published in the *BOE* Number 42, 18 February 2004, pp. 7592-7593 (BOE, 2004).

[9] Commission of the European Communities. (2003). *Promoting Language Learning and Linguistic Diversity: An Action Plan 2004 – 2006*. Brussels. p. 3.

[10] Article 5, paragraph h, *Royal Decree 117/2004*, published in the Official Spanish Gazette (BOE) Number 42, 18 February 2004, p. 7576 (BOE, 2004).

[11] Commission of the European Communities. (2003). *Promoting Language Learning and Linguistic Diversity: An Action Plan 2004 – 2006*. Brussels, Com (2003) 449 final. p. 8.

is, in some ways, understandable. The traditional focus of Higher Education establishments has been on the production and dissemination of *knowledge*, rather than on *skills and knowing-how-to-do* something. University departments have tended to define course content in terms of knowledge *about* the subject rather than with what can be done with that knowledge, and Language Departments have not been an exception to this general rule, tending to offer courses a*bout* the language and *about* the culture and peoples using the language, rather than general or specific communicative skills in the language itself. These latter have perhaps been undervalued as not being 'academic'. According to Toudic (2003), university language courses for students of other subjects have often been regarded as an extension of secondary school language learning. As a consequence, writes Toudic, "language teachers and learners in such courses were rarely awarded much attention or consideration by the HE [Higher Education] language community" and students interested in developing their language skills were expected to search for language courses in the wider world outside the university.

2.1.2 The European Commission Action Plan for promoting language learning

However, in July 2003 the European Commission adopted the *Action Plan* (Commission of the European Communities, 2003) for the promotion of language learning and linguistic diversity, in which the member states accepted that:

> Higher Education institutions play a key role in promoting societal and individual multilingualism … [and that] … all students should study abroad, preferably in a foreign language, for at least one term, and should gain an accepted language qualification as part of their degree course.
>
> (Commission of the European Communities, 2003: 8)

The Action Plan also recommended that each university implement its own coherent language policy to promote "language learning and linguistic diversity, both amongst its learning community and in the wider locality" (*ibid.*). Several universities in Spain have now recognised the need to design and implement institutional language policies[12], and have established "[...] una amplia oferta de aprendizaje lingüístico" (Mateo Martínez, 1999: 12).

In fact, many of the Schools and Faculties on the UPV campus already offered courses focusing on enhancing domain-specific or career-specific skills in several languages. These subjects are quite well-established – although the greatest demand is for courses in English. As further evidence of the recognition now given to technical or professional English, in the *Escuela Técnica Superior de Ingenieria de Diseño* (ETSID), the School where this study was carried out, it is now possible for a student of Electrical Engineering to complete 55% of the total number of required credits in English. To give another example, since 2003 students may submit their Final Year Project in English[13]. These and similar initiatives recognise the need to satisfy the increasing demand for language courses and a recognition that knowing other languages is an important and necessary skill.

2.1.3 Growing awareness of the importance of L2s in tertiary education

[12] For example, the Polytechnic University of Valencia has recently opened a Language Centre (*Centro de Lenguas*) whose principal objective is to: "[...] responder a las demandas y necesidades en el conocimiento de lenguas extranjeras para facilitar la integración de sus miembros en el Espacio Europeo de Formación Superior"
Source: <http://www.upv.es/cdl/centrodelenguas.html>.
Date visited: 17 October 2005

[13] And, of course, the author of this research has benefitted from the change of climate by being able to write and submit this thesis (to the University of Valencia) in his native language.

The developments which have resulted in the growing recognition of the importance of knowing other languages and cultures, and which have contributed to the increased demand amongst the university population for language courses, can be synthesised as follows:

1. The impulse given to languages in secondary education discussed earlier has raised awareness of their importance.

2. Although graduates of engineering still need a strong foundation in theory and technical knowledge, success in their chosen professions does not now depend on technical skill alone. The demand from industry is for industrial engineers with supporting work skills. These non-technical (or ‘soft core’) skills include, amongst others, project planning, problem-solving, time management, teamwork, the ability to communicate in one’s native language as well as in (specifically) English and another foreign language (Hedberg, 1999). Given the increasing amount of international collaboration on educational and industrial projects, the demand for greater mobility of employees and the consequent need for all participants in these initiatives to operate in multi-cultural environments, greater linguistic and communicative skills are considered by many sectors of industry to be “basic components” (López & Edwards, 2006) of the global competences required by engineers in the information society. Second languages can now be regarded as, in the words of Mateo Martínez (1999: 12), “[...] herramientas precisas para completar los conocimientos específicos de las diversas especialidades y tareas universitarias”.

3. As a result, language skills are considered fundamental for enhancing career prospects in a highly competitive international environment. To give an anecdotal example, a recent television advertisement for an English language course broadcast on Spanish television shows an otherwise incompetent company worker receiving praise and promotion from his

English boss. A co-worker who tells a colleague that he can not understand why the worker concerned is so highly regarded by his superiors is told, "Yes, but he can speak English"[14].

Essentially, the same message is included in a letter from the Coordinator of the White Book for Materials Engineers (*Libro Blanco de Ingeniería de Materiales*):

> Dentro del Bloque de Materias Formativas Básicas, y dentro de Idiomas Modernos, figura la asignatura de Inglés. Al tratarse de Ingenierías, sería más correcto referirse a esta materia como Inglés Técnico.
> Respecto al conocimiento del Inglés, el documento [the White Book or *Libro Blanco*] destaca su importancia al tratarse de una lengua de uso habitual en el mundo científico y técnico ... Para potenciar y mejorar el nivel de conocimientos de lengua inglesa de los estudiantes, sería mejor incluir la asignatura de Inglés técnico dentro de las titulaciones correspondientes. Eso facilitaría que los alumnos consiguieran conocimientos de inglés específicos para cada especialidad y, al mismo tiempo, permitiría que nuestros estudiantes fuesen más competitivos con el resto de titulados europeos.

4. European exchange programmes and the European Credit Transfer System (ECTS) have been instrumental in encouraging students and academic staff to participate in Europe-wide mobility opportunities. This, in turn, has highlighted the importance of foreign languages and given an impetus to the demand for language courses as the students themselves realise that a knowledge of languages is important for academic and professional development. The *Escuela Técnica Superior de Ingenieria de Diseño* (ETSID), participates actively in many of these exchange programmes; for example, *Sócrates-Erasmus, Leonardo da Vinci, Tempus Tacis, Programa de Cooperación Interuniversitaria (PCI), América Latina*

[14] Broadcast during August and September 2005, advertising language courses published by Planeta Agostini.

Formación Académica (*ALFA)* and the University Polytechnic of Valencia's own student mobility programme, *Programa de Movilidad Estudiantil (PROMOE)*. The School maintains Socrates-Erasmus exchange agreements with over one hundred European partners, providing the possibility for more than three hundred students to carry out part of their studies abroad[15].

5. Research into language learning has shown that different language skills and competences can be learned and used in different ways according to the learner's specific needs and abilities. For example, the aim of the Certificates in English Language Skills (CELS) offered by the University of Cambridge Local Examinations Syndicate is to assess English language competence in each of the four skill areas of reading, writing, listening and speaking, instead of a more general proficiency in an integrated exam. In this way a candidate can "gain certification for what they can do, without being penalised for what they cannot do"[16].

6. Language qualifications based on specific assessment criteria are widely accepted as proof of language competence in different professional contexts. The Cambridge Business English Communication (BEC) exams are an example.

7. With regard specifically to English, it is now the international language for business and commerce, as well as for science and technology. The most prestigious and widely-read journals and publications for many different disciplines are in English (Alcaraz Varó, 2000: 15), and Internet has only increased the dominant role of English in the dissemination of

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[15] I am grateful to Dr Pedro Fuentes, Head of International Relations at the *ETSID* for providing me with this infomation.

[16] Certificates in English Language Skills Handbook (UCLES), p. 7.

academic research and knowledge. One result of this is that, as Alcaraz Varó (2000: 15) points out:

> [...] todos los científicos e investigadores que desean participar de esa 'aldea global' que hoy constituye el mundo de la ciencia y de los conocimientos se ven, de una u otra forma, forzados al aprendizaje del inglés como lengua profesional y académica.

Similarly, the Spanish Association of Naval and Oceanic Engineers (*Colegio Oficial de Ingenieros Navales y Oceánicos*) recognises that:

> El conocimiento del Inglés, en el presente es necesario al ser la lengua del mundo científico-técnico y en la que encontrará la mayor parte de la documentación que se necesitará, tanto en el campo académico como profesional.
>
> (Colegio Oficial de Ingenieros Navales y Oceánicos, 2000: 81)

8. Appropriate language skills are recognised as a means of accessing information (via the Internet, data banks, libraries and other sources).

Thus, language training in tertiary education is now recognised as an important component in the students' academic and professional preparation and has meant that while in the past many language learners reached the peak of their language learning during the final year of secondary education after which, with no opportunities to practise, a steady decline set in, they now have the chance to consolidate and develop their language skills. These may be in general proficiency or in a specific mode such as speaking or reading, or they may be specific to a subject area such as electronics, architecture, information science or whatever. These developments have gone some way to establishing an environment which is favourable to language learning and teaching.

2.2 Limiting objectives: the importance of reading comprehension

However, there are several factors which oblige those of us who teach languages in universities to limit our objectives. Firstly, the second language is an optional subject and as such has to compete with every other core and optional subject; the number of hours allotted to language study is limited. The students who took part in this research can expect only around sixty hours of contact time per semester and, depending on their choices, they will only study a second language for a maximum of two semesters and quite possibly only one in the whole of their university degree programmes. Currently, the ETSID offers two English courses each lasting one semester (or 6 credits); *Inglés I* takes place from September to February, while *Inglés II* is taught in the second semester from February to June. Despite the course names, *Inglés II* is not a continuation of *Inglés I*. The content of *Inglés I* is related to engineering in general, while *Inglés II* is more specific to each specialisation (Chemical, Electrical, Electronic or Mechanical Engineering). Students may study both courses or just one and do not need to have passed *Inglés I* to take *Inglés II*. The vast majority of students choose to study languages in their first or second year of study and very rarely in their third or fourth year. Thus, before they leave university they will have had plenty of time to forget what they learned during the language course. Additionally, large classes and sometimes irregular attendance make it difficult to follow an individual's progress. These factors, as well as the generally low proficiency level and the widespread reluctance – not to say horror – on the part of the students to engage in oral activities, oblige those of us who teach languages to limit our objectives: one of these is to develop our students' reading comprehension skills.

Simply put, the ability to read in a second language – and the focus from now on will be on reading in English as an L2 – is important for both academic and professional advancement. This is not to place reading over and above other language or communication skills, but in the context of our institution and the needs of our students and graduates it does identify reading comprehension in English as a prime skill. As Alcaraz Varó (2000: 202) points out with respect to English for professional or academic purposes, “La comprensión lectora, desde un punto de vista práctico, es probablemente la destreza más útil”. Ramírez Verdugo (2004: 91) puts it rather more strongly:

> [...] since the vast majority of technical and scientific literature is published nowadays in English, being able to read in this language has become essential in Secondary and University studies.

The ability to read autonomously in English not only enables the student to draw on a much wider information base and carry out research more effectively, but companies require their engineers to be able to access the vast amount of technical, scientific and commercial information available – an availability, especially in electronic form, which we now take for granted. This information has to be searched for, identified, read and understood. The relevant details need to be extracted, recorded, integrated with data from other sources, and applied to the task in hand. In this respect, Salaberri & Zaro (2004: 5) suggest that for students at an intermediate level:

> [...] la lengua inglesa deberá considerarse ante todo un instrumento de comunicación de los alumnos, pero también un instrumento de investigación al servicio de sus necesidades e intereses, presentes y futuros.

To take the argument a little further, most of the world’s knowledge, as Stanovich, West, Cunningham, Cipielewski and Siddiqui, (1996: 19) remark, is stored in print, either on paper in hard copy format or, increasingly, in electronic form. Access to this knowledge is achieved through reading.

Moreover, because printed materials provide a stable and permanent information base, they allow the reader to refer back to them, to reflect on their content and their form. This is perhaps one of the main differences between reading and listening. The spoken word imposes an immediate and linear type of processing, and acoustic information can only be held in memory for a short time before it is replaced by additional incoming information. The written word is a more durable and effective means of recording and transmitting information[17]. Furthermore, reading is not only a means of accessing information. It is also a mechanism through which we build up knowledge structures; including knowledge of language, general background knowledge, domain specific knowledge, as well as knowledge of reading itself and the organisational, stylistic and linguistic conventions underlying the different genres of written materials. Thus, it is a primary mechanism through which learners build and modify both declarative and procedural knowledge.

With respect to language knowledge, people who engage in extensive reading have been shown to have larger vocabularies, produce longer sentences and use more complex grammatical structures (Daneman, 1991; Hafiz & Tudor, 1989; Wells, 1986). Extensive reading in a second language produces similar beneficial effects (Cho & Krashen, 1994; Elley, 1991). According to Sternberg & Powell (1983), the correlation between vocabulary size and comprehension observed in many L1 studies derives from the ability to learn new information from context. In their view, the same types of semantic, syntactic, inferential and integrative processes that are used to decode and understand texts are also used to infer the

[17] It is interesting to note that Sequoya (1770?-1843), the inventor of the Cherokee alphabet, believed that the secret of the white men's power was their written language, which freed them from relying on memory and word of mouth. Between 1809-1821 he developed the Cherokee alphabet by adapting letters from English, Greek and Hebrew to represent the syllables of spoken Cherokee. His alphabet allowed the Cherokee to publish newspapers and books in their own language.

meaning of unfamiliar vocabulary, and they suggest that differences in vocabulary knowledge or grammatical knowledge may not be the *cause* of differences in comprehension ability but rather are the *result* of differences in comprehension skills, which themselves depend on the amount of reading done by students.

Being able to read is particularly important in education. As Grabe (1991: 389) points out, “literacy in academic settings in developed countries exists within the context of massive amounts of print information”. It is only through reading that one can access this vast store of knowledge. However, reading on its own is not enough. As the authors of the *Second Report of the International Adult Literacy Survey* (IALS, 2003: 1)[18] point out:

> [...] literacy means more than knowing how to read, write or calculate. It involves *understanding* and *being able to use* the information required to function effectively in the knowledge-based societies that will dominate the twenty-first century [authors’ italics]
>
> Source: International Adult Literacy Survey (IALS), 2003: 1)

In the educational systems of developed societies the principal means of transmitting and acquiring information is through written texts, in particular expository texts. Given the limitations on the number of hours a university lecturer can dedicate to actually imparting knowledge in the lecture hall, not to mention current trends towards independent and group project work, written texts not only help to reinforce topics dealt with during teaching time, they also enable learners to access information

[18] *Literacy Skills for the Knowledge Society* (2003) is a comparative study of literacy skills in twelve countries, Australia, Belgium (Flanders), Canada, Germany, Ireland, the Netherlands, New Zealand, Poland, Sweden, Switzerland (French- and German-speaking) the United Kingdom and the United States. It is published by the Organization for Economic Co-operation and Development (OECD) in cooperation with Human Resources Development Canada (HRDC).

outside their classes[19]. Texts are, therefore, a primary source of information, and academic success at higher levels of secondary and tertiary education is dependent on accessing information from written discourse in an efficient and meaningful way.

Particularly at the tertiary level, texts are a rich source of formal knowledge, but they can be conceptually (and linguistically) more complex and more demanding, often presenting multiple viewpoints or conflicting theories. Students not only have to read and understand these texts, they must evaluate the information, extract what is relevant to their purpose, synthesise this with data from other sources and integrate it into their knowledge structures. Students who have problems comprehending written texts therefore, especially expository texts – which present their own difficulties to the reader, as we shall see – will also have problems learning. If they are unable to access the information independently, if their reading is inefficient and their comprehension limited, it is unlikely they will become independent learners. Difficulties with reading are a huge handicap in our technological-information age, yet as Grabe & Stoller (2002: 1) remark:

> As we enter a new century, productive and educated citizens will require even stronger literacy abilities (including both reading and writing) in increasingly large numbers of societal settings.

2.2.1 Electronic literacy

Mention of the technological-information age brings us to a further point. Access to the vast amount of resources to be found on the World Wide Web (WWW), or efficient use of the Internet (i.e. the WWW plus electronic

[19] On a point of terminology, it is perhaps worth noting that, in English universities at least, undergraduates do not *study* for their degrees they *read* for them; i.e. they *read* chemical engineering or electronics or philosophy or whatever.

mail), requires knowing how to use the corresponding information and communication technologies. These technologies have given rise to a new repetoire of skills known as *electronic literacy* – the ability to find, select, organise and make use of information, as well as to read and write in the new medium (Shetzer & Warschauer, 2000: 173). According to the International Certificate Conference (ICC) Report (2003: 4, 14), the 'new literacies' comprise the interplay of technical, critical, linguistic and cultural skills required for use of the Internet. Thus, if we want our learners to make use of the opportunities provided by the Internet we must ensure they learn the language and skills needed to be able to use the technologies. In many cases "English is the default language through which to do this" (Mishan, 2005: 246), and for many, learning English will be a prerequisite to be able to function well on the Internet (Warschauer & Whittaker, 1997).

2.2.2 Autonomous learning and lifelong learning

Two final points regarding the importance of reading comprehension are related to the most recent broad movement in language pedagogy; namely, *autonomous learning* or *self-directed learning*, and to the prominence now given to *lifelong learning* by the European Union.

Over the past three decades there has been a gradual move towards an emphasis on the learner. This is reflected in the terminology used to characterise the teaching profession: 'language teaching' in the 1970s, moving on towards the end of the 1980s to 'language teaching and learning', and culminating in the 1990s with 'language learning'. The shift in emphasis to the individual learner is not merely a question of terms, however. It has been accompanied by considerable changes in classroom practice. As Casado & García (2000: 79) describe it:

> Los alumnos, por su parte, han pasado de ser meros receptores pasivos del saber a participar más activamente en los procesos de enseñanza-aprendizaje. La teoría cognitiva asume el papel del alumno como intérprete y organizador de la información facilitada por el profesor. El alumno toma la nueva información y la analiza, interpreta o revísa a la luz de los conocimientos que ya tiene. Al mismo tiempo, se contempla el proceso de enseñanza-aprendizaje como algo creativo que permite al alumno explorar el lenguaje y organizar sus nuevos conocimientos utilizando para ello sus propios esquemas organizativos.

It is clear from this description that in autonomous learning, or learner-centred environments, the role of the teacher has altered dramatically. He or she is no longer the sole source of knowledge and information but has become a counsellor, facilitator (Benson, 2001: 171) and a manager of learning resources. Many teachers feel that this change in their roles has undermined their authority. To continue with the quote from Casado & García (2000: *ibid.*):

> Todo ello conlleva una pérdida de autoridad por parte del profesor que deja de ser el foco de atención para orientar su enseñanza hacia las necesidades y los centros de interés de sus alumnos.

However, these new roles "can demand broader knowledge, expertise and initiative than does the expository model of teaching" (Mishan, 2005: 9). Changing the terms used to describe what teachers do, as Little (2004: 2) argues, "in no way diminishes their [the teachers'] responsibility for making things happen". And he goes on: "[...] the teacher's key role is to create and maintain a learning community; if teachers stop teaching, most learners will stop learning".

The teacher remains, therefore, the learner's most valuable resource. His or her key role is to present academic content in a way that promotes learning, or, as Hoffman (1991: 921) stresses, to organise and manage "the instructional environment in a way that serves to maximise student engagement in academics".

Closely associated with autonomous learning is the view that education is a lifelong process and lifelong learning has become one of the guiding principles for the development of education and training within the European Union (Commission of the European Communities, 2001)[20]. Lifelong learning is broadly defined as:

> [...] all learning activity undertaken throughout life, with the aid of improving knowledge, skills and competences within a personal, civil, social and/or employment-related perspective.
> (Commission of the European Communities, 2001: 9).

In order for people to carry on learning after leaving formal education, opportunities to do so must be provided, and people need to be trained in how to learn independently and to recognise that they are responsible for their own learning (González Fernández, 2001; Holec, 1979: Little, 1991). As González Fernández (2001) points out:

> Tanto el aprendizaje espontáneo de la autorregulación como su entrenamiento se ven favorecidos si en el sujeto concurren unas determinadas características (motivación, conocimientos o estrategias), y si el contexto que le rodea fomenta la autorregulación (ofreciendo modelos adecuados, feedback sobre la actuación, o posibilidad de ayuda externa).

[20] With regard to lifelong learning in Spain, Paragraph 1 of Article 52 of the *Organic Law 10/2002* (BOE, 2002: 45202) states that:
"1. La educación permanente tiene como objetivo ofrecer a todos los ciudadanos la posibilidad de formarse a lo largo de toda la vida, con el fin de adquirir, actualizar, completar y ampliar sus capacidades y conocimientos para su desarrollo personal o profesional."

With respect specifically to language learning, the European Commission Directorate-General for Education and Cultural Vocational training (2003: 4) states that:

> To foster ‘learning to learn’ skills and to enable people to keep developing their linguistic competencies[21] after leaving school, a strong element of autonomous learning should be introduced in language courses. Learners should be trained to use autonomous learning tools as well as instruments which support the monitoring and self-assessment of the learning progress and process.

Autonomous learning does not necessarily mean that students know what they should do. As Renkl (1997: 25) observes:

> [...] learners, left to their own devices, typically fail to show effective learning behaviour when no external support (e.g., teacher guidance or scaffolding) is present.

And Nunan (1997: 194) points out that: “at the beginning of the learning process learners do not know what is best”. They do nevertheless, have the potential to discover what is best for them (Mishan, 2005: 9). In fact, Little (1997: 230) argues that “in the development of learner autonomy, learning goes hand in hand with learning how to learn”.

Neither does autonomous learning mean that learners work on their own[22]. Like other culturally determined human capacities, autonomy develops in interaction with others and, moreover, in the words of Little (2004: 1):

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[21] We have found this word spelled as *competences* and as *competencies* – sometimes within the same document – and current usage appears to find both acceptable. Although we favour the former, we have not changed the latter spelling when it is included in a citation.

[22] In this sense the Coordinator of the *Libro Blanco de Ingeniería de Materiales* referred to earlier, seems absolutlely correct to affirm that: “Es evidente que un sistema exclusivamente de aprendizaje autónomo paralelo a los estudios no es suficiente para el aprendizaje de una lengua”.

> […] entails a variety of self-regulatory behaviours that develop – *through practice* – as a *fully integrated* part of the knowledge and skills that are the goal of learning [italics in the original].

One of the aims of the educator, therefore, should be to help students manage self-directed, autonomous learning (Williams & Burden, 1997) and, as Urquhart & Weir (1998: 181) comment:

> Teaching students to read effectively unaided would seem to be a potentially powerful contribution to this [managing self-directed, autonomous learning], if not the single most important. If we can help students to read carefully and expeditiously on their own for their own purposes, then this would be success indeed.

From the above discussion it should be clear that any education system should be trying to produce citizens who are not only skilled and capable readers in their native language but also in at least one second language. Before going any further, therefore, it seems necessary to clarify what is meant by *second language proficiency*; i.e., to specify the sorts of knowledge and skills involved in 'knowing' a second language, and to what degree, so that learners may be described as having achieved this or that level of attainment. The next section, therefore, explores the notion of second language proficiency and what learners at different levels of proficiency may be expected to be able to do in the language, first in general terms, then more specifically for reading.

2.3 Characterising second language proficiency

> Proficiency can be looked at as a *goal* and thus be defined in terms of objectives or standards. These can then serve as criteria by which to assess proficiency as an empirical *fact*,

> that is the actual performance of given individual learners or groups of learners. Once proficiency has been established it can be related to the other variables in the model [of second language learning]: context, learner characteristics, learning conditions and learning process. The conceptualization and description of proficiency is therefore an important step in the study of second language learning.
>
> (Stern, 1983: 341)

In this section, we first discuss the current trends in describing second language proficiency in terms of *communicative competence*. This approach has been adopted in many parts of the English-teaching world including North and South America, Australasia and much of Europe including Spain. We then look more specifically at how these relate to English as a second language reading ability; that is, what learners can be expected to be able to do in reading tasks requiring real world communicative interaction (McNamara,1996; O'Malley & Valdez Pierce, 1996), from there to reading in study contexts and then to the L2 reading proficiency level of the subjects who participated in this study.

2.3.1 Communicative competence

Up to around the beginning of the 1970s, concepts of language proficiency were based mainly on the linguistic forms of a language such as phonology, vocabulary, and grammar (Stern, 1983: 347). Since the 1970s, language teaching has been largely dominated by Communicative philosophy. The communicative approach (which reflects a more social view of language, as opposed to a purely linguistic one) is generally thought of as originating with the publication in 1965 of Chomsky's *Aspects of the Theory of Syntax* (Howatt, 1984), in which he distinguishes between speakers' *competence*; i.e., their knowledge of the language system and their *performance*; i.e., their use of the language. Chomky's notion of competence was then picked up by an anthropologist, Dell Hymes (1971), who coined the term 'Communicative Competence' to describe the knowledge language users need in addition to the grammatical forms of the language: “There are rules of use without which the rules of grammar would be useless” (Hymes 1979: 15). In Hymes’ view, therefore, competence includes concepts of appropriateness and acceptability, and “involves far more than knowledge of (and ability for) grammaticality” (Brumfit & Johnson, 1979: 13-14). Thus, current notions of communicative competence include the ability to use sociocultural, pragmatic and discourse features as well as linguistic forms), in order to communicate succesfully in a given situation, where ‘communicate successfully’ means to achieve the desired outcome from the interaction (Mishan, 2005: 3). The desired outcome (or purpose) could be anything from ordering a meal in a restaurant, writing a letter, listening to a lecture or reading an article on the Internet to extract information on a specific topic.

Several models of communicative competence exist within the second language teaching community. One widely-recognised model by Canale (1983), based on an earlier framework suggested by Canale & Swain (1980), which itself grew out of Hymes’ work, identified four components:

> *Grammatical Competence* - the ability to use the forms of the language such as lexis, literal meaning, pronunciation, sentence structure.
>
> *Discourse Competence* - the ability to understand and create written and spoken forms of the language that are longer than sentences. Discourse competence includes understanding how texts relate to the context or situation in which they are used, and recognises that what makes a text coherent often depends more on our background knowledge, or on overall text stucture, than with the structure of individual sentences or the meanings of individual words.

> *Sociolinguistic Competence* – the ability to express, interpret and negotiate meaning according to culturally-derived norms and expectations. In other words, the ability to use language appropriately in different contexts. As such sociolinguistic competence may overlap considerably with discourse competence.

> *Strategic Competence* - the ability to use verbal or non-verbal strategies to overcome or compensate for breakdowns in communication due to limited ability in any of the previous areas or performance limitations.

While there seems to be broad agreement in the literature as to what makes up the first three areas of competence – although the terminology varies – there is some debate about how to characterise strategic competence. In its original formulation, strategic competence is called into play "to compensate for breakdowns in communication due to performance variables or to insufficient competence" (Canale & Swain, 1980: 30; cf. Canale, 1983) in any of the other areas. This seems to suggest that strategies, or strategic processes, are *only* engaged in when difficulties arise in using language. However, according to Wenden (1987: 7) the term 'strategies' has been used to refer to:

> [...] techniques, tactics, potentially conscious plans, consciously employed operations, learning skills, basic skills, functional skills, cognitive abilities, language processing strategies, problem-solving procedures.

"These multiple designations", says Wenden (ibid.), "point to the elusive nature of the term".

Grabe (2000) also notes that in the context of reading comprehension the term ‘strategies’ is used in various ways and is often badly-defined. Urquhart & Weir (1998: 96) suggest that there is considerable ‘confusion’ in the literature over what is a strategy and what is a skill, and note that at times the two terms seem to be used interchangeably. Their conclusion is that strategies are conscious decisions taken by the reader in an attempt to resolve a problem, while skills operate subconsciously and are abilities which have been automatised[23].

One logical result of this view is that the same process could be considered a skill when used by a reader automatically in his or her L1, a strategy as the reader is still developing his or her L2 reading proficiency, and as a skill again when the reader’s L2 reading has reached a sufficiently advanced level that the specific behaviour has become automatised and is, once more, below the level of consciousness. However, it is a view which seems to be generally accepted. Cohen (1998: 4), for example, writes that what distinguishes strategic from non-strategic processes is the element of consciousness (“even if the learner is only partially aware of them”), together with an element of choice. While for Riggenbach (1999: 12):

> [...] any conscious methods that, employed by the learner, result in communication – effective transmission of a spoken or written message – can be conceived of as “strategies,” since learners are negotiating meaning: they are structuring new input so that it is comprehensible, they are deciphering text that was previously opaque, or they are shaping and reshaping their own communications so that they are understood by the receiver of the message.

23 This idea of automatic processes operating subconsciously is what we believe Kintsch (2005: 125) refers to when he says that (to repeat the quotation from page 4) “fluent adult reading is more akin to automatic perception than deliberate analysis”.

Alderson (2000: 15) makes the further point that strategies may be *combinations* of processes:

> These conscious strategies involve a deliberate choice of process or task, each of which may involve different constellations of skill and knowledge.

As an example of a conscious strategy involving deliberate choice, Alderson gives the ability to infer the meaning of unknown words from a text: to continue with the quote cited above (Alderson, 2000: 15):

> Such strategies may be semi-conscious, or at least recoverable to consciousness, as when we try to figure out the meaning of a word we have never met before by thinking about the context in which it comes, its form, the sort of word it is (noun, verb and so on) and the sort of meaning it is likely to have. We may consciously decide to look the word up in a dictionary, or not to worry about its 'exact meaning', since we have sufficient idea of what it must mean to be able to continue reading without disruption.

Curiously, Alderson (2000: 310) also complains that what used to be called skills are now being reclassified as strategies and gives as an example the ability to infer the meaning of unknown words from a text. It is not our wish to contribute further to this confusion, thus for our purposes the term 'strategies' will be understood as referring generally to the resources employed by readers in their attempts to understand a text and contruct meaning. As Block (1986: 465) puts it:

> [...] strategies indicate how readers conceive a task, what textual cues they attend to, how they make sense of what they read, and what they do when they do not understand.

This allows for a fairly wide range of behaviours and includes both cognitive and metacognitive strategies. Cognitive strategies are the "familiar mental processes that enable us to read" (Urquhart & Weir, 1998: 179). They range from working out the meanings of words, to making inferences to looking through a text quickly to get the gist. Metacognitive strategies (for example, planning, monitoring, self evaluation and generally thinking about the process) involve “an awareness of one’s own mental processes” (Williams & Burden, 1997: 148) and an ability to control and regulate them consciously in an appropriate way. How readers use strategies and their knowledge of them is a function of individual reader characteristics (Flavell, 1979).

More recent models of language use, therefore, (e.g. Bachman, 1990; Bachman & Palmer, 1996, Savignon, 1997), tend to see strategic competence as underlying all language behaviour, including language learning. Bachman (1990: 100), for example, defines strategic competence as:

> [...] an important part of all communicative language use, not just that in which language abilities are deficient and must be compensated for by other means.

Bachman & Palmer (1996) go even further. They identify three components of strategic competence: goal setting, assessment and planning, which together comprise:

> [...] a set of metacognitive processes, or strategies, which can be thought of as higher order executive processes that provide a cognitive management function in language use, as well as in other cognitive activities.
>
> (Bachman & Palmer, 1996: 70)

Thus, for Bachman & Palmer (1996), strategic competence is not unique to language behaviour but is a more general ability, underlying other aspects of human behaviour, too. (The components of Bachman & Palmer’s (1996) model of language ability are shown in Appendix A, Table A1). Such strategies enable learners to plan, control, coordinate and evaluate the (language) learning activities and 'language use events' (Cohen, 1998: 7) they are engaged in. Cohen (1998: 12), amongst others (e.g., Campanario, 2001c; Swanson, 1990), also recognises the fact that the distinction between metacognitive and cognitive strategies is not always clear-cut and that on occasions the same strategy may be interpretable as both a metacognitive and a cognitive strategy. As Campanario (2001c: 3.7) explains it:

> Muchas estrategias que se han considerado tradicionalmente como cognitivas son útiles también porque proporcionan los medios necesarios para controlar el éxito de los esfuerzos del que aprende […] Por ejemplo, el relacionar la información que se está aprendiendo con conocimientos previos se puede considerar una de las destrezas cognitivas de aprendizaje más relevantes. Sin embargo, en la medida en que esta estrategia puede ayudar a detectar dificultades de comprensión, puede considerarse también como metacognitiva.

2.3.2 The Common European Framework of Reference for Languages

In Europe the most influential of the various systems for defining and assessing levels of language proficiency is currently the Common European Framework of Reference for Languages (CEF) developed by the Council of Europe (2001a), which:

> [...] provides a common basis for the elaboration of language syllabuses, curriculum guidelines, examinations, textbooks, etc. across Europe. It describes in a comprehensive way what language learners have to learn to do in order to use a language for communication and what knowledge and skills they have to develop so as to be able to act effectively. The description also covers the cultural context in which language is set. The Framework also defines levels of proficiency which allow learners' progress to be measured at each stage of learning and on a life-long basis.
>
> Council of Europe (2001a: 1)

The CEF, in common with schemes devised by other language organisations such as the Association of Language Testers in Europe (ALTE) or the American Council on the Teaching of Foreign Languages (ACTFL), characterises language proficiency with reference to performance skills and competences which go beyond the range of ability associated with purely linguistic elements of a language (such as vocabulary, grammar, phonology or morphology), but include sociolinguistic and pragmatic knowledge and skills. The aim of these ongoing efforts is to establish common standards for defining, describing and assessing levels of language proficiency in terms of *communicative competence*, and specifying what the learner at a particular level should be able to do on a given type of task in the context of a particular situation. The CEF establishes six broad levels of language proficiency. Each is characterised by a set of descriptors or statements describing what learners should be able to do at each level. Table A2 in Appendix A shows the levels (with level A1 being the lowest and level C2 the highest) and their corresponding descriptors for global language performance.

The authors of the *Common European Framework of Reference for Languages: Learning, teaching, assessment. A Guide for Users* also recognise that “the working of language depends on there being close correlations” (Bailly, Devitt, Gremmo, Heyworth, Hopkins, Jones, Makosch, Riley, Stoks, & Trim, 2002: 24) between competences directly concerned with language and those of a more general character. In their scheme of communicative competence, which, they note, “lays no claim to being philosophically or scientifically authoritative” (*ibid.*), they identify two broad areas which they call ‘general competences’ and ‘communicative language competences’, shown below in Table 2.1. Each of these broad areas is comprised of different aspects of knowledge and skill.

It can be seen that general competences are not specific to language, but 'are called upon for actions of all kinds, including language activities' (Bailly et al., 2002: 9), while communicative language competences are 'those which empower a person to act using specifically linguistic means' (*ibid.*). Thus, competences are seen as 'the sum of knowledge, skills and characteristics that allow a person to perform actions' (*ibid.*)[24]. Strategic competence as such is not mentioned specifically and appears to have been subsumed into other areas, nevertheless the use of strategies is seen as:

> [...] a means the language user exploits to mobilise and balance his or her resources, to activate skills and procedures, in order to fulfil the demands of communication in context and successfully complete the task in question in the most comprehensive or most economical way feasible depending on his or her precise purpose.
>
> (Bailly et al., 2002: 25)

Like Bachman & Palmer (1996), then, the CEF does not regard the use of strategies simply as a way of making up for a language deficit or a breakdown in communication. As its authors point out (Bailly et.al., 2002: 25) "Native speakers regularly employ communication strategies of all kinds [...] when the strategy is appropriate to the communicative demands placed upon them".

The CEF, although it purports to be a set of guidelines only, has been adopted in many countries, including Spain. The *Royal Decree 117/2004*, which establishes the curriculum for secondary education, states that:

> El Consejo de Europa [...] establece un marco de referencia común europeo para el aprendizaje de lenguas extranjeras, indicando que para desarrollar progresivamente la

[24] For a fuller discussion of these see: Council of Europe, 2001b: 101-130; or Bailly *et.al.*, 2002: 26-33.

competencia comunicativa en una determinada lengua, el alumnado debe ser capaz de llevar a cabo una serie de tareas de comunicación.

Royal Decree 117/2004, pp. 7592-7593

<table>
<tr><th colspan="3">Components of communicative competence identified by the CEF</th></tr>
<tr><td rowspan="4">General competences</td><td>declarative knowledge (savoir)</td><td>· knowledge of the world
· sociocultural knowledge
· intercultural awareness</td></tr>
<tr><td>skills and know-how (savoir-faire)</td><td>· practical skills and know-how
· intercultural skills and know-how</td></tr>
<tr><td>existential competence (savoir-être)</td><td></td></tr>
<tr><td>ability to learn (savoir-apprendre)</td><td>· language and communication awareness
· general phonetic skills
· study skills
· heuristic skills</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Communicative language competences</td><td>linguistic competences</td><td>· lexical competence
· grammatical competence
· semantic competence
· phonological competence
· orthographic competence
· orthoepic competence</td></tr>
<tr><td>sociolinguistic competences</td><td>· markers of social relations
· politeness conventions
· expressions of folk-wisdom
· register differences
· dialect and accent</td></tr>
<tr><td>pragmatic competences</td><td>· discourse competence
· functional competence
· schematic design competence</td></tr>
</table>

Table 2.1. The components of communicative competence identified by the CEF.
Source: based on the discussion in Bailly et. al., 2002: 25-26.

The Spanish Ministry of Education and Science has adopted a four-component model of communicative competence comprised of linguistic, pragmatic or discourse, sociolinguistic and strategic competences, although the last of these seems to be almost an optional component:

> La competencia comunicativa, que se desarrollará en el proceso de realización de tareas de comunicación, incluirá las siguientes subcompetencias: competencia lingüística (elementos semánticos, morfosintácticos y fonológicos), competencia pragmática o discursiva (funciones, actos de habla, conversación, etc.) y competencia sociolingüística (convenciones sociales, intencionalidad comunicativa, registros, etc.). La competencia estratégica se podría incluir también como subcompetencia de la competencia comunicativa.
>
> *Royal Decree 117/2004*, p. 7593

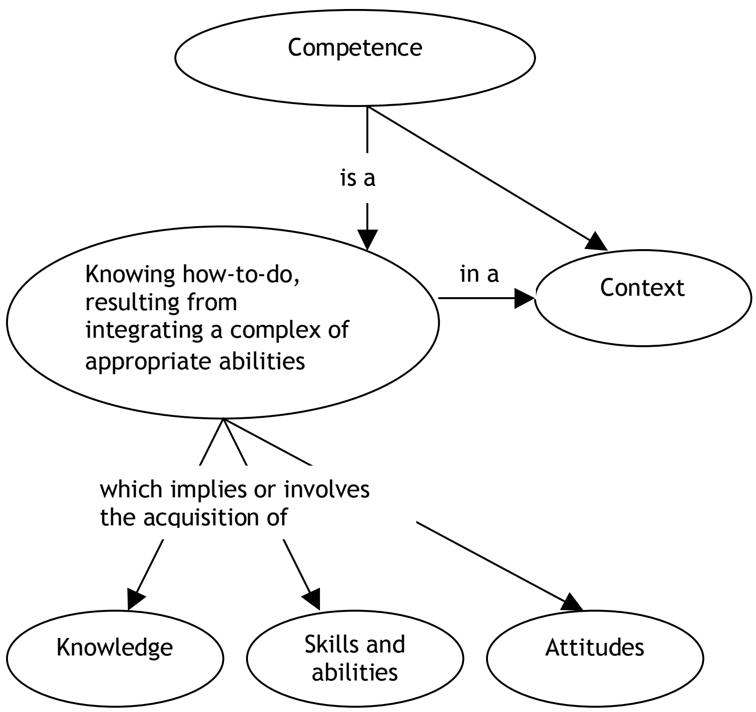
However, the notion of strategic competence in the *Royal Decree 117/2004* is clearly much broader than Canale & Swain's (1980), and follows the CEF. In order to carry out communication tasks:

> [...] se activa la competencia comunicativa, se ponen en juego diversas estrategias y se utilizan diferentes destrezas lingüísticas y discursivas de forma contextualizada.
>
> *Royal Decree 117/2004*, p. 7593

To sum up so far, current thinking sees language proficiency as involving a broad range of abilities, knowledge and skills which go beyond the purely linguistic elements of the language. The notion of *communicative competence* refers to how well a language user is able to carry out a specific communicative task in a specific context which has a specific communicative purpose[25]. The communicative purpose ('finalidad comunicativa') is, in simple terms, "what we do through language" (Wilkins, 1976: 41). Successful communication takes place when the language user's goals are satisfied. Language competence is characterised

[25] This idea is expressed in *Royal Decree 117/2004* as: "[...] que tienen una finalidad comunicativa concreta dentro de un ámbito específico" (BOE, 2004: 7593).

less in terms of knowledge of lexical, phonological, morphological and syntactic aspects of language, and more in terms of how well the learner can perform various language functions. Thus, there has been a shift towards semantic, pragmatic and sociolinguistic aspects, where language is no longer regarded merely as a set of structures but as a means of communication through which people can encode messages[26]. Figure 2.1 (adapted from Edwards, Donderis, Pardo & Ballester, 2005) shows how the notion of competence is generally conceived within the Spanish education system, at least at a theoretical level.



[26] We may note, along with Mishan (2005: 53), that in some ways the communicative approach is a form of "pedagogical imperialism", driven by the centralisation of the ELT publishing industry, and that in some cultures (Mishan (*ibid.*) cites, for example, Greece, Japan, Korea, China and some Arabic nations) the communicative approach may imply classroom practices, teacher-learner relationships and so on which are unsuitable for the pedagogical context.

Fig. 2.1. Components of competence.
Source: Edwards, Donderis, Pardo & Ballester, 2005.

It should be stressed that communicative competence is specific to a particular domain or context, and also that it is not known what the relative contributions of each component (general knowledge, general competences, linguistic, sociolinguistic, pragmatic) of communicative competence are.

2.3.3 Communicative competence and reading

The CEF is not specific to reading academic material, or indeed to any of the main language modes (speaking, listening, reading and writing). It does, however, distinguish several kinds of reading (2002: 68-69) including:

- reading for general orientation;
- reading for information, e.g. using reference works;
- reading and following instructions;
- reading for pleasure.

and notes (p. 69) that the language user may read:

- for gist;
- for specific information;
- for detailed understanding;
- for implications, etc.

In other words, the CEF recognises that different tasks may require different types of reading or, to put it another way, different types of reading may be more appropriate than others to the successful and efficient completion of any given task in any given communicative situation. This means that it may be better not to regard reading comprehension as a skill in itself, applicable to all readers or all texts regardless of the reading situation, but to focus more on the different strategies or types of reading most appropriate to achieve specific objectives in a specific context and conclude, along with Urquhart & Weir (1998: 88) that the best way to understand comprehension is to regard it as “the product resulting from a particular reading task”. Urquhart & Weir (1998: 123) suggest four generic types of reading, which are shown below in Table 2.2.

	Global	Local
Expeditious	A. Skimming quickly to establish discourse topic and main ideas. Search reading to locate quickly and understand information relevant to predetermined needs.	B. Scanning to locate specific information; symbol or group of symbols; names, dates, figures or words.
Careful	C. Reading carefully to establish accurate comprehension of the explicitly stated main ideas the author wishes to convey; propositional inferencing.	D. Understanding syntactic structure of sentence and clause. Understanding lexical and/or grammatical cohesion. Understanding lexis/deducing meaning of lexical items from morphology and context.

Table 2.2. Matrix of reading types
(from Urquhart & Weir, 1998: 123)

The CEF provides more specific statements describing what readers at different levels of attainment should be able to do for the types of reading it has identified[27]. These, for reading for orientation (or overall reading comprehension), reading instructions and reading for information and argument, which are relevant to reading in academic and professional contexts, are shown below in Tables 2.3, 2.4 and 2.5, respectively. It should be borne in mind that the mean proficiency level of the students in the main experiment carried out in this research corresponds to level B1.

[27] The CEF descriptors for the self-assessment of general reading are included in Appendix A, Table A3.

The CEF descriptors for reading for orientation	
Level	*Descriptors*
A1	Can recognise familiar names, words and very basic phrases on simple notices in the most common everyday situations.
A2	Can find specific, predictable information in simple everyday material such as advertisements, prospectuses, menus, reference lists and timetables. Can locate specific information in lists and isolate the information required (e.g. use the 'Yellow Pages' to find a service or tradesman). Can understand everyday signs and notices: in public places, such as streets, restaurants, railway stations; in workplaces, such as directions, instructions, hazard warnings.
B1	Can scan longer texts in order to locate desired information, and gather information from different parts of a text, or from different texts in order to fulfil a specific task. Can find and understand relevant information in everyday material, such as letters, brochures and short official documents.
B2	Can scan quickly through long and complex texts, locating relevant details. Can quickly identify the content and relevance of news items, articles and reports on a wide range of professional topics, deciding whether closer study is worthwhile.
C1 + C2	As B2

Table 2.3. The CEF illustrative descriptors used for reading for orientation.
Source: Council of Europe, 2001b: 70.

The CEF descriptors for reading instructions	
A1	Can follow short, simple written directions (e.g. to go from X to Y).
A2	Can understand regulations, for example safety, when expressed in simple language. Can understand simple instructions on equipment encountered in everyday life – such as a public telephone.
B1	Can understand clearly written, straightforward instructions for a piece of equipment.
B2	Can understand lengthy, complex instructions in his field, including details on conditions and warnings,provided he/she can reread difficult sections.
C1	Can understand in detail lengthy, complex instructions on a new machine or procedure, whether or not the instructions relate to his/her own area of speciality, provided he/she can reread difficult sections.
C2	As C1

Table 2.4. The CEF descriptors for reading instructions.

Source: Council of Europe, 2001b: 70.

The CEF descriptors for reading for information and argument	
A1	Can get an idea of the content of simpler informational material and short simple descriptions, especially if there is visual support.
A2	Can identify specific information in simpler written material he/she encounters such as letters, brochures and short newspaper articles describing events.
B1	Can identify the main conclusions in clearly signalled argumentative texts. Can recognise the line of argument in the treatment of the issue presented, though not necessarily in detail. Can recognise significant points in straightforward newspaper articles on familiar subjects.
B2	Can obtain information, ideas and opinions from highly specialised sources within his/her field. Can understand specialised articles outside his/her field, provided he/she can use a dictionary occasionally to confirm his/her interpretation of terminology. Can understand articles and reports concerned with contemporary problems in which the writers adopt particular stances or viewpoints.
C1	Can understand in detail a wide range of lengthy, complex texts likely to be encountered in social, professional or academic life, identifying finer points of detail including attitudes and implied as well as stated opinions.
C2	As C1

Table 2.5. The CEF illustrative descriptors used for reading for information and argument.
Source: Council of Europe, 2001b: 70.

The Association of Language Testers in Europe framework

Several other language organisations (as well as individuals) have tried to describe an ascending series of levels for foreign language reading comprehension. One European initiative, which is very closely related to the CEF, is the research programme being carried out by the Association of Language Testers in Europe (ALTE). The aim of this research is to establish a framework of 'key levels' of language performance describing levels of attainment through a series of 'Can Do' statements[28]. Currently the ALTE

[28] More detailed information regarding the ALTE project, inluding how the 'Can Do' statements were developed and how they are related to the Council of Europe

Framework is a five-level system. The validation process carried out by ALTE has apparently confirmed that the Council of Europe (CEF) levels A2 to C2 correspond broadly to ALTE levels 1 to 5 (Bailly et. al., 2002: 49). At the time of writing, work on defining the initial level (A1/Breakthrough) is in progress. The relationship between the two Frameworks can be seen in Table 2.6, below:

CEF levels	ALTE levels	ALTE scale labels
A1	Breakthrough	Beginner
A2	1	Elementary
B1	2	Lower intermediate
B2	3	Upper intermediate
C1	4	Lower advanced
C2	5	Upper advanced

Table 2.6. The relationship between the CEF and ALTE levels.
Source: Council of Europe, 2001b: 249.

The principal features describing overall general ability for each level in the ALTE scheme are shown in Appendix A, Table A4. However, the ALTE has also produced descriptive statements illustrating typical ability in a social and tourist context, in a work context and in a study context. It is the latter which is of more interest to our purposes. Table 2.7 shows the ALTE Can-Do statements summarising what a reader at each level should be able to do with respect to reading for study purposes. In order to aid comparison, the equivalent CEF levels are included in the first column.

Also available at the ALTE website are rather more extended descriptions of what learners can be expected to be able to do at each level. The 'Can Do' statements thus describe:

Framework can be found at Council of Europe, 2001b: Appendix D (pp. 244-250) or at the ALTE website, <www.alte.org>.

> [...] real-world language skills and performance at a number of key levels ... [and] ... can be used to define the stage the learner has reached and specify what the learner at a particular level should be able to do on a given type of task.
> (Council of Europe, 2001b: 244-245)

ALTE 'Can Do' summary statements for reading in a study context		
CEF levels	**ALTE levels**	**Summary statements**
A1	0	Can read basic notices and instructions.
A2	1	Can understand the general meaning of a simplified textbook or article, reading very slowly.
B1	2	Can understand basic instructions and messages, for example computer library catalogues, with some help.
B2	3	Can scan texts for relevant information and grasp main point of text.
C1	4	Can read quickly enough to cope with the demands of an academic course.
C2	5	Can access all sources of information quickly and reliably

Table 2.7. The ALTE 'Can Do' summary statements for reading in a study context.
Source: Association of Language Testers in Europe (ALTE)
<http://www.alte.org/can_do/study.cfm>
Date retrieved: 28 April 2004

The 'Can Do' descriptions for reading in a study context are shown below in Table 2.8. Column 1 shows the CEF level with the corresponding ALTE level in Column 2. Column 3 shows the descriptive labels used by ALTE for each level on the scale, while the final column includes the descriptive statements. No descriptor for reading in a study context at level A1 (Beginner/Breakthrough level) is available.

One question that arises is what is meant by 'can do'? Should it be understood as being successful at a given task *every* time it is carried out or only sometimes? ALTE offers a definition in terms of *how likely* it is that

CEF levels	ALTE levels	ALTE scale labels	ALTE Descriptors for reading in a study context
A2	1	Elementary	If studying, they [the readers] can get basic information such as class times from notices, and make some limited use of sources of information such as computers and bilingual dictionaries. At this level users are unlikely to be able to study an academic subject through the medium of a foreign language, and are most likely to be studying the language itself.
B1	2	Lower intermediate	If studying, reading speed for longer texts is likely to be slow. They can understand a graphic presentation of a familiar topic, as long as not much text is involved. They can extract information from a textbook or article if it is presented in simplified form or if they are given plenty of time and they can make use of support materials such as dictionaries.
B2	3	Upper intermediate	At this level, users are likely to have enough language ability to cope with some non-academic training courses which are conducted in the language being learnt. Users at this level can follow a lecture, presentation or demonstration on a familiar topic or where the context is well known, but are likely to have difficulty in following abstract argumentation. They can read simple textbooks and articles, but cannot read quickly enough to cope with an academic course.
C1	4	Lower advanced	If studying, reading related to the users own subject area presents problems only when abstract or metaphorical language and cultural allusions are frequent. However, the user still has difficulty getting through the amount of reading required on an academic course, and may not be able to cope with postgraduate study.
C2	5	Upper advanced	If studying, they can use written sources of information effectively. In dealing with texts, reading speed is still slow for a postgraduate level of study, and culturally remote references in the material may interfere with understanding. Sources of information can be accessed, the usefulness of materials assessed and dictionaries used effectively.

Table 2.8. The ALTE 'Can Do' statements for reading in a study context.

Source: http://www.alte.org/can_do/framework/level1.cfm> [level1-level5.cfm] a person at a certain level will succeed at certain tasks, and have chosen the figure of 80% because this score:

> [...] is frequently used in domain- or criterion-referenced testing as an indication of mastery in a given domain. Thus, candidates achieving an ordinary pass in an ALTE exam at a given level should have an 80 per cent chance of succeeding on tasks identified as describing that level.
>
> (Council of Europe, 2001b: 248)

Data collected so far apparently indicates that this figure accords well with the average probability of successfully completing a task in accordance with the 'Can Do' statements at the relevant level (Council of Europe, 2001b: 248).

The ACTFL Proficiency Guidelines

The ALTE descriptors are, nevertheless, fairly general. More specific are the *Proficiency Guidelines* developed in the United States, by the American Council on the Teaching of Foreign Languages (ACTFL)[29]. The *Proficiency Guidelines* (ACTFL, 1986) were developed as an attempt to find a standardised means of assessing achievement in terms of learners' functional ability to communicate in a foreign language. The Guidelines are available for the four modes of speaking, listening, reading, and writing. Together they represent a hierarchy of global characterisations of

[29] The ACTFL Guidelines were developed from a system originating in the 1950s at the Foreign Service Institute (FSI) of the US State Department, in order to assess whether personnel had sufficient language proficiency to satisfy the foreign language requirements of a particular position in the diplomatic service. The FSI model was later taken up by other US government agencies and coordinated by the Interagency Language Roundtable (ILR), who developed a five-point scale consisting of a set of descriptions of abilities to communicate in a language. Following the so-called 'proficiency movement' in the 1980s, an adapted version of the ILR model, under the auspices of the ACTFL and known as the Proficiency Guidelines, were developed.

integrated performance and, in common with the CEF and ALTE schemes, “do not measure what individuals achieve through specific classroom instruction, but assess what individuals can and cannot do”[30] at different stages of proficiency. Also, like the CEF and ALTE frameworks, the different levels of proficiency represent a range of abilities at different stages of learning. The descriptors are, therefore, not exhaustive but represent a sample of what the learner can do within a particular level. Each level subsumes all the previous levels.

Equivalences between the different schemes we have discussed (CEF, ALTE and ACTFL) as well as with several other existing frameworks are not easy to establish, due partly to the fact that much of the information is unpublished or restricted to the internal use only of the organisation which uses the scheme. However, the *A Worldwide ELT EFL ESL EAL LEP ESOL Assessment Scales and Tests Mapping Project* (AWEMAP, 2002), have devised the AWEMAP Chart (2002)[31] which shows how several of the currently existing assessment frameworks compare. Table 2.9 (which is based on the information available in this chart) shows how the levels established by the CEF and ALTE schemes correspond to the ACTFL Proficiency Guidelines. Also shown are the equivalent University of Cambridge Examinations Syndicate (UCLES) exams, and the levels corresponding to the International English Language Testing Service (IELTS). With respect to the last two, it is worth noting that British universities will accept the CAE (Cambridge Advanced Exam) or the CPE (Cambridge Proficiency Exam), while the absolute minimum acceptable grade on the IELTS for university entrance is 6. Students, achieving this score would still need a considerable amount of language support in order

[30] Source:
<http://www.sil.org/lingualinks/LANGUAGELEARNING/OtherResources/ACTFL ProficiencyGuidelines/TheACTFLGuidelines.htm>

[31] Available as a freely accessible document at
<http://www.geocities.com/esolscale/>.

to complete their studies, and most universities would require a higher grade depending on the degree course and the demand for places.

The darkly shaded area in Table 2.9 corresponds to the ACTFL levels most appropriate for higher education; namely *Superior* and *Distinguished* (excluding *Native*). The ACTFL descriptions for reading which correspond to these levels (and, therefore, to CEF levels C1 and C2) are shown in Table 2.10. The ACTFL Reading Proficiency Guidelines for all levels are shown in Appendix A, Table A5.

One thing the CEF, ALTE and ACTFL guidelines have in common is an underlying belief that language learning activities should promote active, communicative interaction among learners, and that the learners should be given opportunities to practise realistic language tasks in a range of contexts likely to be encountered in real-life social, professional, personal and academic settings.

We are now in a position to discuss, in more meaningful terms, the second language proficiency levels of the students who participated in this study – who may be regarded as generally representative of incoming students, at least for the near future. It is this latter group who, it is hoped, will be the main beneficiaries of this research. In the next section, therefore, we describe the English language proficiency of the students in terms of communicative abilities for both general language competence and with respect to their literacy skills (more specific details regarding the participants are given in Chapters 7 and 8 where the research is described fully) and we present the case for developing their reading comprehension abilities.

<table>
<tr><td colspan="6">Chart showing how different assessment frameworks compare</td></tr>
<tr><th>CEF levels</th><th>ALTE levels</th><th>ALTE scale labels</th><th>ACTFL</th><th>Equivalent UCLES exam</th><th>IELTS scale</th></tr>
<tr><td></td><td></td><td></td><td>0</td><td></td><td></td></tr>
<tr><td>A1</td><td>Breakthrough</td><td>Beginner</td><td>Novice - low</td><td>--</td><td>1</td></tr>
<tr><td rowspan="2">A2</td><td rowspan="2">1</td><td rowspan="2">Elementary</td><td>Novice - mid</td><td rowspan="2">KET</td><td>2</td></tr>
<tr><td>Novice - high</td><td>3</td></tr>
<tr><td rowspan="2">B1</td><td rowspan="3">2</td><td rowspan="3">Lower intermediate</td><td>Intermediate - low</td><td rowspan="3">PET</td><td rowspan="3">4</td></tr>
<tr><td>Intermediate - mid</td></tr>
<tr><td>B1+</td><td>Intermediate - high</td></tr>
<tr><td>B2</td><td rowspan="2">3</td><td rowspan="2">Upper intermediate</td><td>Advanced</td><td rowspan="2">FCE</td><td rowspan="2">5</td></tr>
<tr><td>B2+</td><td>Advanced plus</td></tr>
<tr><td>C1</td><td>4</td><td>Lower advanced</td><td>Superior</td><td>CAE</td><td>6</td></tr>
<tr><td>C2
C2.2
(proposed)</td><td>5</td><td>Upper advanced</td><td>Distinguished</td><td>CPE</td><td>7
8</td></tr>
<tr><td>--</td><td>--</td><td></td><td>Native</td><td>(diploma)</td><td>9</td></tr>
</table>

Table 2.9. The relationship between the CEF, ALTE, ACTFL, UCLES and IELTS levels.
Source: Based on the AWEMAP Chart (2002), <http://www.geocities.com/esolscale/>

Superior *CEF - C1* *ALTE - 4*	Able to read with almost complete comprehension and at normal speed expository prose on unfamiliar subjects and a variety of literary texts. Reading ability is not dependent on subject matter knowledge, although the reader is not expected to comprehend thoroughly texts which are highly dependent on knowledge of the target culture. Reads easily for pleasure. Superior-level texts feature hypotheses, argumentation, and supported opinions, and include grammatical patterns and vocabulary ordinarily encountered in academic/professional reading. At this level, due to the control of general vocabulary and structure, the reader is almost always able to match the meanings derived from extralinguistic knowledge with meanings derived from knowledge of the language, allowing for smooth and efficient reading of diverse texts. Occasional misunderstandings may still occur; for example, the reader may experience some difficulty with unusually complex structures and low-frequency idioms. At the Superior level the reader can match strategies, top-down or bottom-up, which are most appropriate to the text. (Top-down strategies rely on real-world knowledge and prediction based on genre and organizational scheme of the text. Bottom-up strategies rely on actual linguistic knowledge.) Material at this level will include a variety of literary texts, editorials, correspondence, general reports, and technical material in professional fields. Rereading is rarely necessary, and misreading is rare.
Distinguished *CEF - C2* *ALTE - 5*	Able to read fluently and accurately most styles and forms of the language pertinent to academic and professional needs. Able to relate inferences in the text to real-world knowledge and understand almost all sociolinguistic and cultural references by processing language from within the cultural framework. Able to understand a writer's use of nuance and subtlety. Can readily follow unpredictable turns of thought and author intent in such materials as sophisticated editorials, specialized journal articles, and literary texts such as novels, plays, poems, as well as in any subject matter area directed to the general reader.

Table 2.10. ACTFL proficiency guidelines for reading, most appropriate for higher education.
Source: American Council for the Teaching of Foreign Languages, 1983.

2.4 The case for developing the L2 reading skills of the subjects in this study

2.4.1 English proficiency level

Since 2002 we have administered an initial level test at the beginning of the academic year to all students taking English (*Inglés I*). The test used is the paper and pen version of the Quick Placement Test (QPT) published by Oxford University Press in conjunction with the University of Cambridge Local Examinations Syndicate who developed and constructed the test and who carry out ongoing validation of the materials. One of the advantages of this test is that marks are linked to the Council of Europe Common Framework of Reference for Languages (CEF) and also to the levels developed by the Association of Language Testers in Europe (ALTE), discussed earlier in this Chapter (see also Appendix A). Table 2.11 shows how the scores in the QPT map onto the Council of Europe framework and the corresponding levels established by ALTE. For scores of 36 or above, students are recommended to take the second part of the QPT.

QPT score	Council of Europe levels	ALTE levels
0 - 15	A1 Basic user	0 Beginner
16 - 23	A2 Basic user	1 Elementary
24 - 30	B1 Independent user	2 Lower intermediate
31 - 40	B2 Independent user	3 Upper intermediate

Table 2.11. QPT scores and their equivalent Council of Europe and ALTE levels.

During the time we have been using this test to assess the entry level of our students, we have found it to be not only a reliable assessment tool but also that it discriminates well between levels, especially at the lower end of the range (elementary – lower intermediate) which is the level at which most of our students enter the university. Table 2.12 shows the average scores for the cohorts from 2002 to 2005.

Year of entry	*Average QPT score*
2002	23.60
2003	24.03
2004	24.17
2005	24.28

Table 2.12. Average QPT scores for students registered for 'Inglés I' for the years 2002-2005.

It can be seen from Table 2.12 that for the last three years (2002-2005), the mean for all students corresponds to level B1 on the CEF, equivalent to ALTE level 2. According to the 'Can-Do' descriptors on the ALTE web site it is not until learners have reached level 4 that they "Can read quickly enough to cope with the demands of an academic course", thus, the starting level of English of the participants in our study would prevent them from being accepted onto a tertiary level course in their specialisations taught entirely in English. Furthermore, the lexical knowledge of the learners at the lower end of the range does not reach the 5000 words (3000 word families) considered necessary for 'minimal comprehension' by Laufer (1992), and falls well short of covering the 95% of the text which she considers necessary to be able to make sense of (i) unfamiliar words in a text, and (ii) interpret its global meaning (see also Laufer, 1997; Grabe & Stoller, 2002; Hirsch & Nation, 1992; Liu & Nation, 1985).

2.4.2 Reading behaviour and literacy

With respect to the students' reading behaviour, Bernhardt (1991b) argued that literacy should be viewed as operational knowledge; that is, knowing how to approach a text, knowing why one approaches a text and knowing what to do with it. In this sense, the students where this study was carried out are not particularly literate in English as their second language. Indeed, the majority of them present a similar profile to those described by Ramírez Verdugo (2004) in her study with 40 students of computer science in Madrid, all with an "intermediate' level of English" (p. 5), to whom she taught reading strategies. Ramírez Verdugo (2004: 92) describes the subjects in her study as lacking confidence in their English reading skills, often reading deliberately slowly, "proceeding word by word, looking up words frequently in the dictionary and relying excessively on translation".

In informal interviews carried out in groups of 2-4 where their reading habits were discussed, most of our students at the *ETSID* describe approaching all L2 texts in the same way, starting at the top of the page and picking their way laboriously through each word regardless of the task or the type of text. In other words, they do not read with a set purpose. Moreover, rather than trying to understand the writer's ideas and reasoning, they process texts in a shallow way, focusing on surface features such as simple facts and definitions mentioned explicitly in the text. Before going any further, we should make clear that these remarks and those that follow are not meant as criticisms, they merely describe the sort of inflexible reading behaviour which, as Urquhart & Weir (1998: 245) observe, is exhibited by many L2 readers. We should also make clear that more specific details regarding the subjects who participated in the research are given in the relevant sections in Chapters 7 and 8.

In class, when answering questions about a text, students frequently reproduce the exact wording or syntax even when this is not appropriate, and include information which is irrelevant. When the task requires them to ask questions, these are nearly always of the simple verification type requiring a yes or no answer and referring to explicit facts in the text. Only very rarely do they ask a question requiring inferencing or the integration of information from different parts of the text.

In addition, observation of their reading behaviour in class when reading hardcopy English texts (and in the study areas and the library of the *ETSID* when reading L1 texts) also showed that one of the most frequent strategies employed, apparently to aid understanding, was highlighting (either by underlining or with a fluorescent marker pen) sections of the text which were identified as important. In class, this was done within the context of carrying out tasks of the information-transfer type requiring global and specific information contained within a text to be identified and either recorded for future use or applied immediately in order to complete a broader activity. However, in both their L1 and L2 reading, the sections highlighted in this way frequently consisted of whole paragraphs and even entire pages, which suggests that the readers were not, in fact, identifying the most important information relevant to the task in hand or, at the very least, not separating it or extracting it from unimportant details. Not only does highlighting such long sections of text indicate that readers are not being sufficiently selective, it is also inefficient. Moreover, given that many materials are now accessed and read online; i.e. on a screen in electronic format, highlighting in this way is not possible, and students need to be able to identify relevant details and record them efficiently.

2.4.3 Low expectations

Stanovich (1986) referred to differences in reading ability as creating what he called ‘the Matthew effect’[32] , whereby those who can read, read more and develop their reading skills, while those who do not or can not read

[32] The term comes from the Book of Matthew in the New Testament 25: 9. “For unto everyone that hath shall be given, and he shall have in abundance, but from him that hath not shall be taken away even that which he hath.”

become impoverished readers. A sort of 'the rich get richer while the poor get poorer'. In other words, while good readers read more and develop their reading skills, the opposite occurs with poor readers. Because students with reading difficulties read less, the cognitive-linguistic processing mechanisms and skills involved in reading comprehension are given less chance to develop. And, as reading can be a frustrating experience requiring considerable effort, poor readers may feel that reading is not worth the effort involved. They become demotivated, have low expectations and do not read for pleasure. Their low levels of practice, in turn, exacerbate their reading problems.

This is the case with many of our own students. The results of a survey into Spanish (L1) and English (L2) reading habits we carried out among 100 of our first-year undergraduates show that they do very little reading outside the classroom[33]. Students were asked to state approximately how many hours per week they spent reading outside the University in Spanish and in English. Any kind of reading was included; books, magazines, electronic texts, comics. According to their responses, the average time per week spent reading off the campus was 4 hours 6 minutes in Spanish and 3 minutes in English. However, if these statistics suggest that all students spent at least 3 minutes reading in English they are misleading. Only three students (3%) of the one hundred reported doing any reading in English at all and the bulk of the total time was accounted for by one student who reported reading in English for 3 hours per week. The other two each reported reading in English for 1 hour per week. Similarly, the majority of students read for less time in their L1 than the mean suggested by these figures. An example of the survey question is shown in Appendix B.

All of the students who took part in the survey recognised the usefulness of being able to read in English and reported that it is a skill they would like

[33] The survey was carried out with the new student intake in October 2004.

to develop and improve. The main reason given for not reading was a self-perceived lack of proficiency in reading English which gave rise to feelings of frustration, demotivation and a strong desire to avoid the effort involved. Thus, many students are reluctant to make use of materials in English because they feel that they will be unable to understand or that the process will be too slow and too laborious and that the time invested in reading English texts will not give sufficient returns.

2.4.4 Reading skills in L1 and L2

It is sometimes argued that reading skills are ‘universal’ (e.g Cummins, 1979, 1991); that is, reading skills in one language can be transferred to reading in a second language. The corollary is that if one has weak first language reading skills then second language reading will also be poor. Many teachers of second languages, says Alderson (2000: 23), believe that the poor L2 reading of their students is due to “a lack of good reading abilities/skills/habits in the first language”, even though this notion has little support in the literature (Alderson, 2000: 24).

With respect to our own students, we assume that in their first language they have relatively well-developed text-processing skills. After all, reading comprehension involves more than just linguistic knowledge; it is linked to more general cognitive processes which our students will have used (and use) routinely during the twelve or thirteen years of formal schooling they have already completed. And they have attained a sufficient level of education to pass the *Examen de Selectividad* and gain entrance to the *ETSID*, an achievement which indicates that their general cognitive/academic literacy skills must be fairly well-developed. Thus, they are not without text-processing strategies when reading L1 texts, and, if we accept Cummins’ (1979/1991) linguistic interdependence hypothesis[34], then, despite any language difficulties, nor are they completely bereft of processing resources when it comes to reading L2 texts either – although a certain amount of ‘prompting’ may be required for them to engage these resources.

However, some research indicates that readers may not be able to apply all their L1 higher-level reading skills to second language texts unless and until they have reached a certain ‘threshold’ level of proficiency in the target language (Alderson, 1984; Bernhardt & Kamil, 1995; Clarke, 1979; Mohammed & Swales, 1984; Ridgway, 1997). Alderson (2000: 24) notes that results from the research literature “increasingly confirm the existence of a linguistic threshold” and adds that:

> [...] poor second-language reading performance is likely to be due to insufficient language knowledge, and any attempt at remediation might profitably pay attention to the linguistic problem than to any supposed reading deficit.

This sounds like reasonable advice: however good readers’ L1 reading skills are, or however expert they are in domain knowledge (the subject-matter of the text), if they can not understand the language in which the text is written, skills in one of the other areas contributing to reading comprehension will not compensate and they are not going to be able to make any sense of the text. Alderson (2000: 39) concludes that “second-language knowledge is more important than first-language reading abilities”.

[34] Cummins’ (1979/1991) interdependence hypothesis assumes that although the surface features of different languages are distinct there is a common underlying cognitive/academic proficiency that facilitates the transfer of cognitive/academic literacy-related skills across languages.

One could argue, therefore, that it might be better to pay attention to the 'linguistic problem'; that is, to improve the students' all round knowledge of English, than to concentrate on developing their competence in a particular area. On the other hand, one can also make quite a strong case for devoting time and resources to developing students' reading skills.

Firstly, we have already identified (in Section 2.2) reading comprehension as an especially worthwhile area in which to develop students' abilities in terms of learner autonomy and academic and professional needs. Secondly, and from a purely linguistic point of view, increasing L2 language knowledge does not by itself necessarily improve L2 reading skills (Hacquebord, 1994), just as some native speakers are not necessarily good comprehenders of L1 texts.

Thirdly, although the 'L2 reading comprehension threshold' is a "well-documented phenomenon" (Walter, 2002: 4), it is not known exactly where the threshold lies, although it appears to occur "somewhere in the intermediate proficiency range" (Walter, *ibid.*) which as we have seen in Table 2.9 above, is a rather broad area corresponding to ALTE levels 2 and 3 or CEF levels B1 to B2+ (and which is the range in which most of our students find themselves, albeit in its lower reaches). Yet, as Alderson (2000: 39) himself points out, the so-called threshold level is not an absolute but will vary depending on the task type, the language of the text, the background knowledge of the readers and the topic. As Urquart & Weir (1998: 72-73) put it:

> The mistake is to imply that there is a general linguistic threshold level, valid for all tasks and all subjects. In fact, it seems obvious that some tasks will require a higher threshold level than others. It is probably also true that some subjects are able to make more of their limited linguistic proficiency than others. Thus the threshold level must be 'reset' for each subject or group of subjects, and each set of tasks.

We need also to bear in mind that the semester lasts four months, that some students may never reach their 'personal' thresholds anyway while ohers may already have attained theirs. Many may never formally study English again. Developing students' reading skills, on the other hand, equips them with know-how they are able to use *immediately* in order to carry out academic coursework, as well as contributing to making them autonomous learners and adding to their bank of academic/professional skills.

2.4.5 Course requirements

Students in the *ETSID* are expected, as part of their degree courses, to read authentic materials in English, either from textbooks, supplementary documents or increasingly in electronic form on the World Wide Web (WWW). Many of the subject lecturers include texts written in English in the reading and bibliography lists they provide to the students. To give just two examples, the course on *Electrónica Analógica y de Potencia* includes three recommended books in English: *Electronic Devices and Circuit Theory* by R. Boylestad and L. Nashelsky (1997), published by Prentice Hall, *Electronic circuits, discrete and integrated* by D.L. Schilling and C. Belove (1993), published by McGraw-Hill, and *Power Electronics – Converters, Application and Design*, by N. Mohan, T.M. Underland and W.P. Robbins (1995), and published by John Wiley. Students who take the computer-assisted drawing course (*Dibujo Asistido por Ordenador*) are recommended to read *AutoCAD And Its Applications: Advanced (Autocad 2005)* by T. Shumaker and D. Madsen (2005), published by Goodheart-Wilcox[35].

[35] I am grateful to my colleagues Arturo Gil, Pedro Fuentes, Vicente Donderis and Jordi Blanes for discussing this with me and for providing me with the information.

In addition, many students will go on Erasmus exchange programmes abroad where they will follow university courses in English, carry out Final Year Projects or be required to work as a member of a team.

Given these requirements, together with the importance of reading we have already discussed and the current state of our students' L2 reading skills and habits, it was decided to investigate different ways of encouraging students to read more strategically, with the ultimate aim of applying the findings in order to develop students' proficiency in reading expository texts in English, where 'proficiency' (as the discussion earlier in this Chapter should have made clear), refers not simply to what students know, but to what they *know* and *can do*[36].

In other words, our concern has been to equip students with the text-processing skills and strategies needed to meet their academic and future professional needs, and to instil in the students confidence in their own ability to successfully carry out reading tasks requiring the application of real world skills and competences.

The consequence of *not* intervening in this way would be that although the good readers might improve their reading skills, the poor readers would certainly not get better; in other words, the gap between the good readers and the poor readers (the Matthew effect referrred to earlier) would widen (Stanovich, 1986; Pearson & Fielding, 1991). Thus, our focus has been on developing strategic reading skills in order to facilitate cognitive and academic learning. General aims included developing different types of expeditious or careful reading appropriate to a particular task, purpose or text, the identification and extraction of relevant information and the effective recording of this information; and developing a repertoire of

[36] Put simply and concisely, *proficiency*, in this sense, refers to *outcomes*.

reading strategies in order to enhance learner autonomy and equip and encourage learners to make greater use of the considerable English language resources at their disposal.

2.5 Conclusion to Part I

The purpose of Part I has been to set the scene, as it were, for the rest of the study. Chapter 1 began by offering a definition of reading comprehension which emphasised how readers construct meaning from texts and how the elaboration (or self-explanation) of information in a text can lead to increased understanding and learning. It was also noted that self-explanation can be operationalised in different ways. Chapter 1 then went on to present the hypotheses underlying the study and stated the research questions the study has attempted to answer.

Chapter 2 described the context of the study, focusing first on the general objectives for language learning in Spain as established by the relevant legislation and which, in turn, is based on contemporary views of what it means to ‘know’ a language. The increased recognition of the important role foreign languages can play for students in tertiary education in Spain was discussed and the reasons for this synthesised under eight points. An emphasis was placed on developing literacy skills in English for academic and professional purposes. The Chapter then addressed the issue of how general second language competence, and more specifically competence in reading for study purposes, can be characterised in terms of performance statements which describe what readers can or can not do (i.e., communicative competence) at a number of key levels. Armed with this characterisation, the students who participated in the study were described in more meaningful terms. The Chapter closed by taking the case for concentrating efforts on developing the students’ reading skills a little further, and stated how this goal fitted in with more general aims and objectives.

In the following four Chapters which make up Part II, we shall explore in more detail some of the knowledge and process variables involved in reading comprehension.

Part II

Chapter 3

General cognitive processes and knowledge variables involved in reading comprehension

3.1 Variables that influence reading

There are many variables which bear upon the reading process, but there seems to be broad, general agreement in the research about how they might be classified. For example, the Rand Report (Snow, 2002) puts forward the following four principal categories: characteristics of the text, characteristics of the reader, the comprehension activities (carried out by the reader), and the sociocultural context. Both Pearson (2001) and Alexander & Jetton (2000) identify the text, the reader (learner), and the context as key dimensions but do not include comprehension activities on the same level. Following Kintsch (1988) and Otero (1998) we will assume four basic categories:

- characteristics of the text
- characteristics of the reader
- characteristics of the task
- the context.

A detailed specification of all of these is beyond the scope of this study. Briefly, therefore, *text characteristics* include such factors as genre, coherence[37], complexity, or amount of information presented.

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[37] *Text coherence* can be defined in various ways: van Oostendorp (1994) sees it as a measure of how the concepts in a text are semantically related to each other. For Kintsch (1988) and McNamara, Kintsch, Songer & Kintsch (1996), it refers to the

Characteristics of the reader include background knowledge, which can be further sub-divided into general world knowledge, domain knowledge and linguistic knowledge (Beck, Perfetti & McKeown, 1982; Coté, Goldman & Saul, 1998). Linguistic knowledge itself may include vocabulary (in L1, e.g., Daneman, 1991; Sternberg & Powell, 1983, in L2, e.g., Cho & Krashen, 1994; Hirsh & Nation, 1992; Read, 2000), or syntactic knowledge (in L1, e.g., Daneman, 1991; Sternberg & Powell, 1983, in L2, e.g., Devine, 1988; Alderson, 2000).

Metalinguistic knowledge and metacognition are also important factors. These refer to the reader's skill in inference-making (e.g., Cain & Oakhill, 2003; McNamara, Kintsch, Songer & Kintsch, 1996; Oakhill & Yuill, 1996), comprehension monitoring (e.g., Alderson 2000; Alderson, Clapham & Steel, 1997; Palincsar & Brown, 1984) or applying appropriate comprehension strategies (e.g., Block, 1986, 1992; Cohen, 1998). Other reader characteristics which have been identified as influencing the reading processes engaged in by the learner are the attitude to, and interest in, the text topic and to the task in hand (Hidi, 1990), as well as

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forms of linguistic coherence of the propositions (such as the syntactic relations), while for Baker (1985), coherence refers to the structural cohesiveness of the text at global, more schematic levels.

Text coherence at both the propositional (microstructural) and global (macrostructural) levels can strongly influence learning and comprehension (Kintsch, 1990; van Dijk, 1980; van Dijk & Kintsch, 1983) as well as inference making, problem-solving and subsequent retention of information (Kintsch, 1998). When information in a text is made more explicit, or when text coherence is enhanced by the addition of bridging inferences (Britton & Gülgöz, 1991), causal connections or more background information (Beck, McKeown, Sinatra & Loxterman, 1991), inference making, understanding and recall also improve.

Strictly speaking, as Vidal-Abarca (2004 in press) points out, coherence is not a characteristic of the text but a property of the reader's mental representation. Indeed, the same text may induce a highly coherent representation in one reader yet be virtually incomprehensible to another. Thus, the term 'text coherence' or the adjective 'coherent' when applied to a text, should more properly be understood as referring to whether the text is able to foment a coherent mental representation in the reader's mind.

the reader's attitude[38] to reading in general (e.g., Day & Bamford, 1998; Harmon, 1999). Some readers, for example, actively engage with a text and try to understand the ideas and relate these to their existing knowledge. Others seem to be satisfied with processing words rather than ideas and to be content with what we can call a shallow comprehension of the material. According to Day and Bamford (1998: 23), one of the factors influencing attitude to reading in an L2 is attitude to reading in one's L1.

> Assuming that students are already literate in their first language, one source of attitudes toward second language reading is the attitude that students have toward reading in their native language.

Task characteristics refer to the goals or purpose of reading. Different tasks place different cognitive demands on the reader, thus, the kind of reading engaged in may depend on the task to be carried out or purpose of reading (Kintsch, 1998; Otero, 1998). By manipulating the task requirements, readers can be induced to process information they might not normally encode. For example, Horiba (1996) asked non-native readers to process causually related pairs of sentences[39] under two encoding conditions: elaboration and studying to memorise. She found that the readers who elaborated links between the sentences had a better memory for their content than those readers who simply studied them for memorisation. She concluded that the strategies of elaboration and

[38] Reading attitude is a complex theoretical construct which is defined in various ways. For example, "a system of feelings related to reading which causes the learner to approach or avoid a reading situation" (Alexander & Filler, 1976: 1) or "a state of mind, accompanied by feelings and emotions, that make reading more or less probable" (Smith, 1990: 215). According to an extensive review of the literature by Reeves (2002), there is considerable agreement among contemporary researchers that reading attitude is defined by three components: cognitive (personal, evaluative beliefs), affective (feelings and emotions), and conative (action readiness and behavioral intentions).

[39] As Horiba (1996) herself points out, the materials used in her study were fragments of discourse, which perhaps casts doubt on any generalisations to reader behaviour with longer pieces of text.

integration facilitate readers' (both native and non-native) comprehension and memory for content.

Reading context refers to the social or physical setting. For example, it seems that students' ability to detect contradictions in a technical text is facilitated when the text is presented in a science class as opposed to a language class (García-Arista, Campanario & Otero, 1996; Garner, 1990). Schellings & van Hout-Wolters (1995) found that students identified the main points in a text differently when the text was presented in an educational setting and when it was given as free reading. Reading individually or cooperatively (Karau & Williams, 1993, cited by Elshout-Mohr & van Daalen-Kapteijns, 2002) has also been found to influence reading processes.

Clearly, reading comprehension is highly complex, involving many different cognitive skills and processes. The different processing and knowledge variables involved may each make distinct contributions to comprehension (Perfetti, Marron & Foltz, 1996) and to the construction of meaning. This means that there are many different aspects of reading where breakdowns or difficulties may arise, and these, in turn, may themselves be the cause of further problems. Breakdowns in reading comprehension may occur at word-level, sentence-level and discourse-level. These three different language levels provide us with a general framework around which we have organised Part II of this study, although it should not be taken as implying that we believe language processing takes place in a modular way.

The focus of the four Chapters making up Part II, therefore, is to describe, albeit in fairly general terms, some of the principal cognitive processes and knowledge factors involved in reading comprehension. In Chapter 3, we first clarify some of the terminolgy used in the reading comprehension literature and state how it is employed here. We then consider some general assumptions regarding the comprehension processes which are thought to be involved in the reading process. These general assumptions are described within the context of a theoretical framework which draws heavily on the Landscape model of reading (Linderholm, Virtue, Tzeng and van den Broek, 2004; van den Broek, Young, Tzeng and Linderholm, 1999; van den Broek, Virtue, Everson, Tzeng and Sung, 2002). This provides us with a starting point to explore, in Chapters 4, 5 and 6 respectively, some of the word-level, sentence-level and discourse-level variables which bear on reading comprehension. To be specific, in Chapter 4, we look at three factors involved in the recognition of words; namely, decoding, phonological skills and vocabulary knowledge. We then discuss how ‘deficits’ in any one of these areas may be a source of difficulties for comprehension for readers reading in a foreign language, focusing on readers whose first language is Spanish and target language is English. Chapter 5 is concerned with two variables involved at the sentence-level; knowledge of syntax and the use of context, while in Chapter 6 we explore two ‘higher-level’ processing variables and one knowledge variable employed by readers at the discourse level. Respectively, these are inferencing and comprehension monitoring and knowledge of text structure. These are discussed with reference to expository texts, focusing on some of the difficulties inherent in such texts for both L1 and, more especially, L2 readers.

3.2 Terminology

3.2.1 Processes, operations and components

Traditional models of cognitive processing distinguish between ‘processes’ or ‘operations’ (which allow the cognitive system to interpret the information it receives), and ‘components’ (which postulate that the factor they represent is present in some way in the reading process). The model of reading offered by Urquhart & Weir (1998: 106), and which is based on previous work by Just & Carpenter (1980; 1987) and by Kintsch & van Dijk (1978), will serve as an example of how these terms are employed. Urquhart & Weir's (1998) model, or as they prefer to call it, a 'generalised representation' of some aspects of reading, includes processes such as encoding word meanings, parsing syntax, integrating information, monitoring, goalsetting or simply deciding whether to move on to the next sentence. 'Monitoring' involves assessing whether comprehension has taken place, while 'Goalsetting' refers to deciding on the purpose of reading and what kind of reading should be undertaken. Urquhart & Weir (*op. cit.*), also call these activities 'reader behaviours'. With respect to components, apart from the Monitor and the Goalsetter (which instructs the system as to the kind of reading to be engaged in), the model includes separate storage components such as working memory (WM), long-term memory (LTM), and a lexicon.

Connectionist models, do not make such distinctions. For example, they do not include an independent memory store such as a lexicon, which contains specific information about words. In fact, connectionist models do not distinguish between memory stores and processes at all. Rather, all information is distributed among a network of connections, and what the system 'knows' depends on the weight (or strength) between the connections which the system has acquired (McLeod, Plunkett & Rolls, 1998). Some connectionist models emphasise distributed representations, where a concept is represented by a pattern of activation distributed over a number of nodes. Others, such as Kintsch's (1988, 1998) Construction-Integration model, involve local representations where a concept or an entire proposition is represented by a single node (Sanjosé, Vidal-Abarca & Padilla, 2006). Learning is a dynamic process, represented by changes in the weights or strengths of the connections between nodes (Kintsch, 1998), and memory is understood "[...] as an associative network of nodes that influence one another, each node being activated or inhibited with respect to the other nodes of the network" (Sanjosé, Vidal-Abarca & Padilla, 2006: 3).

There is also evidence to suggest that in an activity as complex as reading (which draws on several different sources of information and involves different types of operations), information is processed by the reader in parallel rather than serially (Grabe, 1991; Just & Carpenter, 1980; McClleland & Rumelhart, 1981). If this were not the case, reading would require much more time than it actually does.

A practice which currently seems to be popular in the literature is to employ terminology drawn from both 'traditional' and connectionist paradigms, and for ease of reference and convenience we adopt this practice here. Thus, terms such as the 'mental lexicon', 'episodic memory', 'working memory', 'nodes' or 'network of connections' do not necessarily imply that these structures exist as biological components or separate, identifiable systems. Rather they should be viewed as convenient labels for useful concepts.

3.2.2 Decoding and comprehension

The reading research literature frequently distinguishes two main components of reading: decoding and comprehension. In skilled readers, the interaction between decoding processes and comprehension processes occurs rapidly, automatically and simultaneously. Stated briefly, 'comprehension' refers to the overall understanding processes whereby meaning is constructed within sentences, across sentences, and over larger units of text, including the text as a whole.

The second main component, decoding, is defined in the literature in several ways. For many researchers (e.g., Hoover & Tunmer, 1993) it is a somewhat restricted notion, the term being limited to replacing graphemes (letters) with their corresponding phonemes (sounds). Goodman (1967; 1970) calls this process *recoding*. For Goodman (1967; 1994), decoding includes recognising what the word means (i.e., lexical access), and the input may be graphemic (in which case the word is recognised directly) or phonemic (in which case word recognition is mediated through phonemes). Ehri (1999) uses the term to refer to word recognition in general regardless of how this is accomplished, for example by recoding from graphemes to phonemes, by sight recognition or by analogy. For Carpenter & Just (1986), it involves the oculomotor, perceptual and parsing aspects of reading through which written symbols are translated into language. Eskey (1988: 94), too, uses 'decoding' to refer to the recognition of both words *and* syntactic structures. Good readers, he says:

> [...] can decode, with occasional exceptions, both the lexical units and syntactic structures they encounter in texts, and they do so for the most part, not by guessing from context or prior knowledge of the world, but by a kind of automatic identification that requires no conscious cognitive effort.

When children first start learning to read their mother tongue, an emphasis is usually placed on decoding (in the restricted sense we have mentioned), and the reading materials they are provided with are designed to give practice in letter-sound relationships, word recognition and lexical access. Some attention may be given to the syntactic parsing of simple sentences, but attention to broader interpretative skills (thinking about the ideas or arguments the writer has tried to develop) is rarely given.

Skill in decoding is usually reflected in relatively fluent oral reading (i.e. reading aloud), however, skill in decoding does not necessarily lead to skill in comprehension. It is possible, once one knows the rules, to read aloud quite fluently phonetic languages such as Finnish, Slovenian or Spanish with no understanding. Even in first language reading, many readers are able to decode texts but still have difficulty understanding what they have decoded (Daneman, 1991; Yuill & Oakhill, 1991), and second language readers experience the same problem; they are able to read aloud the words of a sentence, and even understand the individual words, but not the overall meaning. The following statement from one of the think-aloud protocols in the preliminary research we carried out to investigate the comprehension strategies used by readers in their L1 and L2 is illustrative of this. The reader (identified as Subject #3) has just read the following sentence in English, her L2:

> *The ever increasing concerns with performance and cost faced by companies competing in the global marketplace require that a spectrum of issues in the science of manufacturing be addressed.*
> (Introduction to Materials Selection, ll. 56-58)

[7] <<La siguiente frase, entiendo las palabras independientemente, por traducción, pero al englobarlo no me deja entender del todo lo que la frase me quiere decir, no no lo encuentro mucho sentido>>.

Thus, although understanding words is a necessary reading skill, it does not amount to reading comprehension. Nevertheless, unless the reader has mastered decoding skills, effective comprehension is unlikely to occur (Just & Carpenter, 1987; Perfetti, 1988). To state the obvious, reading involves the processing of linguistic data. Consequently, one reason often given for the poor comprehension of L2 readers is low language proficiency (for example, limited vocabulary or difficulties with syntax), and it is true that for efficient reading to take place the reader must be able to pick up on a variety of linguistic clues present in the text, clues which, as we shall see, are not always available to second language readers. However, as we have already noted, if language proficiency alone were the basis of skilled reading, all L1 readers would automatically be good readers. This is not the case even for adults, and the relationship between language proficiency and reading skill is more intricate.

3.3 General assumptions

3.3.1 Levels of representation

According to the widely accepted distinctions proposed by Kintsch (1998) and van Dijk and Kintsch (1983), the meaning of a written text can be constructed at several different levels of representation[40]; namely, the surface code, the textbase, and the situation model.

The *surface code* refers to the exact words and syntax of sentences. This is the most superficial and short-lived level of representation and is quickly lost from memory. Normally, the surface code of the most recently read clause or sentence is retained until it is replaced by the next sentence.

The *textbase* or *propositional textbase*[41] – also referred to as the *explicit proposition* representation (Graesser, León & Otero, 2002) – is an interconnected network of the propositions contained in the text. These may correspond to exact phrases but may also include a number of

[40] In the text-processing literature, the term 'levels of representation' is typically used as a conceptual aid to distinguish between the processing of different kinds of information. It does not refer to spatially distinct representations.

[41] Not all researchers accept that there is a separate textbase. The alternative view is that lexical items and syntactic structure serve as cues to guide the construction of the situation model without the need for any intermediate textbase of propositions (Gernsbacher, 1990; Givón, 1992; Perfetti & Britt, 1995).

inferences necessary to establish coherence at a local level, or possibly in accordance with a macrostructure. The propositional textbase preserves the meaning, but not necessarily in the original words and syntax of the text.

The *situation model* (or *mental model*) is a microworld of what the text is about. To construct a situation model the reader integrates propositions contained in the text with relevant background knowledge and, through processes of elaboration and inference[42], builds up new propositions and relations that are not necessarily explicit in the original text. To give a reasonably everyday example, the situation model of an internal combustion engine may include the electrical and mechanical components of the system, the function of each of these components (individually and together), their spatial arrangement, the causal chain of events as the system functions, and how the system can be manipulated by an agent (e.g. the driver of the vehicle). The situation model is considered as the most enduring representation in memory.

Perfetti (1989) argued that the main difference between the level at which the reader identifies propositions and the level at which he or she uses interpretive processes is in the richness of the inferences. Moreover, although both levels may be initiated as the reader begins reading, the development of the situation model may follow *after* the explicit propositions have been identified (Fincher-Kiefer, 1993). In Underwood & Batt's (1996: 217) view:

> [...] comprehension can be said to require the construction of a mental model in which the function of inferences acts to link the individual propositions in a unified representation.

[42] We understand an *inference* as any piece of information that is not explicitly stated in the text and which is generated by connecting ideas or information contained in different sections of the text or in memory.

A fourth level of representation of scientific texts, the *problem model,* has been proposed by Nathan, Kintsch & Young (1992). The problem model is similar to the situation model but takes into account the formal (mathematical) relations that exist between the various elements in a particular problem or situation. To build a problem model, in addition to relevant background knowledge, the reader needs to apply relevant mathematical and scientific knowledge to the situation. To give an example, a student reader may be able to build an appropriate situation model for a text describing, let us say, a situation where galvanic corrosion has occurred. A reader with deeper knowledge, however, will be able to go even further, representing the situation in terms of the variables and relations between the elements of the compositon cell, such as the corrosion potential and relative nobility of the materials involved, the differences in the atom binding energies, ion concentration in the electrolyte, and so on, and be able to specify the relations among these variables in the microenvironment under consideration.

Additionally, representations and processes are acknowledged to occur at two other levels; the *pragmatic communication* level and the *text genre* level (Graesser, Millis & Zwaan, 1997). The first of these refers to the pragmatic communicative context within which the text is used. The text genre refers to the type of text. Many categories and sub-categories of text genre have been identified; for example, expository, narrative, descriptive, persuasive, humorous, etc.

The distinctions between the different levels of understanding are not always easy to define (Alderson, 2000), and processing at one level does not exclude processing at another. Moreover, different kinds of information, drawn from distinct levels, can be included in the same representation. As Graesser et al. (1997: 168) point out, the "[...] various levels interact with one other in complex ways that are not well understood".

3.3.2 Types of reading

Implicit in the levels of meanings distinction is that there is a hierarchy of difficulty with the surface form being at an easier or 'lower' level than the textbase, and the textbase at an easier or 'lower' level than the situation model. To some extent, therefore, in the context of reading comprehension, more value is placed on understanding the propositional content than the surface form, more value is placed on developing a mental model than on understanding the propositonal textbase. Indeed, for many writers comprehension "[...] depends on a well-constructed situation model" (Dunlosky, Rawson & Hacker, 2002: 264), and in the active construction of meaning it is the reader who may have to do most of the work[43]. According to Sartre (1949):

> The reader is left with everything to do, yet everything has already been done; the work only exists precisely on the level of his abilities; while he reads and creates, he knows that he could always create more profoundly; and this is why the work appears to him as inexhaustible and as impenetrable as an object.

It could be argued that Sartre (and Calvino) were referring to literary text such as narrative, and that not all reading requires the construction of a richly connected mental model. As we have already observed in our discussion of communicative competence and reading (in sub-section 2.3.3), depending on the reading task and the reader's purpose, other kinds of reading may be more appropriate. Consider, for example, a reader who wishes to find out what the recommended tyre pressures of a vehicle

[43] Consider, too, Italo Calvino's seven types of reader in Chapter 11 of his book *If on a winter's night a traveller*.

should be; let us examine briefly what might be involved in finding this information?

The initial step could be for the reader to select, from among various documents, the manual corresponding to the vehicle type and model. Second, the reader turns to the index ready to search for 'Tyres'. It is not necessary to begin reading from the letter 'A' or even 'T', rather the reader quickly looks for the combination 'Ty' or maybe 'Ti' if the manual is in American English and the reader's background knowledge includes awareness of this difference in spelling. Once the word 'Tyres' has been located, the reader fixes (or focuses) on 'pressure', ignoring other possibilities such as 'changing', 'make' or 'sizes' and notes the page number corresponding to 'Tyres – pressure'. Finally, the reader turns to the page indicated, and after quickly scanning the page, locates the information in a table.

There is no need in this case to construct any meaning representation. Equally, there is no need for any syntactic processing, or for integrating the meaning of words into a text structure. Even completing the reading of sentences or checking the coherence of micropropositions would be redundant and there is no need to build a macrostructure. Nor is it necessary to begin reading the manual from the very first word of the first page, to then continue in a linear way until the information required has been located. Rather, it is possible, and more efficient, to follow a certain operating procedure (choose the appropriate manual → go to the index → locate the topic → locate the page → scan the page → obtain the data) which, in this case, really requires nothing more than the *recognition* of certain words and numbers without the need to access their meaning or phonological representations. Put another way, the reader might opt to interact with the text in a particular way, applying to the task in hand a kind of quick and selective (expeditious) reading and an appropriate, previously learned schemata or script (Schank & Abelson, 1977) which already formed part of his or her world knowledge.

In most cases, reading is carried out in order to satisfy some objective which the reader has before starting to read, and, as Farr, Carey & Tone, (1986: 141) note, it is the reader's purpose which "[...] determines whether and how a reader interacts with a particular text". More experienced readers, at least in their first language, can activate different forms of reading, different forms of processing the information, depending on the type of text and on their objectives or goals (Zwaan, 1993, 1994; Horiba, 2000). In the above example of searching for tyre pressures, the kind of reading engaged in, the *standards of coherence* (see Section 3.2.5 below) the reader might apply, and the processes used in order to achieve his or her goals, are different to the kinds the reader might employ if he or she wished to understand a more literary text such as a narrative, which again might be different from the kind involved in understanding the following instructions taken from a sample reading comprehension test for the *Diploma Superior de Español como Lengua Extranjera*:

> Lo que usted debe hacer es relacionar cada pregunta de la COLUMNA A con su respuesta correspondiente de la COLUMNA B, tal como puede ver en el ejemplo, en el que a la pregunta 6 de la COLUMNA A le corresponde la respuesta C de la COLUMNA B.
> Source:
> <http://www.auladiez.com/ejercicios/comprension_lectura_entrevista.html>
> Date retrieved: 14 February 2004

This, in turn, is different from the kind of reading we might use when we read a CD cover to find out who the musicians are, or from what we might do when studying for an exam, or even while waiting our turn at the dentist. In this latter situation our reading may be more arbitrary. Rather than trying to identify important details and learn something new, we may omit or skip over sections of the text. Our objective might be simply to while away the time and avoid becoming impatient, or we might be so preoccupied with subjecting our teeth to the dentist's attentions that we may be reading 'mechanically', without really thinking about, or even noticing, what we are reading.

Thus, there are many different reading behaviours, and many reading situations when the primary aim of the reader is *not* to comprehend the passage[44]. In this research, however, we are concerned with developing strategic reading skills for study purposes (i.e. to learn)[45], where the primary aim is, indeed, to construct a deep comprehension of the passage. In broad terms, this refers to reading situations where, at the global level, the reader must read carefully in order to establish accurate comprehension of the main ideas (whether explicitly stated or implicit in the text) by generating inferences and applying background knowledge in order to build a coherent model of the situation described in the text. At the local (sentence) level, this may involve understanding the syntactic structure of sentences and clauses, understanding lexical and/or grammatical cohesion, and understanding lexical items, if necessary by recourse to deducing their meanings from morphology and context (cf. Urquhart & Weir, 1998: 123). This does not mean, though, that readers will necessarily need to understand every word of the text. What is more

[44] In contrast to Rayner & Pollatsek (1989: 449) who stated that "When you read a passage of text, your primary aim is to comprehend the passage". A view which rather obscures the differences between different types of reading.

[45] As reported on pages 1 and 36 of the newspaper *El País* of 21 December 2005, the Spanish literary agent, Carmen Balcells, in her acceptance speech on being awarded a Doctor *honoris causa* by the Universidad Autónoma de Barcelona, distinguished between reading literature which allows the reader to discover "un mundo de sueños y de emociones" and what she referred to as "libros oficiales" which contain academic knowledge. In asking someone the question, "¿Estudias o lees?", she also differentiated between reading in order to pass an exam and reading for pleasure. We should note that reading to pass an exam is not necessarily the same as reading to learn.

important is that the task they are asked to carry out is *appropriate* to the text. In the words of Guariento & Morley (2001: 348):

> In developing [...] strategic competencies, texts do not [...] need to be simplified; it is what learners are expected to do with the texts that has to be controlled.

3.3.3 Building a network of meaning

Most current theories of reading comprehension assume that as a reader advances through a text, he or she establishes meaningful connections between the propositions (concepts or ideas) contained in the text or generated from the reader's previous knowledge, in order to build a mental representation of the text in memory (e.g. Just & Carpenter 1992; Kintsch, 1988; van den Broek, Rapp & Kendeou, 2005). In fluent, adult reading "... what is in fact comprehended is not sentences, but conceptual content" (De Beaugrande, 1982: 180). Moreover, concepts (or propositions) are activated in a cyclical manner (Linderholm, Virtue, Tzeng & van den Broek, 2004). Thus, the focus of any current reading cycle would be the text segment (or input segment) — which is usually a phrase (Sanjosé, Vidal-Abarca & Padilla, 2006), but which may be a sentence, clause, phrase, or some other combination of text elements — under scrutiny at that moment.

The individual concepts (which could be represented by a word, a phrase, or a larger unit of text) and the relations between them can be conceived of as a network of interconnected nodes, where each node represents a concept or proposition, while the connections are established through the semantic relations (e.g. causal or referential links) between the concepts. It is also assumed that concepts are not activated in an all-or-nothing way (Gerrig & McKoon, 1998) but fluctuate along a continuum and, moreover, "are activated in a cyclical manner" (Linderholm, et al., 2004: 167). It is these fluctuating activations which form the basis of the memory representation of the text. When a new element (a new idea or new information) is activated, it is added as a node to the episodic memory representation. If the element already exists, its trace is strengthened. When two elements are activated together, a connection is established between them. Similarly, if the connection already exists, it is strengthened. Thus, new text elements may be activated, existing elements may increase or decrease their level of activation, while others may decay altogether. At any given moment, therefore, the reading process can be seen as a 'landscape' of fluctuating activations. The contents and structure of the developing memory representation are determined by the level of activation of the different text elements. It is these patterns of activation which "are at the heart of reading comprehension" (van den Broek et al., 2002: 137).

3.3.4 Sources of information

Input to the mental representation of the text derives from several potential sources (van den Broek et al, 2002; van den Broek et al, 2005). The most obvious is the focal sentence; i.e., the piece of text currently being read. A second source is the information from the prior reading cycle that may still be held in working memory (WM) and thus still available for use by the reader. The third potential source of information is the developing representation of the text in episodic memory, while the fourth consists of background knowledge (domain-specific or general knowledge) in semantic LTM which may be accessed by the reader. It appears from the research that the information from these two latter sources may influence processing at different levels of representation, with reactivated episodic information having more influence on the developing situation model, while general world knowledge influences processing at a greater range of levels; for example, lexical, featural, schematic (Cook & Guérard, 2005).

3.3.5 *Standards of coherence*

One of the principal determinants of what information is accessed at any particular reading cycle, and where it is accessed from, relates to the standards of coherence that the reader has established for the reading situation (van den Broek et al., 2001; van den Broek et al., 2002; van Oostendorp, 1994; see also Goldman, Varma & Coté, 1996; Kaakinen & Hyönä, 2005). The standards of coherence for any particular reading situation reflect the reader's knowledge and beliefs about what constitutes good comprehension of the text being read (van den Broek et al., 2002).

According to the *standards of coherence framework*, it is the goal or purpose of reading which determines the standards of coherence a reader maintains during reading (van den Broek, et al. 2005; van den Broek, Lorch, Linderholm, & Gustafson, 2001). In other words, the criteria for what is considered a sufficient level of comprehension are determined by the standards of coherence the reader adopts in any particular reading situation. The reader may, therefore, adjust comprehension processes to satisfy the current criteria. For example, the reader might decide to search episodic or semantic memory for more information, to engage in 'lookbacks'; i.e. search previous portions of the text, or to look up in a dictionary the meaning of an unfamiliar word. Readers' standards of coherence may also vary as a function of other factors, such as the type of text, individual differences and so on (Narvaez, van den Broek & Ruiz, 1999; van den Broek, Lorch, Linderholm, & Gustafson, 2001). In this latter study, van den Broek and his colleagues asked the participants to read an expository text for either study or for pleasure. The analysis of the think aloud protocols revealed that when reading for study purposes, readers generated more inferences to enhance coherence, such as explaining and predicting, than when reading for pleasure. Furthermore, they frequently repeated and paraphrased portions of the text. When reading for pleasure, on the other hand, participants were not so concerned with coherence of the text but tried to relate what the text was about to their own experiences by making associative inferences and evaluating the text topic. Subsequent recall was better in the study condition than in the pleasure condition.

3.3.6 Processing information from a written text

In order to extract, integrate or use in some way the information contained in a text, the cognitive system must have some means of encoding or representing the data it receives (which ranges from individual letters and words to the complete text), and at the same time it must have different ways of processing this information.

<u>Bottom-up and top-down processes</u>

Research into text comprehension has identified a variety of cognitive processes which are used by readers in the construction of the meaning of a written text. These processes are often described in information processing terms as ‘bottom-up’ or ‘top-down’ depending on their position in the flow of information.

Bottom-up processes begin with sensory stimulation, which in the case of reading originates in the text, hence these processes are also called ‘text-driven’ or ‘data-driven’. From the perception and identification of letters and words, processing moves to ‘higher levels’; that is, to the identification of sentences, on to meaning and then to thinking (Davies, 1995). Top-down processes are also known as ‘reader-driven’. Top-down models of reading “[...] predict that the processing sequence proceeds from predictions about meaning to attention to progressively smaller units, for example letters, visual features” (Davies, 1995: 175). To use top-down processes the reader may apply his or her metacognitive abilities, his or her existing knowledge in the form of schemata (or ‘packets of knowledge’). Thus, they include applying hypotheses, integrating subject or world knowledge, generating inferences and the construction of a macrostructure.

Constructionist versus memory-based models

During the last decade or so the issue of whether top-down or bottom-up processes predominate has given rise to considerable debate in the specialised L1 discourse processing literature (Long & Lea, 2005). Briefly, on one hand, the so-called *constructionist theory* (Graesser, Singer & Trabasso, 1994; Long, Seely & Oppy, 1996) emphasises top-down processes, and characterises reading as a “search (or effort) after meaning” (Graesser, Singer & Trabasso, 1994: 371) involving active and sometimes effortful processes. According to (Graesser, Singer & Trabasso, 1994: 371-372), the constructionist view (which is also often called the *explanation-based view* because of its emphasis on the reader’s explanations) is based on three assumptions:

1. The reader constructs a meaning representation that addresses his or her goals (The reader goal assumption).
2. The reader attempts to construct a meaning representation that is coherent at both local and global levels (The coherence assumption).
3. The reader attempts to explain why actions, events and states are mentioned in the text (The explanation assumption).

Thus, although both low level, automatic processes and controlled, strategic processes are used by readers, one of the fundamental principles of the constructionist view is that higher order processes are brought to bear on comprehension in the reader’s active search for information that is relevant to the development of a meaningful representation of the text.

According to proponents of the second view, which is often called *memory-based text processing*, reading comprehension can be characterised as an essentially passive, bottom-up process which relies on low-level, automatic, memory retrieval processes such as *resonance* (Gerrig & McKoon, 1998; McKoon & Ratcliff, 1998, Myers & O'Brien, 1998; O'Brien & Myers, 1999). Incoming text information, as well as information already in WM, acts as a signal to all of LTM (including general world knowledge and the developing episodic memory representation). Concepts in LTM that match or share features with the input will 'resonate' in response (cf. Ratcliff, 1978) as a function of the degree of featural overlap between them. This process is not under the reader's strategic control, and is 'dumb' in the sense that irrelevant, although related concepts, may be activated.

Several factors have been shown to influence the passive reactivation of antecedent information, including elaboration (e.g. O'Brien, 1987; O'Brien, Albrecht, Hakala & Rizella, 1995) distance (O'Brien, 1987), featural overlap (Albrecht & Myers, 1998; Albrecht & O'Brien, 1993) and causal connections (O'Brien & Myers, 1987; Rizella & O'Brien, 1996). Thus, the underlying principle of the memory-based view is that text processing is subserved by ordinary memory processes. In the words of Gerrig & O'Brien (2005: 228):

> [...] memory-based processing rejects the whole goal-driven analysis of explanation-based processing. On the memory-based view, the automatic processes associated with text processing are memory processes that function broadly in circumstances of human cognition.

Despite this apparent polarisation of views, there are now several attempts to develop frameworks which recognise the contribution of both memory-based and constructionist processes, and attempt to ascertain how they may interact (see, for example, Cook & Myers, 2004; van den Broek, Rapp & Kendeou, 2005). As Kintsch (2005: 126) notes:

> Both top-down and bottom-up processes are integral parts of perception, problem solving and comprehension [...] It makes no sense to ask whether one is more important than the other: Nothing happens without both.

<u>Reading as an interactive process</u>

To speak of bottom-up or top-down processes does not mean to say that reading occurs in only one direction (either bottom-up or top-down). Nowadays most researchers in the field of text comprehension accept that reading is an *interactive* process and that a complete model of comprehension must include both top-down and bottom-up components. In the words of Urquhart & Weir (1998: 40), “we are all interactive theorists now”. In interactive models of reading, the reader synthesises information arriving “simultaneously from various sources” (Stanovich, 1980: 35); for example orthographic, phonetic, lexical, syntactic, semantic schematic. Or, as Swaffar, Arens & Byrnes (1991: 21) note, “Fluent readers synthesize textual subsystems (e.g., content, context, intent, language) into a larger metasystem of meaning”.

All these operations occur simultaneously and interact with each other at multiple levels so reading is both perceptive and cognitive (Rumelhart, 1977; Kintsch, 2005). Thus, to say that reading is an interactive process refers to the dynamic interaction between the different cognitive processes involved (Rumelhart, 1977; Stanovich, 1980). The term is also used to refer to the interaction between the reader’s existing knowledge, the information suggested by the written text and the context of the reading situation (Carrell, Devine & Eskey, 1988; OSPI, 1998). For example, research has shown that there is a relationship between the kind of processing induced by the task the reader is required to do and the kind of processing induced by the text (Einstein, McDaniel, Owen & Coté, 1990;

McDaniel, Einstein, Dunay & Cobb,1986). Even different readers' assumptions about the type of text they are engaged with may cause them to adopt different processing modes of the same text (Zwaan, 1993, 1994; and see sub-section 3.3.5 above). The term 'interactive' further recognises that reading may involve a sort of dialogue between the reader and the text (Grabe, 1988; Widdowson, 1979). In short, the different variables discussed at the beginning of this Chapter interact in different ways and at many different levels.

3.3.7 The role of working memory

We have noted how information from many different sources is processed continually during reading. Moreover, because texts are processed sequentially and cyclically, text comprehension requires the integration of information across sentences, as well as from different sections of the text and from previous knowledge stored in LTM. This requires temporarily holding in memory previously or just-read information (in order to carry it over to the next cycle or later cycles) while at the same time processing the words and ideas currently in focus. Indeed, although models of text comprehension differ in the mechanisms they postulate for the carry over of information from one reading cycle to another, "[...] they all posit that some residue of the activations in one processing cycle lingers into the next" (Linderholm, Virtue, Tzeng and van den Broek, 2004: 167). This simultaneous storing and processing of information is assumed to take place in working memory (WM).

The concept of working memory is central to cognitive psychology (Cowan, 1999) because it is regarded as the 'vehicle' for the encoding, maintenance and processing operations necessary to carry out complex cognitive tasks, such as reading comprehension. However, the notion of WM is undergoing substantial and rapid changes (Miyake & Shah, 1999).

For example, following Baddeley (1995), Caplan & Waters (1999: 77) defined WM as “a short-duration limited-capacity memory system capable of simultaneously storing and manipulating information in the service of accomplishing a task”, citing the fact that “Appeal to the notion of a limited-capacity working memory system (or to equivalent concepts such as ‘processing resources’) to account for features of human cognitive performance is widespread in cognitive psychology” (Caplan & Waters, *ibid.*). There are several factors which may contribute to WM capacity limitations. Candidates include insufficient knowledge for efficient encoding and retrieval to take place, interference (by similar information), the degree of efficiency of attention and executive control mechanisms, rapid decay of information and limits in processing speed or efficiency.

We can give an example, taken from our preliminary study into comprehension strategies described below in Chapter 7, of how slow reading leads to decay and loss of information from WM. Student #7 has just read the following sentence from the English text *Introduction to Materials Selection*.

> *Corrosion resistance is not the only property to be considered in making materials selection but it is of major importance in the chemical process industries.*
>
> Introduction to Materials Selection, ll. 5-7.

Analysis of the student’s think-aloud protocol for this text revealed the following difficulty:

[8] <<En el tercer punto, la frase es demasiado larga, con lo que olvido lo que voy traduciendo anteriormente y me pierdo. Sé que me están hablando sobre lo mismo de los anteriores puntos, porque vuelve a salir la misma palabra, que es corrosión, pero en este caso supongo que será sobre los procesos industriales, porque me lo dice al final de la frase.>>

He had the same problem a little later with the following sentence:

> *The materials selection process is also influenced by the fact that the materials are either considered for the construction of a new system, or for the modification or repairs in an existing facility.*
> Introduction to Materials Selection, ll. 16-18

[9] <<En el siguiente punto también es demasiado largo en este punto entiendo la mayoria de las cosas, pero volvemos otra vez a lo mismo, que si me si me centro en lo que estoy leyendo olvido lo que ya he leido y entonces pues uff, como no vaya apuntando palabra por palabra.>>

However, it is also the case, as Miyake & Shah (1999: 449) note, that the "emerging consensus is that long-term knowledge and skills play an integral role in working memory performance". In fact, both the constructionist view and the memory-based view of reading discussed in the preceding Section (3.2.6) assume that large amounts of information are activated during sentence comprehension. Words or other text elements may activate not only concepts in LTM, but "entire knowledge structures, such as scripts or schemata", (Long & Lea, 2005: 295). Thus, both views are compatible with models of WM that allow the possibility for large amounts of information to be activated, such as Ericsson & Kintsch's (1995) long-term working memory (LT-WM) model in which the amount of information that can be maintained in an active state is not limited by a fixed capacity.

Many questions about WM in human cognition remain unresolved and the concept is still relatively undefined. It is not clear, for example, exactly what mechanisms or processes comprise WM or whether it is better conceived of as a unitary system. The consensus appears to be that it is made up of multiple components. According to, Cowan (1999: 97), working memory:

> [...] is unlikely to be limited to one mechanism; people are likely to use any processing mechanism at their disposal to come up with the needed information [in order to carry out a particular task]. The use of several mechanisms usually is less taxing than the reliance on any one mechanism.

While Miyake & Shah (1999: 450) define WM as:

> [...] those mechanisms or processes that are involved in the control, regulation, and active maintenance of task-relevant information in the service of complex cognition.

Thus 'working memory' can perhaps be regarded more as an 'umbrella term' (Miyake & Shah (1999: 474) than as a clearly defined concept.

If WM is conceived as consisting of multiple mechanisms then, as regards the processing of text, the range of factors which may limit its capacity (i.e. reduce the *efficiency* with which it operates) is greater than if WM is thought of as a single, unitary, system. For example, the activation mechanisms for just-read or previously-read material (in order to relate this to what is currently being read), executive control mechanisms (such as setting the goal or purpose of reading, ensuring task requirements are adhered to, maintaining standards of coherence, monitoring comprehension, controlling the level of attention), and for the retrieval of information stored in LTM (including linguistic information), must all work together for the WM system to be effective. Indeed, Haenggi & Perfetti (1992; 1994), argue that in L1 reading, comprehension depends primarily on the efficiency with which readers can identify words and encode propositions into WM.

With respect to second language reading, we may speculate that reduced (diminished) language proficiency does not reduce WM capacity as such, but it does reduce the efficiency with which information is processed, where 'efficiency' is a general term involving the activation, association, retrieval, resonance, maintenance, encoding and storage of ideas or concepts.

3.3.8. Implications of the interactive view of reading comprehension

If we accept that reading is interactive in the ways outlined above, there are a number of implications we should be aware of:

(i) Comprehension at a local level (i.e. the focal sentence, or segment of text currently being read) may depend to some extent on the comprehension of other parts of the text or on the degree of global understanding attained. In other words, it may not be possible to assign a meaning to specific micropropositions without taking into account the global meaning of the text.

(ii) Comprehension depends to some extent on the reader's background knowledge of the subject matter; more precisely, on the associations the reader makes between his or her existing knowledge and information in the text.

(iii) The reader draws on cultural and linguistic knowledge and sometimes the two are impossible to separate.

(iv) Consequently, one reader's comprehension may include data which has not been specified in the text itself.

(v) We can expect differences between what different readers understand from the same text or even the same reader at different readings.

3.4 Two sample texts

As an example of what may be involved in comprehending a written text, let us consider two sample texts. The first is a short item which appeared in the British newspaper *The Guardian*?

> If we want a new king and queen of England – a Michael Howard or Theresa May – then find us a suitable Tudor or Stuart (say Alex Tudor and Alec Stewart, to open the bowling and batting). Find us a stray Bourbon to take the biscuit or a Battenburg on free transfer, with cake. Do not any longer assume that the lot we currently endure can be somehow transformed into objects of reverence or patriotic desire. They can't. The Queen may or may not be beyond reproach, but the family she leaves us with and the courtiers who surround her are just one damned reproach after another. They are the Conservative dilemma writ large across the coming century.
>
> Source: *The Guardian*, October 27, 2003, page 11.

In order to understand this text, in order to establish some kind of coherent representation of it in memory, the reader must not only connect the different ideas or concepts (text elements) appearing in different parts of the passage, but also he or she must make connections between these text elements and previous background knowledge.

For example, the descriptive phrases *a stray Bourbon* and *a Battenburg* connect back to "a new king and queen of England". The anaphoric term *They* (in *They can't*) makes a referential connection back to "the lot we currently endure", as does *the family she leaves us with and the courtiers who surround her*. As regards possible connections to previous knowledge, and in order to make sense of the numerous references to different people and ideas, the reader already needs to know something about (in order of appearance); contemporary British politics, English history (specifically the family names of previous sovereigns), the game of cricket and recent members of the English cricket team, certain kinds of biscuits and cakes and the significance of some idiomatic expressions which make reference to them, not to mention the family names of other European monarchies. They also need to have a degree of familiarity with a term associated with football players who are past their best, and some knowledge about the goings on of some of the members of the current Royal Family as well as the relationship between the British Conservative Party and the British Monarchy. These elements in the text may, in turn, activate or trigger associated information in the reader's LTM. Other food-related terms perhaps, or the family names of other European Royal families such as Grimaldi or Romanov.

Some text elements may cause the reader to develop more elaborate interpretations. The use of the phrase "the lot we currently endure" may, for example, suggest to the reader that the author is simply lumping together in a somewhat depreciatory way all the people surrounding the Queen. It may also suggest the hereditary nature of the monarchy, and the belief that it is our destiny or fate (our lot) to put up with them – or theirs to be who they are! The reference to cricket, on the other hand, may excite sporting passions and may cause the reader to speculate on the performance of the current English cricket team – thereby resulting in a disruption to the reading process.

Depending on the interest readers have in the current and continuing status of the British monarchy, on how disposed they are to speculate on the issues raised in the text, and on substantial previous knowledge, they might generate the prediction that the British monarchy will, indeed, be abolished within, say, fifty years (or two generations), but not before the Conservative Party no longer exists as it does today but will have been split into those who accept this possibility and those for whom the abolition of the monarchy is inconceivable.

However, any reader of the above extract who has no prior knowledge of these (very culturally-specific) themes or for whom the idiomatic phrases ‘to take the biscuit’, ‘on a free transfer’, ‘to have your cake and eat it’ (to take just three examples) mean nothing, will have nothing to guide his or her processing. They may find the text almost incomprehensible, and will find it difficult to place the text in its sociocultural and historical context.

Writers and readers do not share exactly the same interests, the same experiences or the same background knowledge, so it seems improbable, if not impossible, that we could all arrive at the same level of comprehension of any given text. Indeed, as we pointed out earlier, the reader has an active role in processing and interpreting written texts. As Rosenblatt (1994: 1063) claimed in his Transactional Model of reading:

> Instead of two fixed entities acting on one another, the reader and the text are two aspects of a total dynamic situation. The ‘meaning’ does not reside ready-made ‘in’ the text or ‘in’ the reader but happens or comes into being during the transaction between reader and text.

This also means, as noted above, that what is understood from any given text will vary between each reader (Goodman, 1994) and quite possibly between each reading. The skills, strategies and techniques employed are part of the general processes of reading, but they will vary depending on the context of the reading situation. And the context or situational factors of the reading situation which influence the processes engaged in by the reader include aspects such as the type of text, the reader’s goals, motivation and interest in the topic or the task, the reader’s existing knowledge of the subject matter, and the reader’s knowledge of the language in which the text is written.

Thus, when a reader reads a text it is never done in a vacuum, and what a reader understands of a text is never unconstrained. Not only do background knowledge, cultural assumptions, motivation and vocabulary knowledge influence the creation of meaning and constrain understanding, but also macroscopic features of the text (e.g. headings, lists, layout) and microscopic features (e.g. clause structure, the choice of lexical items). Some of these constraints are included by writers as intentional scaffolding to guide the reader and facilitate understanding – although in a second language context, many of these signals may not be picked up by readers who have had much less exposure to the written language, writing conventions or characteristics of different genres than L1 readers.

The second sample text consists of three paragraphs which together constitute an introduction to corrosion theory from an informational web site (Goldman & Bisanz, 2002), which is sponsored by a private company dedicated to engineering and corrosion control. Although the site refers to itself as a "popular web site", its primary purpose, as stated on the home page, is "[...] to improve the general awareness of corrosion causes, solutions, and impact on systems and human health"[46].

Corrosion theory

Humans have most likely been trying to understand and control corrosion for as long as they have been using metal objects. The most important periods of prerecorded history are named for the metals that were used for tools and weapons (Iron Age, Bronze Age). With a few exceptions, metals are unstable in ordinary aqueous environments. Metals are usually extracted from ores through the application of a considerable amount of energy. Certain environments offer opportunities for these metals to combine chemically with elements to form compounds and return to their lower energy levels.

Corrosion is the primary means by which metals deteriorate.

[46] Source:<http://www.corrosion-doctors.org>
Date retrieved : May 2003

> Most metals corrode on contact with water (and moisture in the air), acids, bases, salts, oils, aggressive metal polishes, and other solid and liquid chemicals. Metals will also corrode when exposed to gaseous materials like acid vapors, formaldehyde gas, ammonia gas, and sulfur containing gases.
>
> Corrosion specifically refers to any process involving the deterioration or degradation of metal components. The best known case is that of the rusting of steel. Corrosion processes are usually electrochemical in nature, having the essential features of a battery. When metal atoms are exposed to an environment containing water molecules they can give up electrons, becoming themselves positively charged ions, provided an electrical circuit can be completed. This effect can be concentrated locally to form a pit or, sometimes, a crack, or it can extend across a wide area to produce general wastage. Localized corrosion that leads to pitting may provide sites for fatigue initiation and, additionally, corrosive agents like seawater may lead to greatly enhanced growth of the fatigue crack. Pitting corrosion also occurs much faster in areas where microstructural changes have occurred due to welding operations.
>
> Source:< http://www.corrosion-doctors.org/Principles/Theory.htm>
> Date retrieved: May 2003

In order to build a representation of the text in episodic memory, the reader must make connections between the different ideas and concepts occurring in the text and between these and what he or she already knows or believes about the topic. For example, in the third paragraph the noun phrase *the best known case* refers back to the idea of “any process involving the deterioration or degradation of metal components” which, in turn, refers back to “corrosion”. The anaphoric term *they* (in *they can give up electrons*) makes a referential connection back to “metal atoms”, while *This effect* refers back to the idea that, under certain conditions, metal atoms “can give up electrons, becoming themselves positively charged ions”.

There are many ideas or concepts which must be drawn on by the reader in order to understand this text, and it illustrates a particular difficulty relatively common to introductory texts and textbooks; namely that they may introduce concepts, ideas or issues that are new to readers without then explaining them further. As a result, the representation of the text the reader constructs is incomplete. Incompleteness may be especially problematic when readers are unaware of it (Elshout-Mohr & van Daalen-Kapteijns, 1985, cited by Elshout-Mohr & van Daalen-Kapteijns, 2002). Examples of concepts or ideas contained in this extract which may require further clarification include the following:

- the unstable nature of most metals
- the extraction of metals from ores involves considerable amounts of energy
- metal compounds may return to lower energy levels
- electrochemical processes
- the fact that corrosion is essentially an electric circuit, since there is a flow of current between the cathode and anode sites.
- pitting or cracking
- wastage
- fatigue
- microstructural changes caused by welding

3.5 Conclusion

Comprehension and learning from text are influenced by several variables: characteristics of texts, characteristics of readers, the tasks (and purpose of reading) and the context of the reading situation. These factors and how they interact (for example, the prior knowledge which is available to the reader with the design of the written materials, or the type of text with the type of task) influence the kind of reading processes and strategies which are carried out by the reader.

Secondly, reading comprehension is, in the words of Kintsch (2005: 127), “highly interactive”. Reading is a multilevel interactive process, with perceptual, syntactic, semantic, and reasoning processes interacting at many different levels. Units of analysis range from single letters to the text as a whole. As well as processing the explicit features of text, the reader must also bring considerable preexisting knowledge to the reading comprehension process. Thus, the interaction of text-based processes and knowledge-based processes, and of levels within each, is essential (Spiro, 1980).

Thirdly, therefore, reading comprehension involves not only linguistic knowledge but also draws on general knowledge and text processing skills. Effective comprehension entails huge amounts of cognitive processing involving evaluating, inferring, integrating information both within and across texts. It entails cognitive information-processing abilities (such as monitoring the comprehension process, being aware of inconsistencies and anomalies, applying appropriate strategies when comprehension breaks down, modifying one’s existing knowledge structures in response to new information acquired from texts), that promote the construction of meaning. Reading is, therefore, a cognitive-linguistic process that develops through exposure to reading. The more opportunities students have to engage in reading the quicker these processes will become automated and effective and the more opportunities the reader has of building up new knowledge structures from text processing.

In the following three Chapters, we look more closely at word-level, sentence-level and discourse-level processes and at the sort of difficulties L2 readers, and in particular native Spanish readers reading in English as a foreign language, can have with these aspects .

Chapter 4

Word-level variables

4.1 Preliminaries

One of the essential processes in reading is the recognition of individual words, and word recognition skills are usually considered to be 'lower-level' processing skills. However, according to Urquhart & Weir (1998: 51), "the processes of word recognition appear to be extremely complicated and not well understood". It is not our intention to attempt to unravel all of them here, but some kind of preliminary discussion seems necessary as the mechanisms or operations involved in word recognition do have important implications for reading in a second language, especially when we take into account the L2 proficiency level and (lack of) L2 reading habits of the students who are the subjects of this study (see sub-sections 2.4.1 – 2.4.4).

One problem, as Anderson & Shiffrin (1980) point out, is that words may have several potential meanings, and these may be both denotative and connotative (or contextual). According to Dechant (1982), cited in Zakaluk (1996), the word 'run' has 109 different meanings, 'take' has 76 and 'round', 83. A more recent search for 'run' which we carried out using the online version of the Cambridge Advanced Learner's Dictionary (with a total of 170,000 words, phrases and examples[47] compared to the 470,000

[47] http://dictionary.cambridge.org/cald/book/caldbook2.htm

entries in Webster's Third New International Dictionary, Unabridged[48]) gave the results shown in Table 4.1. Words in upper case in the Table are Guidewords which indicate the meaning or context.

ladder (HOLE) run (GO QUICKLY) run (TRAVEL) run (OPERATE) run (FLOW) run (BECOME) run (SHOW) run (POLITICS) run (TAKE) run (BUY) run (SELL) run (ORDINARY) run (AREA) run (POINT) run (HOLE) stand (POLITICS) dry run dummy run fun run hit-and-run (ACCIDENT) hit-and-run (MILITARY) home run milk run print run rat run run-down (REPORT) run-down (CONDITION) run-in run-off run-of-the-mill run-up school run trial run run across sb run across sth run after sb/sth (CHASE) run after sth (TRY TO ACHIEVE) run after sb (TRY TO	run away with sb (FEELING) run away with sth (WIN) run sth by sb run sb/sth down (CRITICIZE) run (sth) down (REDUCE) run sb/sth down (HIT) run sth down (SHIP) run yourself down (TIRE) run (sth) down (LOSE POWER) run sb/sth down (FIND) run sth in (USE CAREFULLY) run sb in (CATCH) run (sth) into sth/sb (HIT) run into sb (MEET) run into sth (EXPERIENCE PROBLEMS) run into sth (REACH) run off (LEAVE) run sth off (PRINT) run sth off (WRITE) run off with sth run on sth (POWER) run to sth (SIZE) run to sth (MONEY) run to sth (ACTIVITY) run sth up (DEBT) run sth up (MATERIAL) run sth up (VALUE) run sth up (FLAG) run up against sth run a bath make your blood run	be/get/run low (on sth) passions run high run rings round sb run/take a risk run the risk of doing sth run its course run errands run for sth run a mile run yourself into the ground run on the spot run sb ragged run round in circles run sb/sth to ground the run of sth be on the run on the run have a good run for your money give sb a run for their money run aground/ashore run sb close run your eye over run in the family run in/through your head/mind run through your mind/head run sb out of town (on a rail) run and run in the long run in the short run run of run the show make sb's blood run

[48] http://www.merriam-webster.com/premium/mwunabridged/

START RELATIONSHIP) run against sb/sth Run along! run around run around after sb run around with sb run away (LEAVE) run away (AVOID) run away with sb (RIDE)	cold go/run round in circles run/go like clockwork run/go deep rush/run sb off their feet run the gamut of sth run the gauntlet go/be run to ground	cold run high run wild run out of steam run away to sea go/run to seed Still waters run deep. run/have a temperature run out of time

Table 4.1. The entries for 'run' in the online *Cambridge Advanced Learner's Dictionary*.
Source: <http://dictionary.cambridge.org>. Date retrieved: 15 December 2005

This example serves to give some idea of the huge volume of contextual variation in meaning in English. This means that word recognition in connected discourse is not solely a matter of rapidly recognising a sequence of individual words each separate from the others. Rather, words can only be understood when combined and related to the words around them. Even then, alternative meanings may be generated. We can only know the intended meaning of 'precipitation' in the following sentence by being aware of the wider context.

The experiment failed because of too much precipitation.

Furthermore, just as word meanings for a child may be more global than for an adult (Clark, 1973); for a language learner the meaning of a particular word may not reflect such fine distinctions or nuances as it might for a native speaker or more experienced learner with greater command of lexis. Thus, at some levels, a series of words such as *answer*, *reply*, *response*, or *device*, *appliance*, *tool*, may be very similar in meaning, or even synonomous, but at more fine grained levels of specification (Sanford, 2002) possess clear distinctions. A further issue concerns whether the contextual variability in meaning involves multiple 'entries' or senses in how the word is represented in the mental lexicon or whether variability exists only ‘online’ and is created during the process of comprehension.

This Chapter, therefore, explores three of the main issues in word recognition; namely decoding, phonological encoding and word knowledge, although in many ways these aspects of word recognition are intimately related. We should also bear in mind that in the comprehension of connected text, and in the interactive model of reading that we assume, words can not really be taken in isolation. Their meaning often depends on the words around them and even the pronunciation of words is influenced by how they combine with other words. In fact, it seems likely that once the basic word recognition skills have been acquired and readers are able to understand connected text:

> [...] the whole reading process becomes so very integrated that, although a variety of skills might be needed, they cannot be identified empirically during the reading process
> (Alderson 2000: 97).

Alderson (*ibid.*) goes on to add, however, that while breaking down reading into different processes may not be possible for advanced readers, a component skills approach may be “valid and justified for beginning, weak, dyslexic or low-level second language readers”. As we shall see below, many of our students seem to be still at a stage of second language reading where ‘difficulties’ with the three factors involved in word recognition we have mentioned (decoding, phonological encoding and word knowledge) do complicate considerably their understanding of English language texts. In the final part of this Chapter we discuss what impact limitations or confusions in each of these areas may have on native Spanish readers, and in particular our own students, reading of English.

4.2 Word recognition and comprehension

Before launching into our discussion, and by way of introducing some of the processes involved in word recognition – and which bear on comprehension and not only on word reading – consider the five rather different meanings and forms of the word ‘fission’ in the following three extracts. The first extract has been taken from an article published on the World Wide Web (WWW) explaining nuclear power, the second from an advertisement, also on the WWW, aimed at professional webpage designers, while the third extract is from the novel, *Artemis Fowl*, by Eoin Colfer published in 2003:

> When a nucleus fissions, it splits into several smaller fragments. These fragments, or fission products, are about equal to half the original mass. Two or three neutrons are also emitted ..... Fission can occur when a nucleus of a heavy atom captures a neutron, or it can happen spontaneously.
>
> Source: <http://www.atomicarchive.com/Fission/Fission1.shtml>
> Date retrieved: September 2004

> Welcome Webmasters to Cash Fission: An Atomic Split from the Ordinary Webmaster Program. Take some time and check out our program, our top converting sites and see why you should sign up now and start making money.
>
> Source: <http://www.cashfission.com/>
> Date retrieved: September 2004

> Artemis nodded. As usual Butler was right, which explained why they were both still alive. Jon Spiro, the American he was meeting, was just the kind of man who attracted assassins’ bullets – a successful IT billionaire with a shady past and alleged Mob connections. Rumor had it that his company, Fission Chips, had made it to the top on the back of stolen research.
>
> (Colfer, 2003: 6)

To begin with the first instance, *fissions*; if we take this word in isolation it is not clear whether it is the plural form of the noun and is meant to indicate several occurrences of fission, or whether the final ‘s’ is the affix indicating third person singular of the verb ‘to fission’. The implication is that word recognition in running discourse is not a matter of rapidly recognising a sequence of individual words each separate from the others. Rather, in order to assign the appropriate meaning to this word, we must take into account the semantic-syntactic structure of its immediate environment. In this case our knowledge of typical (or most plausible) grammatical patterns comes into play – the word ‘when’ followed by an article, followed by a noun, is usually followed by a verb – and this can be an important source of information to aid word recognition.

The same is true for the next instance. Both elements of *fission products* have independent word status, with independent specific and specifiable meanings, but they are bound together by grammatical structure. We have observed that many of our students have particular difficulties recognising complex noun phrases in English – partly, perhaps, because the word order is sometimes the reverse of what it would be in Spanish. ‘Fission’ has to be recognised here as functioning as an adjective, describing the products of the fission process. Problems will arise if it is understood as a noun.

At least word order should not cause problems for native Spanish readers of the third example we wish to explore; namely, *Fission can occur*. Nor should the meanings of the words themselves cause problems. Many English words share common roots from Latin and Greek with their corresponding word in Spanish. The large number of cognates in Spanish and English (e.g. *fisión* – fission; *ocurrir* – occur) can greatly facilitate comprehension and this means that native Spanish readers can often gain sufficient understanding of texts to satisfy a particular need (depending on task demands, type of text and other factors in the particular reading situation), which would otherwise be too difficult for them. In their study of strategies employed by bilingual Spanish-English readers, Jiménez, García & Pearson (1996) found that the use of cognates to resolve the meaning of unknown words was a distinctive feature of bilingual readers' repetoire of skills.

A first reading of the second extract (which includes the fourth instance we wish to examine) suggests no obvious relation between the two words *Cash* and *Fission*. They do not form a lexical unit in the way 'fission products' or 'nuclear fission' do. Enlightenment is reached only by reading the rest of the advertisement. The function of 'Fission' here seems to be to catch the attention of the reader and suggest that the programme being advertised is indeed markedly different (i.e. 'an atomic split') from its competitors. This may not be immediately obvious, though, and the reader may spend some considerable time trying to figure out the connection between the two concepts represented by 'cash' and 'fission'. Just as with newspaper headlines, this stylistic technique may hinder comprehension for readers whose control or awareness of the language is not as great as a native speaker's might be.

Finally, as we are informed that the character of Jon Spiro is the owner of an IT company, we can understand 'Chips' as referring to this particular electronic component and 'Fission' simply as a name; the two being associated through the common idea of high technology, but to interpret it this way would be to miss the humour. The fact that the joke is based on sound /φιΣ↔ντΣιπσ/ implies that when we read these two words, and even if we read them silently, some sort of phonological encoding must take place and that, in the case of those readers who have knowledge of this apparently still most popular item of British cuisine, this must map onto a stored, stable phonological representation in long-term memory which becomes activated when we read the words. The issue here is whether a phonological code is generated automatically when we read, and if so (which appears to be the case), how this may influence word recognition.

Remaining with the third extract, there is also the question of whether such lexical units as ‘a shady past’, ‘rumour has it’, ‘to make it to the top’, ‘on the back of’, are stored as unitary entries in the lexicon – which may well be the case for an experienced, adult, native reader (although we may expect the contents of individual lexicons to vary between individuals), whereas for intermediate non-native readers processing each sequence or string will require a number of lexical access operations as the meaning of each word will need to be recovered separately and the meaning of the sequence built up or constructed. Constructing the meaning will, of course, take longer and consume more cognitive resources and effort as each word in the string must be accessed and the relations between them established. Moreover, it seems possible that the constructed meaning of ‘rumor has it’ (compared with, for example, ‘John has it’) or ‘on the back of’ in the phrase ‘on the back of stolen research’ will be rather different from their lexical meanings.

There are other elements in this third segment which have internal structure and which the reader needs to be able to recognise in order to understand them. One is ‘a successful IT billionaire’, whose components, like *fission products*, each have independent word status with specifiable meanings. A somewhat different case is that of ‘assassins’’ which, despite its apostrophe-only form of the *-s* genitive (i.e., it is not written *assassins’s*), we nevertheless understand from the context as plural. Garman (1990: 243) suggests that different kinds of structure such as these may require different processes of intepretation or recovery from memory.

While the vocabulary and grammatical structure of a text may provide a framework for creating meaning, it is also necessary for the reader to make certain inferences. For example, reference needs to be assigned to the three pronouns ‘they’, ‘he’ and ‘his’. One of the characteristics of pronouns is their lack of of descriptive content (Bosch, 1983). The only information they carry is related to number, gender and person of the potential referents. In the case of ‘they’ in this extract, interpretation is facilitated by the fact that the number of potential referents is limited to the two characters Artemis and Butler. However, while both are potential referents for ‘he’, the informational content of this word is not sufficient by itself to establish which one of them it refers to. For both ‘he’ and ‘his’, the reader needs to infer the meaning from the situation described in the text and by drawing on general knowledge (Garnham & Oakhill, 1985; Tyler & Marslen-Wilson, 1982).

According to Anderson, Reynolds, Schallert & Goetz (1977: 369), cited by Carrell & Eisterhold (1988: 73), “Every act of comprehension involves one’s knowledge of the world as well”. Here, the reader needs to know what an IT company is, what ‘Mob’ refers to (as opposed to ‘mob’) and how the Mob operates. Thus, both linguistic and non-linguistic features provide support for word recognition processes. As Garman (1990: 44) points out:

> Native readers and writers tend, therefore, to be presented with a range of characteristics to exploit in the written forms of language [...] The basic task in reading is to relate the marks on the page to what we know of our language: in this task, a whole range of strategies can be deployed, including those based on grammatical knowledge and real-world knowledge, in addition to strictly sound- and meaning-based cues in the script.

4.2.1 Morphology

A further issue concerns what role the perception of morphological structure might play in word recognition; does it support word recognition or does it arise from it? Are stems and affixes stored in the same mental lexicon as words and accessed in the same way or are different processes involved?

Guarino & Perkins (1986) found that an awareness of form class, which they defined as an "awareness of a word's morphemes or structure units" (p.77), correlated with reading comprehension. It is not clear, though, whether knowledge of form class is more of a bottom-up or top-down process; that is, whether it relates more to the perception of syntactic structure or lexical/semantic knowledge of prefixes and suffixes. In the segment of text we are considering, 'meeting', 'explained' and 'attracted' simply require the addition of an appropriate affix to the word stem without the need for any other modifications. In the case of 'nodded' and 'alleged', while still being regular verbs, the process is not quite as straightforward. Would all these endings be stored along with other attributes of each word, or would the reader need to apply appropriate word formation rules (allege-d; attract-ed; nod-ded) in order to understand?

Some research suggests that inflectional morphology is an area of specific difficulty for adult L2 learners. It has been found, for example, that L2 learners use inflectional morphemes in an unsystematic fashion (Meisel, 1991) and that they do not always recognise morphological patterns in the TL (Klein, 1986; Schmitt and Meara, 1997). Both Haznedar & Schwartz (1997) and Prévost & White (2000) speculate that adult L2 learners' difficulties with inflectional morphology might be due to processing reasons; that is to say, morphologically complex word forms are not accessed (or retrieved) from the lexicon in a consistent manner.

Ullman (2001) puts forward an interesting hypothesis as to how L2 processing might differ from L1 processing. He argues that processing one's first language involves two different brain memory systems, a lexical store of memorised inflected words which depends upon declarative memory and is rooted in temporal lobe structures, and a mental grammar which includes combinatorial rules and is rooted in frontal brain structures. Given these assumptions, Ullman (2001) claims that L2 processing and representation is largely dependent upon the lexical memory system and invokes grammatical computation to a much lesser extent than L1 processing. For morphological processing, this means that L2 learners mainly rely on storage of the full-form of inflected words, while morphological decomposition is underused or even absent in L2 processing of inflected words. According to this account, L2 learners rely on just one of the two processing mechanisms that are employed in L1 processing, and this might perhaps be the reason why inflectional morphology is hard for L2 learners.

Currently, there seems to be little empirical evidence to back up the speculation, and the details of how adult L2 learners process inflected words remain largely unknown. L2 morphological processing is an area which requires future research.

4.2.2 The frontier between linguistic and general knowledge

We would like to make two points arising from the discussion above. The first is that efficient reading requires considerable knowledge of the language in order to pick up on all the clues to meaning which are to be found in the text. Even advanced bilinguals may read up to 30% slower in their L2 (Segalowitz, Poulson & Komoda, 1991), employing cognitive resources which could otherwise be used for higher-level comprehension processes.

Secondly, if a reader makes use of both linguistic and non-linguistic information in his or her construction of meaning of a text, it may be very difficult to discern between the two and decide where one ends and the other begins. Cuenca & Hilferty (1999: 94) emphasise this point:

> [...] la frontera entre conocimiento lingüistico y conocimiento del mundo es artificial, ya que el significado lingüístico se fundamenta directamente en nuestro conocimiento del mundo.

What this means for comprehension is that one reader might construct details for some points or might skip other information to which another reader may give importance. What a reader builds into his or her construction of the text and understands from it may not be specified in the text at all. Thus a certain amount of *interpretation* or creative processing may be engaged in by the reader, whose understanding or comprehension may go beyond what is expressly stated in the text[49]. This has implications for testing reading comprehension as there may be no one correct interpretation or comprehension of a given text.

Before moving on to discuss the decoding and phonological skills involved in word recognition, there is one final point we shall mention in this section concerning the role that memory might have in word recognition and in reading for comprehension. “The internal lexicon is one form of memory support that is essential for reading [...] for without word memories there can be no word recognition” (Underwood & Batt, 1996: 24). As mentioned above, knowledge of the world, or semantic memory, allows us to interpret and build on the ideas suggested by the text.

[49] Garman (1990: 305) makes the point that the three terms *comprehension*, *interpretation* and *understanding* are all frequently used in the literature, even though no “generally agreed usage” exists for them.

It should be clear from the above that the issue of word recognition is very complex. Nevertheless, we shall now go a little deeper into each of the three 'component skills' mentioned earlier: decoding, phonological encoding and word knowledge. However, one form of decoding words is by sounding them out, hence we treat decoding and phonological issues together.

4.3 Decoding and phonological skills

Frith (1985), developing a descriptive model put forward by Marsh, Fiedman, Welch & Desberg (1981), suggested that when children learn to read the process of acquisition goes through three overlapping stages (or more correctly strategies) which readers adopt as they progress in reading skill: logographic, alphabetic and orthographic.

4.3.1 Logographic strategy

In the very earliest stages of reading, beginning readers use a logographic strategy to recognise words as complete wholes (more as pictures, in fact). This first stage is quite brief and contains a small number of vocabulary items – around forty words according to Solé (1992: 60). It can be characterised more as rote learning of a visual stimulus associated with a spoken response (Torrey, 1979) or as a prereading stage (Chall, 1979) rather than as reading proper.

As reading progresses and children become familiar with more words, and especially as a result of explicit teaching (Frith, 1985), they begin to recognise the relationships between letters and their corresponding sounds; between, that is, *graphemes* and their corresponding *phonemes*. A grapheme is a letter or a combination of letters representing the smallest unit of a written word which can be translated into sound, while a phoneme is the sound corresponding to a grapheme. So the process of converting letters to sounds is also known as grapheme-phoneme correspondence or GPC. As López García (1988: 57) points out, "la comprensión llega como unidad mínima al fonema".

4.3.2 Alphabetic strategy

During the second stage, the alphabetic stage, learning to read usually involves some sort of transfer from the spoken to the written language as the phonological forms of words are usually acquired before the graphological forms. By sounding out each letter and blending the sounds together, the beginning reader can put together a pronunciation of the word which can then be checked against the spoken form in his or her oral vocabulary. Once children have learned the relationship between letters and sounds and are able to *decode*[50], are able, that is, to convert written words to spoken words[51], most of the words in their spoken vocabularies will become accessible to them when they see these in print. Moreover, written material for children is usually graded to include only those words which they are expected to already know. This is still a substantial number. Estimations vary, but normal, monolingual, hearing children of five or six years-old whose first language is English are thought to have a personal lexicon of roughly 5,000 word types[52] (Hayes & Ahrens, 1986) or between 2,500-5,000 words (Beck & McKeown, 1991b).

[50] This is a somewhat restricted meaning. We have already noted (in Section 3.1.2) that for several writers the process of 'decoding' involves syntactic processing too.

[51] 'Transforming written words into spoken words' was a definition of reading offered by Perfetti (1985), although one which he himself noted was inadequate.

[52] The term refers to words having unique spellings. Thus 'school' is a distinct type from 'schools' even though they have the same stem and root.

During this second stage of reading development, then, a word is recognised by converting it from a visual form to a spoken form. By converting, that is, its component graphemes to phonemes. It is this phonological or spoken form which is mapped onto the already stored phonological representation of the word – which has been learned through listening and speaking – and which the reader recognises. Through this he or she is able to access the word in his or her mental lexicon (i.e. the store of all words known to the reader) in semantic memory. Based on the discussion above, Figure 4.1 shows a simple illustration of this process. When a word has been recognised, lexical access has been achieved and the word is available to be used in further operations such as deriving its meaning or integrating it with other words.

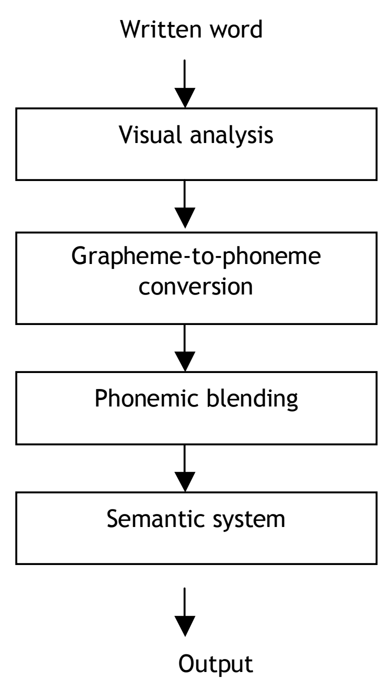

Fig. 4.1. A phonological route to the mental lexicon.

Research by Masterson, Laxon & Stuart (1992) with fifty-four native English-speaking children (average age 5.9 years old) supports the idea of phonologically mediated semantic access. When the children were unable to pronounce any of the irregular target words given to them, they were unable to define them.

4.3.3 Orthographic strategy

The third and final strategy in Frith's model is the orthographic strategy. This is differentiated from the alphabetic strategy claims Frith (1985: 306) by "operating in bigger units and by being non-phonological". At this stage of development, words are not analysed on a grapheme-by-grapheme basis, but rather they are recognised through larger component segments or holistically. This suggests an alternative to the phonological route of lexical access and assumes that visual input is compared to a prototypical, stored visual representation. For skilled readers, word recognition becomes an automatic process not mediated by mapping sounds on to symbols. Rather, access goes straight from the visual input of the word to recognition. A word which can be recognised directly from its orthographic patterns and does not need to be assembled from its phonology becomes part of the reader's sight vocabulary. Based on this description, Figure 4.2 shows a simple illustration of the so-called direct route to lexical access in which the orthographic elements of a word are used to gain direct access to the lexicon without the need for phonological conversion. A word's pronunciation is retrieved after lexical access has been achieved.

Frith (1985) points out that whereas the acquisition of the phonological route requires explicit teaching, the direct route is built up by the reader him or herself independently as a result of frequent exposure to written words. As readers become more and more familiar with words and develop orthographic codes, phonological processing may only be used for unfamiliar or new words (Doctor & Coltheart, 1980) or because the reader uses relatively inefficient visual recognition processes (Backman, Bruck, Herbert & Seidenberg, 1984).

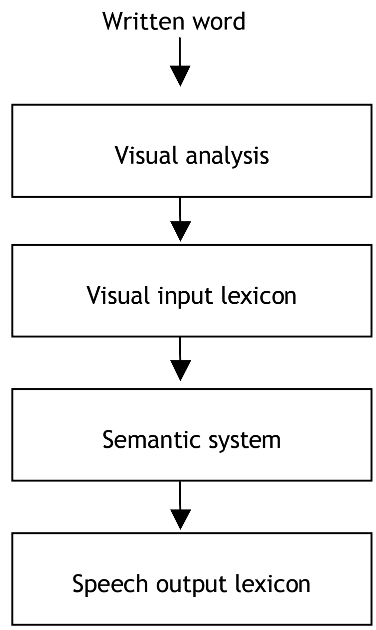

Fig. 4.2. The direct route to lexical access.

In theory, then, in the phonological or non-lexical route, phonology precedes lexical access. In the direct or lexical route, phonology is retrieved after lexical access. However, neither route is able to explain satisfactorily all the effects which research has observed in word recognition. In an attempt to harmonise the two positions, Coltheart (1978) developed the *dual-route hypothesis* which Henderson (1982) refers to as a kind of 'horse race model'.

Dual-route models of word recognition (e.g. Coltheart, 1978; Paap & Noel, 1991) allow for both lexical and non-lexical paths and assume that all known words are stored in a lexicon. According to Castles & Coltheart (1993) and Jiménez (2000), there is evidence for the existence of both mechanisms in English reading and Spanish reading respectively. In Coltheart's (1978, 1993) model (which, we should note, is for reading aloud), there are two lexicons; one is orthographic and is where the orthographic forms of known words are stored, while the other is the store of phonological forms. What basically happens when a word is encountered is that both routes, lexical and sub-lexical in Coltheart's terminology, attempt to identify it. For skilled readers, a known word will travel via the lexical route, accessing its entry in the orthographic recognition system through to the semantic system where its meaning is triggered. Its pronounciation is then retrieved from the phonological output system. As we can pronounce words without accessing their meaning, the model allows the semantic component to be bypassed. An unknown or unfamiliar word, on the other hand, will travel the non-lexical route. It is assumed that these words have no lexical entry or if they do it is only weakly activated. Once the graphemes have been identified their appropriate phonemes can be assigned according to GPC rules (or other orthographic-phonological units)[53]. Finally, the individual sounds are combined to form a pronunciation for the whole word. When reading aloud via the lexical route, a known word's pronounciation is retrieved as a complete whole; for example, the word 'terminology' would be retrieved as a single form. However, as the phonemes in 'terminology' can not all be articulated at the same time there is a short-term phoneme store in which not only phonemes but several strings of words may be held between retrieval and articulation. Retrieving a word as a whole will be more efficient than having to assemble its component phonemes because the load on

[53] Patterson & Morton (1985) proposed replacing the term 'grapheme-phoneme conversion' by the more generic term 'orthographic-phonological conversion' to take account of the fact that the conversion from a visual to a phonological code can be in terms of larger units than graphemes.

phonological processing will be reduced (Patterson & Morton, 1985) leaving more cognitive resources available for other operations. Figure 4.3 shows the main principles of a dual-route model based on the discussion above.

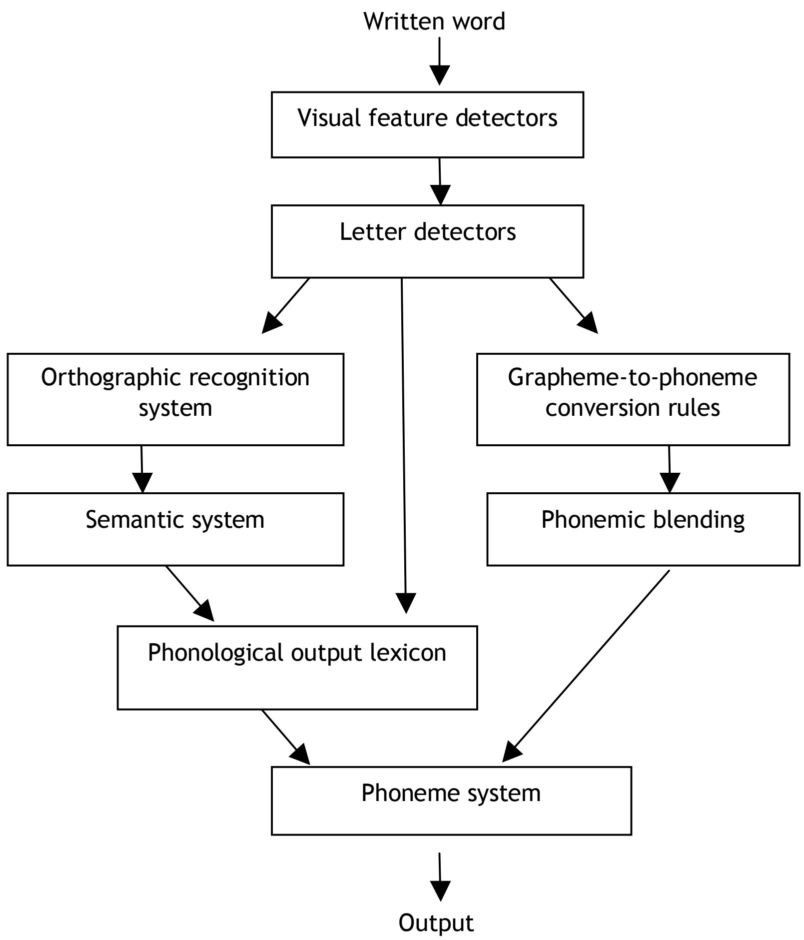

Fig. 4.3. The dual-route model of lexical access.

None of this guarantees, of course, that a word will necessarily be given a correct pronunciation, English orthography being what it is. Even a native reader coming across the word ‘hyperbole’ /haɪpɜ:bəli/ for the first time and applying orthographic-phonological rules would probably pronounce the word /haɪpəbəʊl/. This would be maintained until the reader were corrected – if ever given the low frequency of this word.

Orthographic considerations highight one of the problems in reading English; namely, that the (ir)regularity of letter/sound correspondences is not always predictable. For example the two words ‘through’ and ‘woo’ contain the graphemes OUGH and OO respectively, but they are pronounced the same. In the words ‘although’ and ‘book’ they are pronounced in different ways and, moreover, are different from how they are pronounced in ‘through’ and ‘woo’. The letters -ea-, to take another example, sometimes form one grapheme, as in ‘bread’ or ‘great’ (and in these two examples with distinct corresponding phonemes), sometimes two (‘react’), and sometimes are part of another grapheme (‘beauty’). Even single letters can represent different sounds (contrast the two sounds for ‘s’ in ‘bases’ (the plural of ‘base’), or the ‘a’ in the British English pronunciation of ‘data’, or even the ‘o’ in ‘do’ and ‘don’t’. This means that many words (e.g. ‘the’; ‘one’; ‘two’; ‘rough’), as well as certain combinations of letters (e.g. *kn-* in knife; *-ight* in light; *-tion* in station), must be recognized holistically and treated as single elements[54].

Even from these few example words, we can see that the pronunciation of real words is not decided exclusively by letter to sound mappings. Instead the letter sequence maps onto a word and it is the word which guides the interpretation of the letters or their combinations. In any case, blending phonemes together only results at best in an approximation of the word as it is spoken (Garton & Pratt, 1989). For example, however quickly we make the sounds /p/ /e/ /n/ /s/ /ɪ/ /l/ they never really make the word *pencil*. Thus, although beginning readers can assign a nominal pronunciation value to individual letters, as they develop as readers their knowledge of specific

[54] There are five vowel letters in English, yet fifteen vowel sounds. Many different patterns are used to spell these vowel sounds.

spelling patterns grows. They learn how the sounds may be constrained by other factors such as how the letters combine, or whether such combinations appear in initial, middle or final position of the word.

Readers of English, therefore, need to have sufficient exposure to printed materials in order to develop orthographic codes. Solé (1994: 49) points out that the processes of *alfabetización*:

> [...] a través del cual las personas aprendemos a leer y a escribir [...] van mucho más allá de unas técnicas de traslación del lenguage oral al lenguaje escrito. El dominio de la lectura y la escritura supone el incremento del dominio del lenguaje oral de la conciencia metalingüística (es decir de la capacidad de manipular y reflexionar intencionadamente sobre el lenguaje).

To illustrate this point, as children become more experienced readers in their L1, they will encounter how the nuances of meaning which could be expressed in spoken language through tone of voice, intonation or stress, can be indicated in written language through the use of apostrophes, commas, exclamation marks and other punctuation devices. And they will become familiar with how variations in spelling or the use of upper case or italics, can represent aspects of the sound structure. For just one example of this, from a narrative text in English, consider the following extract from pages 34-35 of *Harry Potter and the Prisoner of Azkaban* by J.K.Rowling. The *Harry Potter* books are considered to be suitable reading for children of around ten or twelve, as well as for adults. In this extract, Stan Shunpike, the conductor of the Knight Bus, is describing the moment when Sirius Black was arrested:

> Anyway, they cornered Black in the middle of a street full of Muggles an' Black took 'is wand out and 'e blasted 'alf the street apart, an' a wizard got it, an' so did a dozen Muggles what got in the way. 'Orrible, eh? An' you know what Black did then?' Stan continued in a dramatic whisper.

> 'What?' said Harry.
> '*Laughed*', said Stan. 'Jus' stood there an' laughed. An' when reinforcements from the Ministry of Magic got there, 'e went wiv 'em quiet as anyfink, still laughing 'is 'ead off. 'Cos 'e's mad, inee, Ern? Inee mad?'

We can see here that although there may be many orthographic similarities between English and Spanish, there are many differences too[55]. Without knowledge of these codes or conventions a reader will have more dificulty in establishing higher meaning units and organisational patterns. The implication is that in order for efficient reading to take place the reader must already be familiar with the linguistic conventions used by the writer, or as Solé (1994: 52) puts it:

> El niño necesita haber desarrollado una cierta conciencia metalingüística para comprender los secretos del código.

The consequence is that the more one reads the easier decoding, and hence word recognition, becomes. Indeed, Perfetti (1994: 853) claims that with respect to beginning L1 reading, decoding "is the fundamental achievement of learning to read", adding that decoding should become automatic through learning and practice.

The reason rapid decoding and word recognition is so important is because in the limited capacity view of the cognitive system that we have assumed,

[55] With respect to punctuation, there are several significant differences between English and Spanish. In Spanish, for example, a comma is often used where English requires a full stop. Splitting a word at the end of a sentence with a hyphen seems to be normal practice even for eleven-year-old Spanish children but is much less frequent in English – perhaps because there are more shorter words in English and it is easier to fit the word within the confines of the line. Interestingly, Alderson (2000: 71) notes that in English, word frequency is very roughly related to word length, with shorter words tending to be more frequent. Another convention, which is very common in Spanish, but unacceptable in English, is to finish a sentence with a series of suspension points (...) to indicate that one could go on to give more examples of whatever the point in question is. This seems to us to be a written equivalent of the spoken *y tal*.

readers who have automatic, accurate and attention-efficient word recognition skills are able to devote more resources to comprehension (Perfetti, 1985). Readers who are able to focus more attention on understanding words than on decoding them are more successful comprehenders than those readers who need to divide their attentional resources equally between decoding and comprehension (Reynolds, Shepard, Lapan, Kreek & Goetz, 1990) or in the words of Serra & Oller (2001: 38):

> Si la descodficiación es muy lenta o dificultosa, ésta exigiría un alto grado de esfuerzo que puede llevar al alumno a perder el significado global de lo que lee.

4.4 Using contextual clues to recognise words

So far we have discussed word recognition in terms of either transforming a written word into a spoken word through a process of phonemic blending or assembly, recognising the whole word visually, or a combination of these processes, but there are other important processes involved that we need to mention. Consider the following sentence:

I read that story last year so I'm going to read this one now.

In order to pronounce the word 'read' correctly, readers need to use both their grammatical knowledge as well as their knowledge of the world. In this sentence it is necessary to identify the meanings of each instance of the word 'read' before assigning it its correct pronunciation, so here, at least, grapheme-to-phoneme conversion is not the first step which must be completed before other processes involved in reading begin to operate. In this sentence the pronunciation of 'read' for skilled readers appears to be post-lexical; that is, in each case the word will have already been recognised and its meaning established *before* it is pronounced. So it appears that 'higher level' processes are influencing 'lower level' processes. In first language or advanced second language reading, these processes are usually so smooth and automatic they go unnoticed. How many readers of the example sentence above were conscious of the different pronunciation required for -ea- in 'year', for example?

Goodman (1967) argued that reading involved the simultaneous use of orthographic, syntactic and semantic knowledge, while recent research has shown that areas of the brain involved in word recognition include those areas associated with the analysis of visual features, orthography, phonology and semantics (Posner, Abdullaev, McCandliss & Sereno, 1999). Thus, it is not only letters or their combinations which influence how a word is decoded; the semantic and syntactic relations words have with other words around them can also play significant roles in how they are understood (Rayner & Pollatsek, 1989). In other words, the context in which the word appears is also used to aid word recognition, and the notion of context does not necessarily refer to the word's immediate environment. It can be expanded to include headings and illustrations (Bransford & Johnson, 1972; Trathen & Reynolds, 2001), readers' goals and objectives (Reynolds, Trathen, Sawyer & Shepard, 1993) and readers' background knowledge (Barry & Lazarte,1998; Carrell & Eisterhold, 1988).

However, while context can support word recognition, the need to spend time and attentional resources on working out the meaning of unknown words from contextual clues is generally inefficient. There is ample evidence from research in L1 reading which shows that good readers can be distinguished from poor readers because the former possess rapid decoding and word recognition skills hence they rely less on context clues to make meaning from a text. It seems that while better comprehenders devote proportionately more attention to understanding than to decoding, less successful comprehenders focus their attention equally on comprehension and decoding (Reynolds, Shepard, Lapan, Kreek & Goetz, 1990). As Van Dijk & Kintsch (1983: 23-24) explained it:

> What is really wrong with poor readers is that they recognize isolated words inaccurately and too slowly, and compensate for their lack in decoding skills with context-dependent guessing or hypothesis testing ... Good readers with their superior decoding skills can decode letters and words rapidly in a bottom-up fashion, and therefore do not normally need to resort to guessing strategies ... What is really at issue are the speed and accuracy of context-free word recognition operations.

This brings us to another important aspect of reading; namely, vocabulary knowledge. Knowing the meanings of words is basic to comprehension and we move on to discuss this aspect of reading, leaving the issue of using context to aid word recognition and comprehension for the next Chapter.

4.5 Vocabulary knowledge

To illustrate the importance of knowing what the words of a text mean, consider the following comments from two of the think-aloud protocols in the preliminary research we carried out to investigate the comprehension strategies used by readers in their L1 and L2 (see Chapter 7). The first extract (numbered [10]) from Subject #3 (who achieved a slightly higher score (25.0) on the English proficiency test than the mean obtained by all participants in the main research described in Chapter 8) refers to the following sentence:

> *better than mm/sec relative velocity accuracy for manoeuvring in the vicinity of the comet*
>
> (Rosetta Spacecraft Design, ll. 35-36)

[10] <<En la siguiente frase vamos, no entiendo nada, porque sigo sin saber lo que es 'accuracy', 'manoeuvring' y 'vicinity', entonces, como no entiendo las palabras, y son básicamente toda la frase, pues no puedo entender la frase.>>

(Subject #3)

The second example (extract [11]) is taken from Subject #7, whose score on the English proficiency test (15, or ALTE level 0/CEF A1) was considerably lower than the mean score in the later study. His comment was made with reference to the sentence below:

> *It usually is much more cost effective to specify a material that will provide an extended life, particularly in areas that are difficult to repair or in components that would cause major shut-downs in case of failure.*
>
> (Rosetta Spacecraft Design, ll. 78-81)

[11] << ¡Madre mia! El siguiente punto es muy largo. Hay muchas palabras que no entiendo, uff, 'usually' será usualmente, pero no lo sé. 'is much' .. mach ..uff .. 'shut-downs' no sé lo que significa, 'failures' tampoco .. no sé, demasiadas palabras, no consigo enlazar el significado, y hay otras que no entiendo. Así es imposible saber de lo que te están hablando.>>

(Subject #7)

For most adult readers reading in their L1, unfamiliar words (perhaps technical words or words borrowed from other languages) will generally be the exception rather than the rule, and understanding word meanings will not be a difficulty the adult L1 reader will have to cope with. In fact, in many studies of adult L1 reading, vocabulary knowledge is often taken for granted (Alderson, 2000), and it is assumed that there is a certain homogeneity between readers regarding this aspect of linguistic knowledge.

For the L2 learner, the situation is very different. Indeed, unfamiliar vocabulary is perhaps the greatest challenge to an L2 reader for, while it is possible to find examples in texts where grammatical structure is crucial to understanding subtle nuances of meaning, it could be argued that what is more important for comprehension is knowing what the words mean (Coady, 1993, Grabe & Stoller, 1997). As Vermeer (1992: 147) affirmed: “Knowing words is the key to understanding and being understood”, while according to Eskey & Grabe (1998: 226):

> [...] all models of reading recognize the importance of vocabulary. However the interactive model goes further. Not only is a large vocabulary important, it is a prerequisite to fluent reading skills. Since automatic word *recognition* is more important to fluent processing of text than context clues as a first strategy, large-scale development of recognition vocabulary is important.

As we have already remarked (in sub-section 2.4.1) some research (e.g., Laufer, 1992; 1997a; Grabe & Stoller, 2002; Liu & Nation, 1983; Nation, 1993) suggests that a good knowledge of at least 5,000 words (3,000 word families) is the minimum required to provide 95% of text coverage for material written in English, and which is necessary (i) in order to make sense of unfamiliar words in a text, and (ii) to interpret the text’s global meaning (Laufer, 1992; Grabe & Stoller, 2002). Of course, the actual number of words required to make sense of a text will depend on many factors; such as the characteristics of the text (e.g., topic, rhetorical structure), characteristics of the reader (disposition, interest), and other situational factors. Even so, 5,000 does not seem a very high number of words, especially when we consider that for *Dutch* Hazenberg & Hulstijn (1996) conclude that the minimal vocabulary size needed for university studies is 10,000 base words.

Fortunately for our students, there are many English words which share common roots from Latin and Greek with their Spanish equivalents. This allows native Spanish readers to capitalize on a large number of cognates when reading English. To give just one example, the words *localised corrosion* are easier to understand for a native Spanish speaker than the words *rust spot*. In a study of the strategies used by bilingual Spanish-English readers, Jiménez, García & Pearson (1996) found that one of the strategies used to resolve the meaning of unknown words when reading in either language was the identification and use of cognates. Other research by Nagy, García, Durgunoglu & Hancin-Bhatt (1993) with bilingual children (4th-6th grade) found that the children who recognised cognates in an English text and knew the word in Spanish had significantly better reading comprehension in English.

At this point, however, it seems worthwhile asking (and answering) the question: what does it mean to know a word? What does word knowledge involve?

4.5.1 What does it mean to know a word?

Beck & McKeown (1991) suggest that knowing a word is not an absolute – it is *not* the case that you either know it or you don't – but that there is a continuum ranging from not knowing the word to "rich decontextualised knowledge of a word's meaning, its relations to other words, and its extension to metaphorical uses" (p. 792), while Nation & Waring (1997) propose a three-dimensional model to describe a person's vocabulary knowledge depending on:

· the number of words known
· the amount of knowledge present for each word (depth of knowledge)
· how quickly the word can be utilised (automaticity)

Knowing a word, therefore, involves being more or less familiar with the following set of features, which refer to the 'depth of knowledge' of a word. This may range from superficial to deep (Read, 1993) at different stages of learning. The higher the degree of familiarity, the closer this knowledge comes to being productive (Melka, 1997):

· pronunciation
· spelling
· grammatical patterns
· meaning(s) – in different contexts
· appropriateness – in different contexts
· relations with other words – typical associations, frequent collocations
· derivations

A somewhat similar set of characteristics was identified by Laufer (1997b) in her discussion of the factors which may either facilitate or hinder a word's learnability. Laufer refers to what she calls 'intralexical' and 'interlexical' factors, as well as to crosslinguistic influences or transfer from the learner's L1. The first group of these, the intralexical factors, refer to a set of properties including:

· the word's pronunciation (or rather its pronounceability)
· its orthography, and the degree of correspondence between how the word is written and how it is said

· word length
· number of syllables
· morphology
· part of speech
· semantic features such as abstractness, appropriateness, idiomaticity, multiple meanings. The latter are a particulary rich area for confusion. Many learners stick to one meaning they know and find it very difficult to use another – even if the one they know has no sense in that new context.

The interlexical factors identified by Laufer (1997b) affecting learnability include the target word's relationships to other words, in addition to sharing some semantic features but not others. For example, teaching associated words, such as synonyms or opposites, at the same time, could result in students confusing form and meaning, leaving them unsure which word means what. A similar confusion may arise with words that share a number of semantic features (cf. Higa, 1963; Nation & Newton, 1997). For example, (i) reply, answer, solution, explanation; (ii) rigid, stiff, unbending, inflexible, stubborn; (iii) axle, shaft, handle

Another quite important contributor to difficulty is 'synformy' (Laufer, 1991). This is the visual or acoustic similarity of lexical forms which may cause learners to confuse similar words.

The small-scale experiment[56] described below was conducted with the aim of exploring our students' depth of knowledge of certain vocabulary items.

[56] The experiment was carried out together with Dr Penny MacDonald with students from what is now called the School of Rural Environments and Enology (*Escuela Técnica Superior del Medio Rural y Enología*) at the UPV. See Perry & MacDonald, 2002.

It used a slightly modified version of the Vocabulary Knowledge Scale (VKS) developed by Paribakht & Wesche (1993; 1997).

4.5.2 Depth of knowledge and the Vocabulary Knowledge Scale

The Vocabulary Knowledge Scale (VKS) was originally developed by Paribakht & Wesche to “distinguish stages in learners’ developing knowledge of particular words” (Paribakht & Wesche, 1997: 179). An example of the form used is shown in Figure 4.4. Subjects are presented with a target word in written form and required to indicate their self-perceived knowledge of the item in question by completing one or more of five self-report categories. These range from total unfamiliarity with the word, to knowledge of how to use it in grammatically and semantically correct ways in a sentence. If the subject either *thinks* or is *sure* s/he knows the meaning of the word, s/he is required to demonstrate this knowledge by providing a translation or a synonym, (although, as we have seen, knowing a word involves more than just this), or by providing an appropriate sentence.

Paribakht & Wesche point out (1997: 179) that, as it stands, the VKS is not designed to show additional word meanings, derivations or associations – although they do seem to have used responses to it to support their claim that their learners achieved both quantitative (more words known) and qualitative (greater depth in their knowledge of target items) gains in vocabulary (*op cit*: 189). In order to apply the VKS to our context we created a slightly modified version with the addition of two more categories (numbers VI and VII) to the original five, resulting in the format shown in Figure 4.5.

Self-report categories

I I don't remember having seen this word before.

II I have seen this word before but I don't know what it means.

III I have seen this word before, and I think it means __________ .
(synonym or translation)

IV I know this word. It means __________ .
(synonym or translation)

V I can use this word in a sentence: __________ .
(write a sentence)
(If you do this section, please also do Section IV.)

Figure 4.4. VKS elicitation scale: from Paribakht and Wesche (1997: 180)

<table>
<tr><td>Target word

according to</td><td>I I don't remember having seen this word before</td><td>II I have seen this word before but I don't know what it means</td><td>III I have seen this word before and I think it means (synonym or translation)</td></tr>
<tr><td colspan="2">IV I know this word. It means (synonym or translation)</td><td colspan="2">V I can use this word in a sentence (write a sentence)</td></tr>
<tr><td colspan="2">VI I know some derivatives of this word</td><td colspan="2">VII I can use these words in sentences (write sentences)</td></tr>
</table>

Figure 4.5. The modified version of the VKS used in the study showing the first of the target items.

4.5.3 Presentation of the VKS to the subjects

Subjects were 22 young adult students in their first year of a three-year course in Agricultural Engineering. All were native speakers of Spanish (Castilian) with about half also having native-like proficiency in Valencian.

To avoid any misunderstandings regarding task requirements the presentation of the material and the instructions were given in Spanish. Using an overhead projector, students were first shown a specimen form and the meaning of each category was elicited. The target word 'undergo' was given and the group of students asked which category they would mark. 'Undergo' was chosen for several interconnected reasons:

i) it was assumed that most students would not know the word
ii) it appears in the text the students would be required to read later in class
iii) it would be a way of pre-teaching its meaning
iv) it would help emphasise that there would be items with which students would be unfamiliar, and that indicating this would be perfectly acceptable. In other words, to clarify to the participants that the activity was not a test of any sort and to encourage them to answer truthfully.

Nevertheless, students had been exposed to all the test items in class work carried out during the previous weeks. We were interested to see whether any of these words were recognised or not.

A second target word, 'farm', was given, since it was assumed:

i) that all students would know the word and be able to give its meaning either as a verb or as a noun and thus encourage them to give multiple meanings of a word if this were the case,
ii) that all students would know derivatives such as farmer, farming, farmed, farmland and be able to use these in sentences.

The categories for 'farm' were completed as a group, and once we were satisfied that students understood the task requirements they were given the VKS forms to complete. No time limit was set and all the target items were seen in isolation; that is, with no contextual clues.

Figure 4.6 shows some of the sentences produced by the students to demonstrate their word knowledge. Column 1 shows the target words, while Column 2 contains examples of sentences written by the students using the word. This exercise corresponds to Category V of the VKS. The samples have been chosen on the basis that they are representative of the same confusions made by at least one third of the subjects. In fact, in Sentences 1, 2 and 9, 80% of the subjects made the same mistake. Thus, the errors which these examples illustrate are not isolated cases. Moreover, the target words were all vocabulary items which the students had come across several times (a minimum of five) in previous classes, either in different texts or included in vocabulary activities. This agrees with other research which has shown that reading a word once is not usually enough for a learner to retain it. Estimations in the literature of how many times we need to see a new word before we learn it range from five to seventeen, averaging out at around ten (cf. Saragi, Nation & Meister, 1978).

Sentence 1 of Figure 4.6 (*I am breeding some birds*) is well formed and seems to be perfectly correct until we look at what the student gave for the meaning of the target word, which is *alimentar* the Spanish equivalent of ‘feed’. This is a clear example of what Laufer (1991) referred to as synformy – in this case confusion over similar looking and sounding words (‘breeding’ and ‘feeding’) compounded here by having related meanings. The same confusion occurred in Sentence 2, while just to confirm the confusion another student put ‘bread’ as a derivative of ‘breeding’.

Target word	*V I can use this word in a sentence (write a sentence)*
breeding	1) I am breeding some birds 2) I am breedingthe pigs their dinner (‘bread’ given as a derivation)
sources	3) The people of the Third World haven’t sources 4) There are a lot of sauces in this park
secure	5) I am secure that you don’t have any money
following	6) I am going to following planting this variety
according to	7) Accordint to this text this is true 8) Accordind to the UCLA ...
develop	9) The plants have been develop with difficulty 10) They need a person capable of develop new techniques 11) It’s an important develop in agriculture 12) I want to se the develop of this tree

Figure 4.6. Examples of students’ use in a sentence of target words (from Category V of the VKS).

Sentences 3 and 4 also indicate confusion between similar words. In Sentence 3, the target word (‘sources’), was understood as ‘resources’, while the author of Sentence 4 clearly ‘suffered’ from what we might call acute acoustic encoding interference (remember that all the target words could be seen throughout the activity), as well as confusion over meaning (the Spanish word for ‘source’ (*fuente*) is the same as that for ‘fountain’). On questioning after the activity, the writer of Sentence 4 confirmed that he had understood ‘source’ as *fuente* and then re-translated this as ‘fountain’ His pronunciation of ‘source’ was something like /sau´use/.

There are several examples, and Sentences 5 and 6 are two of them, where students have given a potentially correct Spanish translation of the target word ('secure' – seguro) but then chosen the wrong meaning in their *productive* use of the word.

Moreover, if Sentence 6 indicates a lack of familiarity with the grammatical patterns of the suffix 'ing', Sentences 7 and 8, although grammatically and semantically correct, suggest a lack of familiarity with its phonological features – surprising when one thinks how frequent it is in English. Nonetheless, various factors may come into play here. Laufer (1997b) cites research by Rodgers (1969) and Gibson & Levin (1975) which indicates that words which are difficult to pronounce are also more difficult to learn than words which are more easily pronounceable. Difficulties with pronouncing certain words (or rather phonemes or other sound units) are often a consequence of the learner's L1 system. /ɪŋ/ is not a sound which is found naturally in Spanish and here it seems to have been lost as the word runs into the /t/ of 'to'.

Pronunciation problems may also explain the errors in Sentences 9-12, although there may be other reasons. Spanish speakers do have difficulty with final consonants, but it still seems strange that even though many of the subjects gave *developed*, *developing*, *development*, as derivatives they did not use these forms in their sentences.

Ryan (1997: 183) speculated that L2 learners bring to their learning of the language a subconsciously acquired and developed set of language skill processes (specific to the L1) which "have been operating since the time when their first language was acquired". Perhaps Spanish speakers rely too heavily on phonological processing when reading new L2 words or accessing old ones. A phonological approach is completely appropriate to Spanish as its orthography is so regular and it has a very consistent set of rules for pronunciation (Thonis, 1983) but not so appropriate for English as there are too many irregularites. Furthermore, for a word to be accessed via the phonological route, the entry in the lexicon must contain a phonological component; that is, it must include information as to how the word is pronounced. If that information is somehow confused or incorrect the word will be reproduced in a confused or incorrect way.

Regarding Sentences 9-12, it has been argued (e.g. Goulden, Nation & Read, 1990) that, for purposes of estimating vocabulary size at least, a word family should be taken as a single lexical item. That is, words related by inflectional or derivational affixations do not represent different items. Our experience, nevertheless, is that L2 students, unlike native speakers, are more often than not unable to recognise or work out the meaning of a derived word from its base form. They lack sufficient language resources (e.g. the morpheme identification rules) to do this. Schmitt & Meara (1997) also found in their study of Japanese students that they [the students] did not know many of the derivative suffixes or even the inflections for English verbs. In the Nagy et al., (1993) study cited earlier, students had more problems recognising cognates when they had slightly different orthographic features like suffixes. This difficulty might be due to the readers' lack of control or familiarity with this aspect of morphology. Thus, in Sentences 9-12 perhaps learners have acquired sufficient semantic content of the word 'develop' to cope with understanding but not enough of its phonological features or its grammatical patterns to be able to use its different forms correctly.

This small study clearly shows that the subjects who participated had only partial knowledge of the target words, and it brought to light some confusions which seem to be caused by the sort of L1 orthographic and phonological processing operations discussed in the previous section. As far as teaching is concerned, it suggests that we should not only aim to increase the size of our students' sight vocabularies, but also their control over the components. This would require repeated exposure to target words in different contexts (recycling) as well as activities which encourage deeper and more active processing. Activities should go beyond simply memorizing new definitions, but rather encourage students to examine relationships between different words and thus help to build semantic networks.

Best of all, it seems, would be for students to engage in extensive reading outside class. Zimmerman (1997: 136-137) concluded that students "should be encouraged to adopt the habit of reading self-selected materials, based on the evidence that incremental knowledge of words may be gained from reading". Studies by Ellis (1995), Ooi & Kim-Seoh (1996) and Rodrigo (1995), the latter carried out with subjects who were learning Spanish and cited in Bamford & Day (1998), all reach broadly similar conclusions. The benefits of extensive reading are not restricted only to gains in L2 vocabulary, however. Improvements are reported in writing, spelling and general linguistic competence (Day & Bamford, 1998; Nation, 1997; Tsang, 1996).

4.6 Difficulties for Spanish L1 readers reading in English

What are the implications of our discussion so far for the students who are the subjects of this study; that is, adults between 18-25 years old. One might think that after already studying English as a foreign language for approximately 8-10 years, their decoding and recognition of English words would have reached a level of automaticity to make this aspect of reading unproblematic. The classroom evidence does not justify this assumption, however, with even high-frequency words such as 'do' /δυ:/ and 'does' /δ℘ζ/ being read as /δ↔υ/and /δ↔υεσ/ respectively.

Studies of literacy development in bilinguals and of the cross-linguistic transfer of skills suggest that the transfer of skills and strategies from L1 reading to L2 reading takes place to a high degree (Kellerman, 1986; Perdue, 1993; Ringbom, 1987), and that the greater the similarity between the writing systems (or scripts) the greater the degree of transfer. This has advantages because it can reduce or ease the difficulties in learning to read the second language (Odlin, 1989).

But transfer can also cause problems. With respect to the decoding of words, although native Spanish readers reading English do not need to learn a new script, they do need to associate new sounds with familiar symbols, and they may have extra difficulties with the auditory discrimination of certain sounds that exist in English but not in Spanish. The classic example of the distinction between ‘ship’ and ‘sheep’ or ‘kiss’ and ‘keys’ for instance, or the difference between ‘walk’ and ‘work’.

Baron & Strawson (1976) suggest that readers in English can be divided into two basic groups which they call ‘Chinese’ and ‘Phonecian’. The characteristic of readers in the Chinese group is their reliance on lexical decoding; i.e. recognising words as whole units. Phonecian readers, on the other hand, use orthographic processes to decode all words. This dependence on the letter-sound correspondences means that a ‘Phonecian reader’ will have difficulty reading any word which does not meet his or her expectations.

Ryan (1997: 195) points out that readers transfer to their reading of a foreign language the phonological system they use when reading their first language and that therefore “there may be invisible barriers to learning form [i.e. the form of words] which lie in the structure of an individual’s first language ... of which the learner is probably totally unaware”.

Because Spanish is a phonetic language with a consistent set of phonics rules, experienced readers of Spanish can pronounce every word based on spelling alone (Sebastian, 1991). Moreover, every word has its own spelling. While it would be dangerous to assume that all native Spanish readers adopt a ‘Phonecian’ approach to reading English, it seems reasonable to speculate that native Spanish readers, used to regular letter-sound correspondences, use an approach which is different to that of native English readers (Suarez & Meara, 1989) who have had to develop a processing system which will allow them to deal with both regular and irregular words. As Clemente Linuesa (2001: 116) remarks:

> Si vemos escrita una palabra por vez primera, seguro que predominará la utilización de la via fonológica, puesto que visualmente no la reconocemos aún y tendremos que utilizar las reglas de transformación letra-sonido.

More specifically, the native Spanish readers of English as an L2 who participated in this study, and who have had (and have) relatively little exposure to reading in English, may apply grapheme-phoneme correspondence rules, together with any other rules of stress, which have been automaticised from their L1. Familiar combinations of letters from the readers’ L1 will set up expectations about subsequent letters as well as about how they are to be phonemically encoded. As a result, their cognitive systems may struggle to respond to unfamiliar letter sequences or they may interpret them in terms of what they already know. So, for example, although in English, two vowels frequently represent only one phoneme (eg. ‘need’, ‘book’, ‘rain’), in Spanish vowels are usually pronounced separately (‘crear’, ‘leer’, ‘país’, ‘diario’). When this is not the case the rules are clear. This might account for why students read words such as pencil’ as /πενΤι:λ/, ‘worked’ as /wɔ:ked/, ‘near’ as /nεɪɑ:/ or ‘chemical engineering’ as /tʃεmɪkæl εnjɪnεɪεərɪn/, suggesting an overreliance on L1 phonological principles. Interestingly, phonological dyslexia (which results from a deficit in the grapheme-phoneme transformation mechanism) amongst children is less common in Spanish than in English, apparently because the regularity or 'shallowness' of Spanish orthography encourages phonological processing in beginning readers of that language. Surface dyslexia, on the other hand, is more common in Spanish. Surface dyslexia is a consequence of an overdependence on the phonological (sub-lexical) route and infrequent use of the direct (lexical) route. Table 4.2 shows a comparison between Castles & Coltheart's (1993) findings with respect to reading in English, and Jiménez's (2001) study (using the same procedure as Castles & Coltheart, 1993) to identify dyslexic subtypes in Spanish orthography.

	Surface	Phonological
English orthography (Castles & Coltheart, 1993)	30%	55%
Spanish orthography (Jiménez, 2001)	53%	18%

Table 4.2. Distribution of surface and phonological dyslexics in English and Spanish.
(Source: Jiménez, 2001)

The higher percentage of surface dyslexics in Spanish may be because the Spanish children participating in the study relied too much on using their phonological analytical skills. Infrequent use of the direct route would hinder the transition from, in Frith's (1985) terms, the alphabetic strategy to the orthographic strategy.

Underwood & Batt (1996: 21) make the point that it is still not clear " exactly which unit (graphemic or phonemic, or both) is used in natural word recognition", and it seems as though experienced readers may use both routes in a complementary way. Rayner & Pollatsek (1989: 109) conclude their discussion of lexical access by stating that "the common ground for all positions is that direct visual access is important and that sound encoding plays some part". In fact, although phonological encoding may not be a necessary first step for lexical access this does not mean that none takes place. It seems, rather, that the generation of a phonological code is automatic (Humphreys, Evett & Taylor, 1982; Underwood & Briggs, 1984). Research by Van Orden (1987) suggests that phonological encoding occurs early on in the process of word recognition is mandatory and plays a constraining role in lexical access. Lukatela & Turvey (1994a, 1994b) also concluded that lexical access is phonologically mediated and, moreover, that there is no visual access independent of phonological access. Urquhart & Weir (1998: 57) point out that "there is considerable evidence that the sounds of words influence the speed or accuracy of silent reading", and we saw earlier (or perhaps heard!) that the humour evident in calling an IT company 'Fission Chips' would not be accessible to us as readers if some sort of phonological encoding did not take place.

We might wonder, therefore, what effect having to assemble the phonology of the word could make on comprehension. It might be that, for an L1 reader of the sentence:

I read that story last year so I'm going to read this one now

the different phonological encodings of each instance of 'read' somehow support or confirm their meanings. A low-level reader, on the other hand, processing the sentence word by word, may very well assign the same pronunciation, let's say for the sake of argument /ρειΘδ/, to both instances of 'read', quite possibly losing an important aspect of meaning in the process. Put another way, it is possible that difficulties in creating a stable phonological representation of a word, or the lack of such a representation, could cause breakdowns or delays in establishing meaning. This could effectively prevent access to meaning via the phonological route

(McShane, 1991). As Solé (1994 : 61) pointed out “en la lectura, significado y descodificación se encuentran siempre presentes”.

This is an area where more research is needed with adult readers. It may be that students would benefit from explicit teaching of orthographic-pronuncation rules and from greater exposure to reading. It certainly seems to be the case that the apparent perversity of English spelling patterns complicates the task of reading. As noted by Clemente Linuesa (2001: 71):

> En casos extremos de la grafía inglesa existe una relación mínima entre grafías y fonemas [...] Estas desviaciones dificultan enormemente el aprendizaje de la lectura a los niños, incluso el acceso a una lengua extranjera a muchos adultos.

Although for skilled, native readers it is not that there are ‘minimal relations’ between graphemes and phonemes but rather that these relations are complex.

However, the main point of these remarks is not that the pronunciation is ‘incorrect’ or not native, or that the grapheme-phoneme correspondence (GPC) rules have only been partially understood. This is not surprising when we consider that, according to Smith (1971), there are over two hundred GPC rules necessary to correctly pronounce the most common 6,000 words used by nine-year-old English children. The subjects of this study will not have had sufficient exposure to reading in English to have fully assimilated these, somewhat abstract, relationships. Even for skilled readers, inconsistencies in the GPC rules can influence the recognition and pronunciation of words (Baron & Strawson, 1976). Rather, it is that the perceptual factors involved in the visual processing of written words are rooted in the first language (Ryan, 1997) especially for less experienced readers, and may cause difficulties in recognising letter-sound correspondences, which in turn may cause processing resources to be engaged which could otherwise be used for comprehension.

Secondly, as Patterson & Morton (1985) argued, the number of sounds which need to be blended in the pronunciation of a word influence reading performance. The need to assemble words from their phonemic components will put an additional load on cognitive resources.

Furthermore, although skilled and less-skilled readers may both eventually access the meaning of words or deliver a recognisable pronunciation of them, the time taken to arrive at the meaning or to "compute the pronunciations" will vary "across levels of reading skill" (Pearlmutter & MacDonald, 1995: 540). This could have a knock-on effect in other areas. For example, research has also shown that there is an optimum reading speed below which it is difficult for readers to conserve what is currently being read in working memory. Of course, reading rate will vary depending on the reading level (i.e. high or low reading skill of the reader), text genre (there is evidence (e.g. Horiba, 2000) that expository texts require longer reading times than do narrative texts[57]), reader familiarity with the topic and the purpose of reading (gist versus details, reading for pleasure or for study), so it may be difficult to agree on an optimal rate for different age groups or reading levels. Nevertheless, Carver (1982; 1983; 1990) puts the optimal rate at 300 words per minute. Nuttall (1986: 56) agrees with this figure as the norm for adult L1 readers of English with average intelligence and education reading a narrative text, while according to Smith (1988: 79), if readers read a text at a rate slower than 200 words per minute they are probably reading "in isolated units rather than as meaningful sentences". Dubin & Bycina (1991) also suggest that 200 words per minute is the minimum required for proper comprehension.

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[57] See Sub-section 6.5.1 for a discussion of the reasons why expository texts are hard to read.

In a prior study to this one, carried out with the aim of identifying and comparing the use of reading comprehension strategies when reading expository texts in L1 (Spanish) and L2 (English), one of the subjects who was particularly hampered by his low level of English vocabulary commented:

[12] <<En el tercer punto, la frase es demasiado larga, con lo que olvido lo que voy traduciendo anteriormente y me pierdo.
[...]
En el siguiente punto también es demasiado largo .. en este punto entiendo la mayoria de las cosas, pero volvemos otra vez a lo mismo, que si me si me centro en lo que estoy leyendo olvido lo que ya he leido.. y entonces pues uff, como no vaya apuntando palabra por palabra.>>
(Subject #7, Perry, 2004)

It may be worth noting that this subject was the only one in that study who reported doing no reading in either L1 or L2 outside the university. But even bilingual readers may have slower reading rates. Segalowitz, Poulsen & Komoda (1991 cited in Anderson, 1999: 2) argue that the reading rate of bilingual readers reading in their L2 can be up to 30% slower than when reading in their L1.

Fourth, readers need a large sight vocabulary. In L2 contexts where the text being read includes lexis which may be unfamiliar to readers, a great deal of cognitive resources will have to be dedicated to the task of word recognition, and readers become ‘word bound’; that is, they process a text as a series of individual words and not as a connected series of propositions. In fact, the propositions may not be recognised as such because too much attention is being paid to each word. However, as we have seen in the section on vocabulary, superficial (as opposed to deep) knowledge of any given word may not be enough for comprehension and may even result in an incorrect interpretation.

There are good arguments here for devoting more class time to developing students' bottom-up processing skills so that words are recognised more automatically. "Good readers", claims Paran (1996: 25), "do not rely on hypothesis formation and prediction as much as is commonly thought. Visual input and bottom-up processing during reading are of great importance".

These 'lower-order' skills are clearly important if learners are to achieve any sort of rapid and effective word recognition in the target language that some writers believe is so important. Coady (1997: 279), for example, suggesed that the 2,000 most frequent words should be learned "to the point of automaticity". There is also the question of which aspects of word recognition are important: the whole word, or recognition of common sound/spelling patterns? Or both? Grabe & Stoller (2002: 79) also suggested that the initial emphasis should be on learning the 2,000-3,000 most common words in the target language in order to provide what they call "an essential foundation for word-recognition automaticity". After that, the vocabulary most appropriate for specific topics can be focused on. Whatever the case may be, knowing the form of a word enables the learner (i) to recognise the word and distinguish it from other words without the need to devote large amounts of processing resources (which can then be applied to comprehension, for example), and (ii) to reproduce the word (in either spoken or written form) so that other readers will recognise it.

4.7 An informal study in recognising orthographic patterns

Finally in this section, we would like to describe an informal study carried out with the aim of assessing in very general terms our students' ability to recognise typical orthographic patterns in English and whether they might be influenced by phonological encoding from their first language. Although the results are inconclusive due to the general nature of the task, they did reveal some surprising data.

Briefly, we provided the subjects with a short, sixty-one word text containing a total of twenty-two anomalous words. The error words were categorised into six groups according to the type of anomaly they represented:

- L1 words which were very similar to their English counterparts
- Words containing a spelling error making them more visually similar to L1 words
- Words containing spelling errors which might cause phonological interference
- Words containing grammatical or morphological errors
- Homonyms
- Other common misspelling errors

We did not expect that all anomalies would be noticed because it was assumed that the participants' attention would be variable, and that the capacity for noticing would also vary among individuals. This can occur for a number of reasons: in Schmidt's (1990) concept of *noticing*, (i) not all input has equal value, and (ii) only input which is noticed is available for intake and effective processing. In the context of our experiment, what this means is that the reader must be aware of some anomaly in order to process it and indicate that it has been noticed. Schmidt (1990) discusses six factors which may influence noticing and make it more likely to occur:

- Frequency
- Perceptual salience
- Instruction
- Individual differences in processing ability

· Readiness
· Task demands.

Frequency simply states that the more times a word form has been seen the more likely it is to be integrated in the learner's interlanguage system so the more likely it is to be noticed.

Perceptual salience refers to how prominent a form is in the input. The more the form stands out (for whatever reason) the more likely it is to be noticed. The opposite is also true; the less perceptually salient a form is, the less likely it is to be noticed.

Instruction the role of instruction does not necessarily lie in explaining or clarifying issues, but in how it might channel resources and bring to the learner's attention what he or she might otherwise have missed.

Individual differences in processing ability some people will be better than others at processing input and better able to notice the various forms in the input. This may be due to greater capacity for attention, or some other language analytic capacity.

Readiness: refers to what the learner's knowledge of the target language predisposes him or her to attend to. Put very simply, you can not see what you do not know. It was thought that the general language proficiency of all the subjects was more than adequate to deal with the ideas expressed in the text and would not be an impediment to noticing the anomalies.

Task demands: refers to what the language user is required to do at any given moment by the task in which he or she is engaged. Tasks which require considerable cognitive resources might mean that noticing is less likely to occur. The task presented to the subjects here was not especially demanding, although it was the final part of a five-part test lasting approximately sixty minutes.

4.7.1 Subjects used in the experiment

The fifty subjects, whose ages ranged from 18-20, had all just begun their first year of university studies in industrial chemical engineering. Their mean level of language proficiency was ALTE level 2, and prior to starting university, they had all studied English at school for an average of eight years with the minimum being seven.

4.7.2 Materials

The short text given to the subjects was a very simple piece of connected discourse. It consisted of sixty-one words containing a total of twenty-two misspelt or anomalous words. The text, together with the instructions, which were in Spanish and included a worked example, are shown below in Table 4.7

To ensure the subjects treated the task seriously, the materials were presented to the students as one of the items making up an initial test which all students are required to take.

The criteria and category for each anomalous word are shown in Table 4.3. There is some overlap between categories and some items could be placed in other categories; *cookt* or *four* for example, could just as well have been classified as ‘Pronunciation/phonological interference’. *Eigth* is in a class of its own. This is such a frequent misspelling that we were curious to see whether it would be noticed even though in the text it has very low salience.

Algunas de las palabras en el ejemplo que sigue están escritas de una forma incorrecta. Corrígelas indicando justo debajo de cada letra errónea si sobra o debe ser sustituida (y con qué letra). Indica también si falta alguna letra y cuál hay que añadir. Utiliza la forma que aparece en el ejemplo. Si hay alguna palabra que no entiendes, márcala con un círculo.

Ejemplo:

```
Spain won nine medalls in the Olympic Gaimes wich finished larst munth.
                   |                   |     |              |    |
                   ø                   ø     h              ø    o
```

John and Mary thort it wood be nice to go to dinar at a new restaurante. They

telefoned to reserv a tavle four eigth o'clock. Unfortunation the meal was bery bad.

The meat was jard to cut becos it wasn'ut cookt properly and it had two mutch sal.

Mary nife's was dirty. The vine was horrible and the serbice was slow.

Fig. 4.7. The test materials

Direct interference from L1 words	Visual interference from L1	Pronunciation /phonological interference	Grammar and morphology	Homonyms	Other common errors
dinar	telefoned	thort	wasn’ut	wood	eigth
restaurante	Vine	reserv	Mary	four	
sal		tavle	nife’s	two	
		bery	unfortunation		
		jard	cookt		
		becos			
		mutch			
		serbice			

Table 4.3. The anomalous words and their categories.

4.7.3 Results

As anticipated above it was not expected that all anomalies would be noticed, however, we did expect some items to be noticed more than others. Table 4.4 shows our predictions for each word together with the results. Column 1 shows each anomalous word. Column 2 indicates the degree to which we thought it would be noticed: 'high' indicates a high probability of being noticed, while 'low' indicates low probability. Column 3 indicates the reason for the high, medium or low rating; for example, we thought that *eigth* was not very salient so it would have a very low probability of being noticed, while *nife's* (or more precisely *Mary nife's*) was very salient and would have a high probability of being noticed. Likewise we predicted that *jard* and *becos* ('hard' and 'because') would be noticed by most subjects because these are high frequency words which should be quite familiar to them, hence these anomalies should be highly salient. Column 4 shows the number of subjects who did not notice the anomaly as indicated on their answer sheets; that is, the ones who provided no correction at all. This figure is expressed as a percentage of the total number of participants. The instructions also asked subjects to circle any word they did not understand; only *thort* was circled by one participant; i.e., 2%. Although some 'corrections' are inaccurate, they still indicate that an anomaly has been noticed and have been counted as such.

(1) *Anomalous word*	**(2)** *Probability of being noticed*	**(3)** *Reason*	**(4)** *% of subjects who did not notice the anomaly*
thort	high	same pronunciation but visually salient	40
wood	medium	same pronunciation as correct form	46
dinar	medium	L1 interference	22
restaurante	medium	L1 interference	16
telefoned	low	visual/phonological interference from L1	46
reserv	low	low visual salience	38
tavle	medium	pronunciation interference from L1	8
four	medium	same pronunciation as correct form	46
eigth	low	low visual salience	86
unfortunation	low	high familiarity with correct form	54
bery	high	pronunciation interference from L1	12
jard	high	high familiarity of correct form	16
becos	high	high familiarity of correct form	8
wasn’ut	low	low visual salience	14
cookt	low	low visual salience/same pronunciation	50
two	low	low visual salience/same pronunciation	68
mutch	medium	low visual salience/same pronunciation	20
sal	medium	L1 interference	46
Mary	High	high salience/familiarity with correct form	86
nife’s	High	high salience/familiarity with correct form	48
vine	medium	visual/phonological interference from L1	42
serbice	medium	pronunciation interference from L1	12

Table 4.4. Predictions and actual results for noticing each word.

Not all the corrections made by the subjects were correct. In the case of *wood*, two of the subjects who noticed the anomaly changed it to 'good' which suggests they were reading the text word by word as 'good' makes no sense in the context.

wasn'ut - 14% of subjects failed to spot the anomaly, while 86% did, being a far higher number than was predicted. Of the 86% (43 subjects) four of them changed *wasn'ut* to *weren'ut* which means that although 86% noticed the anomaly, only 78% gave a correct version and 22% (nearly one quarter) an incorrect one.

cookt - Exactly half of the fifty subjects noticed this anomaly. However, of the twenty-five who offered a corrected version, nineteen of them changed the word to *cook* rather than *cooked*. Put another way, only 12% of the total number of subjects were able to put the word in its correct form.

nife's - 48% of all subjects (twenty-four of the fifty) failed to notice anything wrong with this item. Of the twenty-six who did, however, sixteen of them put the missing letter k in initial position but retained the genitive 's. Only ten of the fifty (20%) rendered the word correctly as *knife*. Even this is more than the number of students who gave a fully correct rendering of 'Mary's knife'. Only 12% of the fifty (six subjects) got this right.

4.7.4 Discussion

Noticing is not only a function of the input but it is also the result of existing knowledge and processing capacities constraining what the reader can attend to. In the case of this exercise, one would have thought that after eight years instruction in English as a foreign language, the subjects' existing knowledge and preparedness; i.e., the subjects' *readiness* (see above) to notice the anomalies, would have been sufficient. Moreover, the task was straightforward and undemanding thus, plenty of attentional resources should have been available for noticing. The fact that items such as *tavle*, *bery* or *serbice* were noticed by 92%, 88% and 88% of the subjects respectively suggests that they were attending to the task (they believed, in fact, that it was part of an initial level test).

Although students will have seen the word 'wood' in other contexts, it is very unlikely they will have seen 'unfortunation' or 'cookt' or a possessive form with genitive 's affixed to the object possessed rather than to the possessor. Presumably then, they did not call on actual instances from memory, but rather applied rules when making their judgements on the well-formedness or otherwise of the items. This is somewhat speculative, but the results for items such as *wood*, *cookt*, *unfortunation* and *Mary nife's* do suggest, at the very least, a lack of familiarity with the spelling and grammatical patterns these items represent and, at worst, considerable confusion about these aspects. On the other hand, the fact that the students *understood* the words seems to bear out Baddeley's (1997: 206) point that " [...] words "are typically learned in terms of their semantic features rather than their phonological or visual characteristics". There seem to be implications here for the teaching, learning and testing of vocabulary and it is an area that deserves more research (see Chapter 10), especially in the educational context of this study.

Chapter 5

Sentence-level variables

In Section 4.4 we noted how context may be used to infer the meaning of unknown words, and in the first part of Chapter 5 we shall briefly discuss the use of context at the sentence level a little further. Following that, we shall go on to focus on the role syntax may play in comprehension.

5.1 Using context

Textbooks frequently instruct students to guess or work out from the context the meaning of unfamiliar vocabulary they come across in texts. Indeed, as stated in the annex of the *Royal Decree 3474* (29 December 2000) one of the overall objectives for language learning in *Bachillerato* is that students know how to:

> Utilizar estrategias de comprensión que permitan inferir significados de léxico desconocido a través del contexto[58].

However, our concern here is not only with using context to infer the meaning of individual words. It can also be used to work out the significance of longer elements of text such as phrases, clauses or even sentences. To give an example, as reported in her think-aloud protocol for the English text *Introduction to Materials Selection*, Student #1 was able

[58] BOE, 2001b: 1870

to understand the gist of the complete sentence shown below because she understood the beginning and the end of the sentence:

> *The advances being made in rapid prototyping, thin film and nanotechnologies, and net shape manufacturing are illustrations of the application of fundamental research to materials processing issues.*
>
> Introduction to Materials Selection, ll. 63-65.

[13] <<Esta frase la he entiendo gracias al principio y al final 'The advances being made in rapid' y luego acaba 'are illustrations of the application of fundamental research to materials processing issues' lo he entiendo porque dice que los avances han sido rápidos y gracias a la búsqueda de mat .. de proceses de materiales o algo así. Luego lo esos todo eso por lo que la búsqueda es fundamental o algo así, no lo entiendo, pero más o menos la idea sí. O sea, ha sido gracias al gracias al principio y al final de la frase, creo yo.>>

(Subject #1, *Introduction to Materials Selection*)

At the broader level, in the case of spoken language context may include intonation, facial expressions or other gestures, while to understand written materials readers may make use of headings, pictures, diagrams (as in the *Rosetta Spacecraft Design* text) or the whole text. Again, Student #1 reports using not only the local context but also the global meaning of the text to help her understand:

[14] <<No entiendo mucho la frase, pero por las frases anteriores, y por todo el texto más o menos si que entiendo lo que quiere decir.>>

(Subject #1, *Introduction to Materials Selection*)

Context may also refer to the use of background knowledge or the application of common sense and logic, and these are not the sole prerogative of advanced L2 learners. Indeed, with respect to learning a language for specific purposes (LSP), or related to a specific area, such as engineering, tourism, the theatre, medicine and so on, the domain-specific knowledge a learner brings to the subject "provides a 'window' into target language texts on that subject" (Mishan, 2005: 63), and means that learners with relevant background knowledge may be able to cope with texts that would normally be considered as being well above their estimated proficiency level (Crandall, 1995: 87).

For the moment, however, we will limit our discussion of using context to working out or guessing the meaning of a word or phrase from the immediately surrounding written text. For many readers this is not such an easy task as textbooks would have them believe.

There are several conditions which must be fulfilled for a reader to be able to successfully infer the meaning of an unknown word. Firstly, and at word-level, the reader must be able to decode the orthographical form of a new word (Ryan, 1997). For languages with similar orthographic scripts this may not cause many problems, but for learners of languages which use unfamilar writing systems there will be additional difficulties. Secondly, and at the contextual level, the learner must have a sufficiently high level of vocabulary (and other TL linguistic knowledge) to be able to understand the context.

The context, moreover, must contain sufficent clues to enable reasonable guesses to be made and possible candidates to be inferred. Additionally, any such clues must be close enough in the text to the target word for the reader to pick up on them (Huckin, Haynes & Coady, 1993; Nagy, 1997).

As an example of how difficult it is to infer an appropriate meaning for unknown words, we refer to one of the think-aloud protocols from the preliminary study reported in Chapter 7. In his protocol for the English text *Introduction to Materials Selection*, Student #2 reports 25 attempts to infer the meaning of unfamilar lexis[59]. Of these 25 items, however, he was able to derive an appropriate meaning for only 40% (10 words or phrases), while the derived meanings of the remaining 60% (15 words or phrases) were incorrect in the context. Moreover, the student seemed to be unaware that he had inferred inappropriate meanings for these items. Table 5.1 shows the words and phrases he reports as being unfamiliar and whose meaning he attempts to clarify. The first column of Table 5.1 is comprised of the source words (that is, the unknown items in the text he specifically mentions) while the second column shows the Spanish equivalent he infers. The upper part of each column shows the words and phrases to which he gives an appropriate meaning in the context in which they appear, while the lower half lists the words and phrases for which he infers an inappropriate meaning.

Student #2's inferred meanings for unknown words and phrases in the text *Introduction to Materials Selection*	
English source words and phrases	*Appropriate inferred meanings in Spanish*
standpoint	punto de vista
this approach	esta elección; una manera alternativa
candidate material	los que están a eligir
an existing facility	algo que está hecho
optimum	óptimo
ease	lo que cueste menos tempo; y sea más fácil su fabricación
advisable	es importante estimar, calcular
codes	códigos
apply	pedir algo, en ese caso utilizan
novel	nuevos
English source words and phrases	*Inappropriate inferred meanings in Spanish*
compromises	comprobar
the technical appraisal	las características técnicas
delivery	ahorrar; la menor pérdida de tiempo

[59] Although in the case of this text he was not the reader who reported most unknown lexis. Student #3 specifically reported difficulties with 41 words or phrases.

corrosion allowance	permite la corrosión; consigue paliar los efectos
seldomly	dificilmente
pressure vessel	presion; “y *vessel* no tengo ni idea”
in the creep range	temperaturas extremas
load carrying ability	“la forma de cargar?”
outstanding	puede ser estar fuera de uso
wrought heat	hechas en mucho calor
cast materials	materiales puros
weladability	maleabilidad
be addressed	apuntar a la dirección
leading	encabezando
purchasing	“no sé”

Table 5.1. Student #2’s inferred meanings for unknown lexis.

Inferring the meaning of words is also conditioned by the reader’s disposition to make the effort to search for the word’s meaning rather than simply ignore the word – the strategy which Laufer (1998) found to be the most frequently employed by learners. To illustrate how this may be a function of individual differences consider the four extracts below (numbers [15]-[18]) from the think-aloud protocols of Students #2, #3, #5 and #6. The passage to which the protocols refer is from the English text *Rosetta Spacecraft Design*. We have chosen this extract because it contains several words which were unfamiliar to the participants:

> *The Rosetta Lander has to be stowed to survive the cruise and eventually to self-eject from the spacecraft. The orbiter must navigate with 10 cm, 1 mm/sec accuracy for the ejection, and then relay data from the SSP* [Surface Science Package, mentioned twelve lines earlier in the text] *back to Earth.*
>
> Rosetta Spacecraft Design, ll. 20-22.

Student #2

[15] <<Continuemos ‘the Rosetta lander’, ‘stowed’ no sé exactamente lo que es .. no sé exactamente el significado de esto, pero bueno, lo .. el caso es que .. el Rosetta,

que .. la nave esta que va a hacer la misión .. debe estar, puede ser atado o fuertemente enganchado .. a la nave .. bueno, pues el Rosetta Lander va a ir metido en un cohete espacial, que es el spacecraft, que lo va a llevar hasta allí, y una vez a la altura a la que se encuentre cerca del .. mm .. del cometa en sí, se soltará y entonces, ya empezará su rumbo hacia allí, entonces lo que quiere decir aquí es .. que tiene que estar 'stowed to survive the cruise', que es fuerte, o que debe estar unido .. o lo que sea, para sobrevivir al viaje, y de repente, en el momento dado, 'selfeject' es soltarse libremente él mismo .. soltarse del .. de la nave, y entonces ya empezar, debe ser así, creo que estará enganchado a la nave, eh

'The orbiter' es el orbital, o .. en este caso se refiere al Rosetta lander, debe navegar con 10 cm .. de accuracy, 'accuracy' no estoy seguro ... me parece que era resistencia o .. o algo así como una resistencia de 10cm, 1mm/sec pero no sé , como no sea, o sea, una forma de medirlo para el .. para el despegue, pues es eso, o los propulsores

'and then relay data' .. y enton .. no, y después devolver datos .. [rereading], SSP, SSP es el Surface Science Package .. 'and then relay data' .. [rereading], debe de ser que .. o una de dos, o .. una vez que acabe la misión devolver los .. la información que ha cogido el SSP al .. a la Tierra, o bien, puede ser un programilla que lo mande para casa, no estoy seguro.>>

Student #3

[16] << De las siguientes frases, 'stowed' no sé lo que significa ni lo puedo deducir. 'selfeject' supongo que es .. ponerse en marcha o colocarse a si mismo, o partir, 'self-' que es a si mismo, y 'eject' que es lo que pone en la radio, que es para abrir la radio, que es ponerse a si mismo, ser capaz de ponerse a si mismo en la nave o .. algo así, o partir la nave por si misma, o salir despedida, algo así, por deducción. Y .. 'relay' tampoco sé lo que es, 'relay data', 'data' supongo que es fecha, por el valenciano, con relación al valenciano, y 'relay' no lo sé, no lo deduzco.>>

Student #5

[17] << En este punto no he entiendo .. había unas palabras que no he entendido, pero lo que es el contexto de la frase .. lo he entendido sin tener que leerla dos veces.>>

Student #6

[18] << En el tercer requerimiento no entiendo hasta el primer punto, que habla sobre el Rosetta, y el viaje sobre el cohete. Y de la segunda frase, lo de la órbita puede navegar con 10 cm no sé a qué se refiere en cuanto al movimiento del Rosetta.>>

It is clear from these protocols that Students #2 and #3 make considerable efforts to understand the meanings of any unknown words they come across and incorporate them in to their mental representations of the text. Indeed, our analysis of the students' think-aloud protocols in the Preliminary Study revealed that of the seven students who participated, Student #2 was the reader who was most disposed to expend time and effort into working out the meaning of unknown words or phrases. Students #5 and #6, on the other hand, do not seem too concerned about remaining with what is, in effect, an incomplete and underspecified representation. Student #5 appears satisfied with the level of global coherence he achieves, and perhaps this is why he leaves the focal sentence only partially processed and moves on to the next sentence. What these extracts seem to show is that not all readers are concerned about processing every word and integrating it into their mental representations of the text, providing that a satisfactory degree of global coherence has been established. This is a point we shall return to at the end of this Chapter.

5.2 Syntax

There are two issues involved here: one concerns the amount of syntactic knowledge and awareness a reader brings to the reading process, while the other refers to whether syntactically more difficult texts will be more difficult to comprehend. The main focus of this Chapter will be on the first of these questions.

Spoken language usually contains clues about how the elements of the text are put together (collocations, phrases, clauses) and the meaning relationships that exist between them. Through the use of degrees of loudness or pitch, stress, phrasing, pauses, and other prosodic contouring which support understanding, a speaker is able to give clues as to how the individual words are organized into higher ‘units of meaning’ or ‘sense units’ (Nuttall, 1982), something which the spaces between written words do not indicate and the reader must work out for him or herself. The research suggests that good readers encode not at the level of individual words but in sense units or phrasal units (Levin & Kaplan, 1970) and, moreover, impose an intonation pattern (Cohen & Freeman, 1978), even when reading silently (Coltheart, 1978).

In order to establish the meaning of a sentence, therefore, the reader not only has to understand the meanings of words, he or she must also take into account the relations holding between them. While for individual words, the literature talks of ‘recognising’, ‘accessing’ or ‘activating’ some kind of previously ‘stored’ representation, with respect to the relations between them, the terminology used refers to ‘processing’ or ‘computing’ these relationships (Garman, 1990).

How does the reader work out the relationships between words, and what sort of relationships do we need to know?

From the 1970s to the early 1990s much of the research in sentence processing (e.g. Bever, 1970; Frazier, 1978; Frazier & Fodor, 1978) assumed that the syntactic processing of a sentence not only preceded semantic processing but was separate from it (Fodor, 1983). There was a widespread assumption (at least in L1 research) that syntactic processing was both an automatic and a fast process. According to Levelt (1978: 49), “The initial part of any sentence comprehension consists of deriving a complete underlying representation of the sentence”, while Garret apparently remarked that “What you have to remember about parsing is that basically it’s a reflex”, which Fodor (1983) described as “the deepest remark” he had heard about the psychological mechanisms mediating speech perception. “Most theories of sentence processing”, writes Frazier, (1998: 126) “incorporate the claim that parsing is both fast and grammatically controlled”. Thus, as McKoon & Ratcliffe (1998: 30) point out, most research into sentence processing assumed that comprehension processes produced “a correct and complete syntactic interpretation of a sentence”.

We wonder whether this claim has its root in Chomsky’s (1965: 3) statement that:

> Linguistic theory is concerned with an ideal speaker-listener, in a completely homogeneous speech-community, who knows his language perfectly and is unaffected by such grammatically irrelevant considerations as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language in actual performance.

Whatever its origin, it is clear that second language learners can not be classified as ‘ideal’ users of the language and nor do they inhabit homogeneous speech-communities. Nor, in fact, do all native speakers know their language perfectly. Quite apart from individual differences in vocabulary knowledge, there is considerable evidence for individual differences in, for example, the ability to cope with syntactic ambiguity (Cupples & Holmes, 1992; Pearlmutter & MacDonald, 1995); in the ability to cope with decreases in syntactic predictablity (Graesser, Hoffman & Clark, 1980); in the ability to assign constituent structure (Cupples & Holmes, 1987; Huey, 1908/1968; Levin & Kaplan, 1970) or in the abilty to judge grammatical acceptability (Spencer, 1972). Moreover, there is evidence that some native speakers of English "do not spontaneously assign a phrasal organisation to text as they read" (Cupples & Holmes, 1987: 180), and the research also suggests a relationship between level of education and grammatical skill (Geer, Gleitman & Gleitman, 1972; Dabrowska, 1997).

As with other highly skilled activities, we might expect the expert knowledge and training of native speakers (who have received so much more exposure to print) to result in faster and more automatic processing (Ericsson & Kintsch, 1995). Greater syntactic knowledge should increase automaticity in recognising syntactic structures which, in turn, should free up processing time and allow more resources to be devoted to meaning. Nevertheless, if even native speakers can find it problematic to resolve the syntactic relations between the component words of sentences, these difficulties are going to be that much greater for learners of the language.

Alderson (2000), referring to research by Flores d'Arcais (1990) and Mitchell, Cuetos & Zagar (1990), points out that syntactic parsing strategies may differ across languages, while Cowan (1976) suggests a *parallel processing theory* of reading in which he claims that the strategies readers use to process texts must be in some ways language-specific. Thus, a reader's L1 will create certain expectations regarding the syntactic structure of a sentence in the second language – which may cause slower reading as well as comprehension difficulties. If this is the case, it seems reasonable to suppose that learners at lower proficiency levels will apply their L1 syntactic rules to the language they are learning more often (and more inappropriately perhaps) than at higher levels.

Devine (1988: 270), citing research by Berman (1984) and Cooper (1984), comments that:

> [...] it is specifically the lack of syntactic knowledge that prohibits readers from successfully comprehending L2 texts.

although she does not mean to imply that this is the only factor. General proficiency in the target language is also important. However, Devine (1988: 271) goes on to say that:

> [...] almost all beginning-level second language readers are simply incapable of handling the syntactic complexities of unaltered L2 reading materials [...] syntactic processing no doubt accounts in large measure for the slow reading rate of L2 learners.

In somewhat of a contrast, Ulijn & Kempen (1976) in a study with native speakers of French, and Dutch speakers learning French, asked both groups to read a text about finding one's way around an imaginary town. The text, which was written in French, existed in two versions: one with syntactic structures found in both French and Dutch, while the other included French syntactic structures not found in Dutch. Contrary to what one might expect, there was no difference in the French or Dutch readers' responses to the text and Ulijn & Kempen (1976: 499) conclude that:

> Under normal conditions reading comprehension is little dependent on a syntactic analysis of the text's sentences. It follows that second language reading comprehension is possible without mastery of the contrasting parts of the second language's syntax. Usually, the reader's conceptual knowledge will compensate for the lack of knowledge about linguistic contrasts between L1 and L2.

We should note, however, firstly that Ulijn & Kempen's subjects had had "considerable exposure" to the target language, so they may well have had sufficient mastery of French syntax to deal effectively with the task given them. Secondly, it may be the case that processing L2 written materials does not need a *thorough* knowledge (i.e., mastery) of the L2 syntax. Just as we can describe learners as having a receptive and productive knowledge of vocabulary, we may also be able to differentiate receptive and productive syntactic knowledge. In fact, one of Carroll's (1965; 1991) four sub-components of language aptitude is *grammatical sensitivity*, which refers to a reader's (passive) understanding or ability to recognise the contribution a particular word makes to the propositional content of a sentence, rather than to the ability to analyse sentences explicitly.

Although Kintsch & Vipond (1979) found that young children learning to read their L1 benefitted from shorter syntactically simplified sentences (which presumably were more in accord with their developmental stage[60]) this may not be the case for adults reading in their L2. Blau (1981), in a study with adult second language readers, found that short, grammatically simple sentences may interfere with comprehension and that readers seemed "to benefit from the information regarding relationships that is revealed by complex sentences" (p. 525).

Ulijn & Kempen (1976) and later Strother & Ulijn (1987) appear to relegate syntax to a minor role in comprehension, concluding that readers use a 'conceptual strategy' when processing texts, drawing on knowledge of lexis and background knowledge of the text topic.

[60] Palermo & Molfese (1972), for example, concluded that children's ability to understand syntactic structures improves until they are at least thirteen years old.

5.2.1 Definitions of syntax

As with the term 'decoding', there are different views about how to define 'syntax'. Horrocks (1987: 24), for example, includes aspects of meaning:

> Syntax is concened with the principles according to which words can be combined to form larger meaningful units, and by which larger units can be combined to form sentences.

While Crystal (1997: 94) offers a definition of syntax which takes how units are combined beyond the level of individual sentences. Syntax, he says, is "the way in which words are arranged to show relationships of meaning within (and sometimes between) sentences". Urquhart & Weir (1998: 60) believe that the conventional or "commonsensical position", as they call it, is that some kind of syntactic parsing is necessary in order to relate the different words in a sentence to each other. However, along with many other researchers into second language reading (which, after all, has been principally concerned with the extraction of meaning[61]), their understanding of what is involved in syntactic processing includes drawing on other kinds of information, including lexical and semantic. And, as Alderson (1993: 218) points out: "the ability to manipulate form without attention to meaning is of limited value and probably rather rare".

Thus, within both L2 and L1 research (e.g., MacDonald, Pearlmutter & Seidenberg, 1994; Trueswell, Tanenhaus & Garnsey, 1994) there has been a move away from the traditional viewpoint, so that the processes involved in computing syntactic relationships make use of constraints from, for example, semantic information, as well as drawing on knowledge

[61] Both Urquhart & Weir (1998) and Bernhardt (1991) note with some surprise that there is relatively little research on the relationship between second language reading ability and syntactic processing.

about the frequency with which syntactic structures occur in the language. Indeed, there is considerable evidence, as Oller (1979: 25) pointed out some time ago, to suggest that:

> [...] as organizational constraints on linguistic sequences are increased, ease of processing (whether perceiving, producing, learning, recalling, etc.) increases at an accelerating rate, almost exponentially. It is as though our learned expectations enable us to lie in wait for elements in a highly constrained linguistic context and make much shorter work of them than would be possible if they took us by surprise.

In other words, the more syntactically predictable a sequence of linguistic elements is, the easier it is to process.

5.2.2 Three principles for input processing

Returning to second language research, Gass & Selinker (2001) have recently suggested that, when attentional resources are limited, semantic comprehension will take priority over syntactic features of the language, although they note that form is “an ultimate goal of language learning” (Gass & Selinker, 2001: 317). In a similar vein, VanPatten (1996) proposed that when there is competition for limited cognitive resources, “learners process input for meaning before they process it for form” (p.14). One of the main assumptions of VanPatten’s input processing model is that “learners are driven to look for the message in the input before looking for how that message is encoded” (VanPatten, 1996: 17). In other words, until proficiency in the second language has reached an adequate level, learners can not attend to both meaning and form and meaning is given precedence.

VanPatten (1996: 14) proposes three principles for input processing:

Principle 1:

Learners process input for meaning before they process it for form.

- Learners process content words in the input before anything else.
- Learners prefer processing lexical items to grammatical items (e.g. morphological markings) for semantic information.
- Learners prefer processing more meaningful morphology before less or non-meaningful morphology (e.g. simple past regular endings before verbal agreement).

Principle 2:

For learners to process form that is non-meaningful (e.g. third person ~s), they must be able to process informational or communicative content at no or little cost to attentional resources.

Principle 3:

Learners possess default strategies that assign the role of agent to the first noun (phrase) they encounter in a sentence.

But:

- The first noun strategy can be overridden by lexical semantics and event probablities.
- Learners will adopt other processing strategies for grammatical role assignments only after their developing system has incorporated other cues (e.g. case marking, acoustic stress).

We noticed, quite by chance, that our students do in fact appear to operate along the lines outlined in VanPatten's three principles (that is, they tend to give meaning preference over form) and a small experiment was devised to explore this possibility further.

5.2.3 Testing comprehension through translation

Translation from L2 to L1 has been reported by Buck (1992) to be a method of testing reading comprehension as effective as more traditional methods. Indeed, it seems reasonable to assume that a translation from L2 to L1 will reflect what is understood (e.g. Parks 1982; Urgese 1989), and we were interested in exploring the possibility of using it in conjunction with other means of evaluating comprehension. As to the criteria for deciding whether a translation were acceptable or not, and bearing in mind that our students are not studying to be professional translators, we decided that the most important feature would be how the translation reflected understanding of the ideas in the source text and not necessarily how well all the language components of the text (lexis, syntax, genre, style, etc.) were realised. In other words, we gave more credit to informational correctness and completeness than to purely linguistic aspects.

One of the L2 texts we used in a small pilot study was a short extract from the English text *Rosetta Spacecraft Design*. This text was also used in the experiment reported in Chapter 7 although with different students. The text is reproduced in full in Appendix C3. The purpose of the Rosetta mission is to rendezvous with a comet in around the year 2014 and carry out measurements and analysis. One of the characteristics of the mission is that it will require:

> Complex spacecraft navigation at low altitude orbits around an irregular celestial body with weak, asymmetric, rotating gravity field, enveloped by dust and gas jets.
>
> *Rosetta Spacecraft Design*, ll.17-18.

This sentence is made up of five noun phrases:

- Complex spacecraft navigation
- low altitude orbits
- irregular celestial body
- weak, asymmetric, rotating gravity field
- gas jets.

One single noun:

- dust.

And one verb phrase:

- enveloped by,

which are marked by the function words ‘at’, ‘around’, ‘an’, ‘with’, ‘and’. We may also note that the comma after ‘field’ serves to separate two clauses while the commas after ‘weak’ and ‘asymmetric’ mark the first and second adjectives in the sequence describing ‘gravity field’.

One of the students participating in the pilot study translated the first noun phrase in this sentence (‘Complex spacecraft navigation’ where both ‘Complex’ and ‘spacecraft’ function as adjectives describing ‘navigation’) as *La navegación de naves espaciales complejas*. Apparently the student was satisfied that ‘complex spacecraft’ constituted a complete noun phrase and for this particular semantic-syntactic unit had not taken the analysis further. We wondered whether more students would do the same.

The extract above, as well as all the text preceding it to provide context, was given to fifty second- and third-year undergraduate students of mechanical engineering whose proficiency level in English ranged between the CEF levels A2 and C1 (ALTE levels 1 and 4) with a mean level of B1 (or ALTE level 2, which is described as ‘lower intermediate’). In fact, the group’s mean score (of 30.0) was only one point below that of the next ALTE level which is labelled ‘upper intermediate’ (see Section 2.3 for further explanation of the CEF and ALTE levels). All the individual words in the sentence were familiar to the subjects in the sense that they could give a Spanish equivalent when the words were presented individually in a random list; i.e., not in the order in which they appear in the sentence above. As we have seen (in Section 4.5), being able to provide an equivalent word in one's L1 does not indicate the depth of knowledge of the L2 word. As well as reading the preceding text, the background to the mission was explained to the students (i.e., that the purpose was to send a probe to land on the surface of the comet and relay data back to Earth). Subjects were then asked only to translate the target sentence into Spanish; we thought that this would show what ideas they had understood. The results are shown below, with the sentences numbered [i] to [viii] being examples of typical student sentences.

With respect to the first idea, that of 'complex spacecraft navigation', 20% (ten students of the fifty) maintained the idea of navigation being complex, 8% (four students) did not mention 'complex' at all, while 72% (thirty-six) assigned 'complex' to 'spacecraft' and not to 'navigation' so that the idea became:

[i] *La navegación de una compleja nave espacial ...*

There were some variations within this: 'spacecraft' was interpreted as plural by two subjects who thus referred to:

[ii] *Una compleja flota de naves espaciales*

while others referred to:

[iii] *Una compleja nave espacial de navegación ...*

19% interpreted 'navigation' as a verb and wrote for example:

[iv] *Una nave espacial compleja navega en órbitas de baja altitud ...*

[v] *Nave espacial compleja navegando con orbitas de altitud baja ...*

Things become more complicated if we go further: 46% interpreted 'orbits' as a verb:

[vi] *La compleja nave espacial a poca altitud orbita alrededor ...*

Finally, the adjective 'weak' was understood as referring to the celestial body (8%) or to the action of navigating (2%) instead of to the gravity field:

[vii] *Nave espacial compleja navegando con una orbita de altitud baja, alrededor de un debil cuerpo celeste irregular ...*

[viii] *Una compleja nave espacial, navega debilmente ...*

What this seems to indicate is that students have not recognised some of the complex noun phrases for what they are; namely, higher units of organisation of meaning within the sentence, and they have assigned different lexical-syntactic functions to some of the sentence elements.

On the other hand, both 'complex spacecraft' and 'complex navigation' are lexically and semantically possible. We wondered how much interference this might have caused, so the same task was given to a different group of fifty subjects with the same average proficiency level as the first group, measured in the same way. For this group the first word of the source sentence was changed from ‘Complex’ to ‘Difficult’ so that it became:

> Difficult spacecraft navigation at low altitude orbits around an irregular celestial body with weak, asymmetric, rotating gravity field, enveloped by dust and gas jets.

Analysis of the students’ sentences showed that this time although 4% (two subjects) did not mention navigation at all, 96% (forty-eight subjects) assigned ‘difficult’ to navigation. A typical sentence was:

> [ix] *Dificil navegación espacial en órbitas de baja altitud ...*

However, the number of students who interpreted both ‘navigation’ (18%) and ‘orbits’ (44%) as verbs was very similar to the first group. Typical translations were:

> [x] *Dificilmente el transbordador espacial navega ...*

> [xi] *Difícil navegación espacial a baja altitud orbita alrededor ...*

A summary of the results from both the ‘Complex Group’ and the ‘Difficult Group’ is shown in Table 5.2. The first column shows the ‘action’ carried out by the participants. The second column shows the results for the group who worked on the ‘Complex’ text (i.e., the text which maintained the original wording), expressed as a percentage of the total number. The third column shows the results for the second group who worked on the ‘Difficult’ text (i.e., the modified text). Thus, for example, 20% of the students in the first group correctly assigned ‘complex’ (the first adjective in the text) to navigation (which means that 80% did not, either assigning it to spacecraft or omitting it altogether). 96% of the second group, however, correctly assigned 'difficult' (the first adjective in the text) to navigation (with only 4% not mentioning it).

Relationship or function	Text 1 'Complex ...'	Text 2 'Difficult ...'
	%	%
first adjective correctly assigned to 'navigation'	20	96
first adjective not mentioned	8	4
first adjective incorrectly assigned to 'spacecraft'	72	0
'navigation' interpreted as a verb	19	18
'orbits' interpreted as a verb	46	44
'rotating' interpreted as a verb	14	4
'weak' assigned to 'celestial body'	12	8

Table 5.2. Summary of the results for both Sentence 1 ('Complex ...') and Sentence 2 ('Difficult...').

Kleiman (1975) suggests that as readers advance through a text they evaluate the word strings in order to decide whether a phrase has been completed or not. The information contained in the phrase is then collapsed into a composite idea which is held in memory while the reader progresses to the next phrase or syntactic unit. Accomplished L1 readers can usually recognise quite easily and rapidly higher units of organization of meaning within a sentence (such as noun phrases), and pick up on the clues offered by punctuation, semantics and syntax and thus read with an appropriate intonation pattern. These clues are not always noticed by second language readers who have had less exposure to written materials in the second language and are less aware of how a sequence of words may be structured.

Returning to the two alternative first position noun phrases, semantically speaking it is perfectly reasonable to have a 'complex spacecraft' but not a 'difficult spacecraft' (Although not impossible. Machines *can* be difficult as the staff of the Applied Linguistics Department of the British University where the following notice appeared can testify: *Remain calm at all times when using this photocopier. Showing anger or frustration will only result in it becoming more difficult*).

Presumably, in each of the first two noun phrases ('Complex spacecraft navigation' and 'low altitude orbits') only the first adjective in each case has been recognised as such. 'Spacecraft' and 'altitude' respectively have been assigned the role of nouns and the analysis has concluded that *Complex spacecraft* constitutes one sense unit and *low altitude* another. Both 'navigation' and 'orbits' have been interpreted as verbs (not unreasonable given that in English a noun is often followed by a verb) and as part of a different syntactic or sense unit.

In fact, it is relatively easy to see how the final 's' of 'orbits' could be confused with the third person verb ending. Perhaps (although this is speculation), L1 Spanish readers selectively pay more attention to verb endings than L1 English readers because in Spanish, subject information is frequently carried in the verb. This means that, compared to English, subjects or subject pronouns are less salient and their omission more likely to go unnoticed. Perhaps this can account for the following two student sentences, taken from the small study described earlier, both of which show some internal incoherence. Accents, where they were missing in the originals, have not been added:

[xii] *Navegación espacial dificultosa a baja altura orbita alrededor de un cuerpo celestial irregular con un campo de gravedad rotatorio, asimétrico y débil y envuelto por polvo y gas.*

[xiii] *La dificil navegación de la nave espacial a baja altitud orbita alrededor de un cuerpo celestial irregular con un débil y asimétrico campo de gravedad, envuelto en polvo y gas.*

It is more difficult to see how 'Navigation' could be taken as a verb because the form of the word corresponds so closely to the Spanish noun form *navegación*. In both groups, almost one fifth of the students have failed to take account of the morphemic structure of the word. Perhaps this shouldn't surprise us so much: we have already noted (in Section 4.2) how second language learners may lack sufficient language resources (including morpheme identification rules) to process these aspects, preferring, as VanPatten says, lexical rather than grammatical information. Gass (1997) suggests that during *spoken* interaction, semantic comprehension occurs prior to syntactic comprehension, and that if a word is understood in the context its morphological characteristics take second place as regards meaning. This may be what has occurred here with a written sentence.

Below are four more examples of student translations, all of which show similar internal inconsistencies to sentences [xii] and [xiii] above. They are reproduced here as written:

[xiv] *Una capsula espacial navegaba con dificultades a baja altitud con una orbita irregular alrededor de un cuerpo celestial durante una semana, asimetricamente, rotando gravitatoriamente, envuelto de polvo y gases.*

[xv] *Dificultad de navegacion espacial en orbitas de baja altitud alrededor de un cuerpo celestial irregular, con debilidad, asimetrica, campo gravitatorio rotatorio, envuelto por polvo y gas.*

[xvi] *Dificiles navegaciones espaciales a bajas órbitas de altitud de un cuerpo celestial irregular con una débil, asimétrica, rotación de lo gravedad, envuelto por polvo y gases.*

[xvii] *Navegación dificultosa espacial con baja altitud de las orbitas alrededor de un irregular cuerpo celeste con*

> *débil, asimetrica, rotando el campo gravitatorio, envuelto por polvo y gases.*

What is interesting in these examples from the point of view of reading comprehension, is how to account for why readers have failed to detect these inconsistencies which, moreover, are not distant from each other in the text, but occur in adjacent or nearly adjacent clauses. On one hand, they could be the result of *production errors*; that is, mistakes in writing down what had been understood. This seems unlikely, however. Firstly, because the students were all native speakers of Spanish and there is no reason to suppose that they would be unable to express their thoughts inadequately in their L1. Moreover, no time limit was imposed on the task, and students were instructed to read through what they had written and, if necessary, re-write it before handing it in. Thus, students were provided with the opportunity to check their work and encouraged to do so. Despite this, they have failed to detect what seem fairly obvious inconsistencies, even when *reading* (or *re-reading*) their own sentences in Spanish.

Bensoussan & Rosenhouse (1990) distinguish between mistranslation and misinterpretation. They argue that the former occurs on the micro-level and can be the result of time pressures, text difficulty or the translation method used. Misinterpretation, on the other hand, shows lack of understanding of the source text. We think that the errors and anomolous sentences in our study suggest lack of understanding rather than production errors involved in translating.

How does the lack of understanding, or miscomprehension, arise? Assuming, along with Alderson (1993: 219), that:

> It must be the case that, in some intuitive sense, a reader must process the grammar in a text in order to understand it [...] the evidence certainly does not support the claim that one can successfully understand text without grammatical ablities [...],

several answers to this question present themselves.

Firstly, even though the reader may very well process the grammar, this does not mean that the result will be the most appropriate. As with depth of vocabulary knowledge (see Section 4.5.2), the processing of syntactic relations is not simply a question of whether the reader understands the grammatical relations or does not. What a reader knows about any given syntactic structure will vary along a continuum ranging from 'complete familiarity' to 'unknown'. If the grammatical organisation of a particular sequence of words is unfamiliar to the reader it will be harder to manipulate (Oller, 1979: 25).

Secondly, there may well be interference from the reader's L1 in terms of the reader's expectations about the internal structure of the sequence.

Thirdly, grammatical knowledge and skill in syntactic processing may be drawn on to a greater or lesser degree; more if we are engaging in careful reading, less if we are processing the text expeditiously. Individual differences between learners may also be a factor, with some learners tending to focus more attention on form, while others give it less. Raising awareness of form has been found to be beneficial for comprehension (Nuttall, 1996; Urquhart & Weir, 1998).

Finally, when processing syntax, the L1 reader usually has a definite advantage over the L2 reader. The essence of syntactic processing is that the reader is working towards determining the interrelationships between the lexical elements of the sentence. However, L2 readers, especially those at the lower levels of proficiency, may not possess enough attentional resources to simultaneously focus on both form *and* meaning, and thus concentrate their attention on the text element carrying the highest communicative load; namely lexical items (VanPatten, 1996). Native readers and more advanced L2 learners, on the other hand, will probably not need to devote extra cognitive resources to understanding the meaning of words or to identifying lexical units (e.g., *low altitude orbits* as opposed to *low altitude* and *orbits*, or that *complex* refers to *navigation* and not to *spacecraft*), and will also be more familiar with a wider and more complex range of grammatical patterns. They are, therefore, more likely to be able to extract meaning from both syntactic and morphological (as well as semantic) information (Klein, 1986; VanPatten, 1990, 1996).

In sum, the degree of familiarity with the form and/or similarity between L1 and TL syntax, as well as the degree of attention paid to form, and the ease with which lexical elements are identified, will constrain how the reader handles the syntactic relations between the sentence elements.

There may, however, be a further constraining factor. In Chapter 3 we made the assumption that one of the goals of reading comprehension is to establish a coherent mental representation of the text which is free of logical inconsistencies. Yet in many of the example sentences above, if the readers were meticulously processing each idea before integrating it into the memory representation, they would have detected any anomalies (for example that navigation, an abstract noun, is the subject of the verb ‘orbits’). Thus, readers appear to have given priority to local coherence rather than to global consistency. The apparently good ‘fit’ of, to take one example, ‘Complex spacecraft’, has pre-empted further processing of the semantic-syntactic unit in which it appears, and the reader has assumed that it will be coherent with the whole. Thus, having achieved what was considered a reasonable rendering, some elements of the sentence have not been processed further, or have not been integrated into the mental representation of the text.

This would seem to confirm the findings discussed at the end of Section 5.1. where it appeared that partial processing of a text is acceptable provided what is understood fits in sufficiently well with the overall gist of the text. In other words, elements of a sentence, ranging from words to whole paragraphs, may be skipped if the reader is satisfied he or she has achieved a satisfactory global comprehension of the text – and if comprehension of local elements can not be achieved. From the discussion in Section 5.2, on the other hand, it seems that readers also engage in partial processing by giving precedence to local coherence (at the sentence, clause or phrase level without even integrating the meaning of adjacent clauses) and assume that global coherence will follow.

In fact, as anyone who reads or has read in a second language knows, the comprehension system is quite capable, and frequently has no option, but to produce a representation of the text which is incomplete and where details are underspecified. Thus, both behaviours may be regarded as fairly 'standard' in second language reading, and neither are they mutually exclusive. The problem is that they both may lead to misunderstanding. According to Gernsbacher's (1990) Structure Building Framework the initial process of comprehension (whether this be listening or reading) involves laying down a foundation onto which subsequent information is mapped in order to develop a mental representation of the content of the text. What provides the foundation, says Gernsbacher (1990: 10) are the *initial* words or sentences. Thus, to go back to our sample text, if *complex spacecraft navigation* is understood as *the navigation of complex spacecraft* and not *the complex navigation of spacecraft*, the whole meaning of the passage is thrown askew.

The question is, whether readers can be trained to read more strategically and hence overcome, or circumvent, some of the problems arising from partial comprehension. Before, reporting on our attempts to train students in this way, we discuss, in the next chapter, some of the processes which may be used by readers at the discourse level. Specifically, inference generation, the use of comprehension monitoring and knowledge of text structure.

Chapter 6

Discourse-level variables

> It is quite correct that printed texts consist of a sequence of sentences, and that oral conversations consist, more or less, of a sequence of spoken utterances. However, discourse cannot be entirely reduced to sentences and utterances. Discourse has a context, cohesion, coherence, and rhetorical structure that weaves together and transcends the sentences/utterances [...] These levels all impose meaning and structure on individual sentences (or utterances) that go well beyond the compositional meaning of sentences in isolation.
>
> Graesser, Gernsbacher & Goldman (2003: 3)

6.1 Introduction

This Chapter is divided into two parts. In the first part (Sections 6.2 – 6.4), we look in general terms at inference making and comprehension monitoring, two of the 'higher level' skills involved in the integration of information and ideas across sentences and from different sections of a text, while the knowledge variable we consider is knowledge of text structure. These three aspects of reading are important for comprehension because they help the reader to construct an integrated and coherent model of a text's meaning (Cain, Oakhill & Bryant, 2004).

We begin the second part of the Chapter (Section 6.5) by exploring these issues with reference specifically to expository texts. First, we will look at some of the general characteristics of expository texts and then discuss why it is that the "comprehension of expository text is more difficult for virtually all students" (Williams, 2002: 1), focusing, in particular, on the features of expository texts which make inference making and comprehension monitoring difficult for both L1 and L2 readers, as well as on the ways in which these features influence how they are processed .

In addition, there are two other important characteristics of the texts used in this research which we would like to discuss in this Chapter. The first (Section 6.6) is their *authentic* nature. During the last thirty-odd years there has been considerable debate and controversy in the second language teaching-learning community not only over what the term 'authentic' means when applied to language learning materials (where *materials* = text + task), but also over whether authentic materials, as opposed to purpose-written ones, should be used at all (Mishan, 2005). The intricacies of the debate over the meaning of the term need not concern us here. For our purposes, and in the context of reading comprehension, an 'authentic' text means that it has been drawn (generally) from existing resources, that its linguistic features have not been simplified, that it has been written for a genuine communicative purpose and that it and any accompanying tasks reflect realistic reading activities requiring real world language skills and communicative interaction. A view based squarely on the position adopted by the Council of Europe in the *Common European Framework of Reference for Languages*, as well as by the ACTFL, ALTE, IELTS, and the University of Cambridge Local Examinations Syndicate (see Chapter 2 for further discussion of these aspects).

The second issue (Section 6.7) concerns the mode of presentation of the texts to the students. Of the ten training texts used in this research, five were presented in hard copy format (i.e., on paper) and five were presented electronically (i.e., on a screen), while the two target texts were both presented on paper. Electronic texts present particular problems to learners, nevertheless, students must acquire electronic literacy if they are to be able to cope with the academic and professional demands of their chosen fields. As LeLoup & Ponterio (2000: 1) point out:

> With the focus on language, communication, and culture in [...] foreign language learning [...] foreign language teachers are continually searching for better ways of accessing authentic materials and providing experiences that will improve their students' knowledge and skills in these target areas. The Internet has transformed communication around the world, it is natural that it should play a major role in the foreign language classroom.

Some discussion of the differences between processing texts in electronic format and processing hard copy texts seems warranted therefore, and we deal with some of these aspects in Section 6.7.

6.2 Inference making

Inference making ability "is a valuable component skill of reading comprehension" (Cain & Oakhill, 2003: 320) because texts do not always contain all the information necessary to understand them. In fact, if the author of a text explicitly gave all the information necessary to understand a piece of text the result would be "grindingly specific", to use a beautifully descriptive phrase from Garman (1990). Generating inferences, therefore, are often a necessary and normal part of reading, and aid in the construction of the meaning-based representation of the text (Hannon & Daneman, 2001; Pressley, 2000). In this respect, inference making may serve several purposes:

(i) to connect ideas contained in different parts of the text – be they in separate clauses, sentences or paragraphs,

(ii) to relate information in the text to background knowledge in order to fill in details, and

(iii) to go beyond what is explicitly stated in the text in order to establish a situation model.

Thus, inferences may be necesary to establish global coherence between different situations or ideas in a text or to establish local coherence between adjacent clauses or sentences (Graesser, Singer & Trabasso, 1994; Long & Chong, 2001).

Inference making may also involve the reader applying common sense or logic as well as integrating background knowledge with information in the text. However, in order to make inferences, a reader must possess sufficient background knowledge to begin with (Barnes, Dennis & Haefele-Kalvaitis, 1996), and the converse is also true, a deficit in domain knowledge may be a cause of low inference generation. Nevertheless, the mere possession of sufficient background knowledge is no guarantee that comprehension will take place or even that readers will make the required inferences. Readers must make the necessary connections and associations from their existing experience and knowledge but they will do so only if they are sufficiently interested in the topic or motivated for some other reason (for example, to pass an exam). For this reason the context of the reading situation is important. The operations engaged in and the amount of analysis carried out depend to some extent on the degree of attention which are given to these activities (Mathewson, 1994), and the level of control readers have over their own processes may directly affect their capacity to understand a text and learn from it (Horiba, 2000).

Furthermore, in a second language reading situation, even familiar ideas and concepts contained in the text may be 'muddied', as it were, by the unfamiliar lexical or syntactic ways in which these are expressed. As a result, even though the reader may have sufficient subject-matter knowledge, he or she may be employing so much attention to simply understanding the words or the relations between them that important associations are missed or connections with existing knowledge are not made.

Failure to generate inferences or making inferences which are not in accord with the author's message may result in a breakdown in communication between the reader and the writer which, according to Mateo Martínez (1999: 49-50):

> Es un problema con el que se encuentran muchos estudiantes [de lenguas extranjeras] de casi todos los niveles que sólo comprenden el nivel superficial del enunciado en otra lengua, siendo incapaces de inferir significados reales pero ocultos, matices irónicos y demás mecanismos de significación que se esconden detrás de las palabras.

Many different classes of inference have been identified and several taxonomies of inferences can be found in the literature, but although the various types go under different names there appears to be general agreement as to how they operate. For example, both van den Broek, Fletcher & Risden (1993) and Trabasso & Magliano (1996) have broadly similar classifications:

van den Broek et al. (1993)	*Trabasso & Magliano (1996)*
backward inferences	explanations
forward elaborations	predictions
orthogonal elaborations	associations
associations	

Backward inferences (or explanations) connect the focal sentence; i.e., the phrase or proposition that is currently being read, with information or events which have occurred previously in the text or with prior thoughts in order to find causes or satisfy anaphoric references. Thus, backward inferences, which are also called bridging inferences (Schmalhofer, McDaniel & Keefe, 2002; Singer & Halldorson 1996) are used to connect different clauses, sentences, or sections of text (McNamara, 2004).

Forward elaborations (predictions) predict ideas or events which are going to occur in the text. They establish possible reasons for the relevance of the focal statement.

Horiba (2000) makes the point that both elaborations and associations draw heavily on background knowledge. She also makes a useful distinction between them. Elaborations, she says, occur when the reader embellishes or adds to the information in the text with implicit or associated information; in other words, when the reader adds details to the situation model or microworld being constructed. Associations, on the other hand, occur when the reader activates related knowledge but without necessarily embellishing or developing the situation model.

It appears that backward inferences or explanations are very frequent in normal reading. Graesser, Millis & Zwaan (1997: 183), report that: “most readers (and good comprehenders in particular) generate more explanation-based inferences than predictions and associative elaborations”, and this seems to be true for different kinds of text including expository technical texts. Moreover, recent research suggests that related information may be activated in LTM regardless of its relevance to the text topic:

> [...] concepts and propositions in WM appear to activate related information in LTM irrespective of the information’s relevance to the developing discourse represention.
>
> (Long & Lea, 2005: 283)

Thus, the processes whereby incoming information in the text activates related information (concepts or propositions) in WM or in LTM, could be triggered by automatic, passive, bottom-up processes (Gerrig & McKoon, 1998; McKoon & Ratcliff, 1998), as well as by the reader carrying out an active search of LTM (Graesser, Singer & Trabasso, 1994; Long, Seely & Oppy, 1996). It is also possible that newly activated information itself triggers the activation of further information through either automatic processes, strategic processes or both (Linderholm et al., 2004). Such information is then available for the reader to use in making sense of the text being read, although this does not mean that associated, elaborated or predicted information generated during reading will necessarily be *integrated* into the reader's LTM (Cook, Limber & O'Brien, 2001). Indeed, according to van den Broek (1994), predictions and associations will only be generated by the reader when he or she is motivated to do so, interested in the topic or has sufficient background knowledge to do so.

6.3 Comprehension monitoring

Comprehension monitoring is an aspect of metacognition that concerns a reader's ability to evaluate his or her understanding of a text, to detect contradictory information, statements that conflict with background knowledge, or information which is anomalous in some other way. When readers ask themselves whether, and how, what they are reading fits in with what they already know about the topic, they are monitoring their comprehension (Pearson & Fielding, 1991). The evidence from L1 reading suggests that comprehension monitoring is largely an automatic process of which readers are unaware unless or until a breakdown in comprehension occurs (Alderson, 2000), although van Oostendorp (2002: 309) makes the point that, when reading scientific text: "Readers often do not adquately control their comprehension and consequently miss errors".

Ideally of course, readers do not simply monitor their comprehension to see whether they have understood or not, they also take the necessary steps to resolve problems which are detected. The control of comprehension, therefore, is carried out in two stages: evaluation and regulation (Baker, 1985a; Otero & Campanario, 1990). In the evaluation stage, the reader detects the problem, while in the regulation stage the reader applies a (suitable) strategy – such as rereading the text, inferring the meaning of unfamiliar vocabulary, making connections to what he or she already knows or to other parts of the text – in order to resolve the difficulty. The term *self-regulated reading* (e.g., Hacker, 1998), rather than comprehension monitoring, has been proposed to highlight the importance of both processes.

Thus, comprehension monitoring may also involve knowledge of appropriate repair strategies to deal with breakdowns in comprehension. Once readers become aware that their comprehension is inadequate, they can take the appropriate steps to remedy the situation, provided they have the knowledge to do so. Readers need to know, therefore, not only how and when to apply repair strategies, but also which ones might be the most effective in any given situation. A further factor which might influence monitoring and strategy use could be the degree of interest the reader has in the task (de Sousa & Oakhill, 1996) or topic.

Perfetti, Moran & Foltz (1996: 144) point out that "[...] comprehenson cannot be monitored or evaluated if no comprehension has taken place", while Rubman and Waters (2000) argue that effective comprehension monitoring can only take place if the reader is able to construct a coherent representation of a text, as this facilitates the detection of internal inconsistencies. Cain, Oakhill & Bryant (2004), however, suggest that the detection of internal inconsistencies can be achieved without building a situation model. They point out that a reader could simply compare explicit statements in the text and evaluate their consistency. This, they say (*op. cit*.: 36), would not involve the reader in the same sort of constructive processing that is necessary for inference generation or the establishing of a situation model. On the other hand, it would mean that the reader were operating at a more superficial level of representation.

It could be argued, as indeed, Block (1992) does, that comprehension monitoring is particularly important in L2 reading, where readers are likely to have reduced linguistic knowledge and will thus need to "[...] repair more gaps in their understanding" (Block, 1992: 320), although as we have already noted (in Section 1.2) linguistic knowledge is not the only factor contributing to comprehension difficulties. Horiba (2000: 227), too, makes the point that compared to proficient native readers reading in their L1, second language readers "[...] are more likely to encounter occasions in which conscious decision making is required during processing of a text". In Horiba's view, the sort of strategic decision making involved, such as deciding how much cognitive resources to allocate to understanding an unfamiliar idea or form, how, what and when other sources of information (e.g., domain knowledge, context, later information in the text) should be drawn on, all influence the processes of text comprehension in such a way that "[...] the process of second language reading clearly differs from the process of first language reading" Horiba, 2000: 227).

The language of the text is not the only factor influencing comprehension monitoring. There appear to be considerable differences between what good readers and poor readers monitor. Both good L1 and L2 readers it seems, tend to use meaning-based cues to evaluate whether they have understood, and to focus on the text's overall significance. Poor readers, on the other hand, tend to use word-level cues, and to focus on intrasentential rather than intersentential consistency (Alderson, 2000; Block, 1992). Comprehenson monitoring is relevant to this study, because readers need to be aware of the kind of reading problems they are experiencing and what they can do to resolve them. Furthermore, and as

McNamara (2004: 23) puts it, comprehension monitoring, be it implicit or explicit, is "inherent to self-explanation".

6.4 Understanding text structure

One possible source of comprehension failure is inadequate knowledge of text structures and genres (Perfetti, 1994). Awareness of text structure (the way the material is organised) and the consequent expectations engendered by certain common features of text may be useful aids for readers, helping them to invoke relevant background information and *schemata*[62] to facilitate their construction of a meaning-based representation. Thus, presenting information from a scientific viewpoint to students who are not used to the conventions regarding the form and function of the different parts of a scientific text, may cause difficulties for these readers (Dall'Alba, 1993). To give a more concrete example, Mohammed & Swales (1984), in their study with twelve native and non-native subjects who were asked to carry out written instructions,

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[62] Schemata (or schemas) are cognitive constructs which facilitate the organisation of information in LTM and allow incoming information to be related to already stored information. According to Cook (1989: 69) "[...] the mind, stimulated by key words or phrases in the text or by the context, activates a knowledge schema".

Researchers have identified several types of schemata: content schemata, linguistic schemata and formal (or textual) schemata (Carrell, 1988; Carrell & Eisterhold, 1983; Carrell, Pharis & Liberto, 1989). Content schemata refers to the readers domain knowledge or world knowledge, and it may range from everyday background information to highly specialised knowledge on specific subject-matter. Linguistic schemata include knowledge of the features of words necessary for decoding, grammatical patterns, vocabulary, etc. Formal schemata refer to discourse level features such as how the text is organised, text type (which, in turn may include aspects such as communicative intent, content, structure, level of formality or register).

Exactly how the terms 'schemata' or 'schema' differ from 'background knowledge' is not clear. Indeed, it has been argued that they are virtually synonomous (Sadoski, Paivio & Goetz, 1991). Similarly, Urquhart & Weir (1998: 71-72) wonder whether "[...] it is in reality useful to apply the same term to notions as different as, say, our knowledge of the passive voice, of behaviour at a wedding, or birds [...] or of newspaper articles".

concluded that “[...] familiarity with the genre of technical instructions” (p. 211), had aided their students’ understanding.

While the story grammar (i.e., the principal components of a story: main character, action, and outcome) of most narrative texts is typically that there are characters, a setting, problems, solutions to the problems, etc., expository writing typically contains a variety of more complex and varied organisational or text structures that present the reader with greater challenges. Indeed, the range and complexity of the various expository text structures means that students need to master several different structures (e.g., description, sequence, compare/contrast, for/against, cause-effect, and problem-solution. This can lead to difficulties in identifying, for example, what the main ideas in a text are, in what is offered as supporting evidence, or in distinguishing between facts and opinions.

We now turn our attention, therefore, to the specific difficulties students may find in reading and learning from the type of informational, expository text used in this research. First we describe some general features of expository texts, then we discuss why such texts are hard to understand. Following that, we broaden the discussion somewhat to explore some of the characteristics of (i) authentic texts, and (ii) electronic texts, and consider how these might influence the processing and comprehension of such texts.

6.5 General features of expository texts

Expository text is usually subject specific, presenting facts and information using little dialogue (Tonjes, Wolpow & Zintz, 1999). Sentences are usually plain statements and the use of interrogatives and continuous verb forms is comparatively rare (Urquhart & Weir, 1998). In an early and important analysis of scientific writing, Barber (1962) reported that the text he analysed consisted of 9,648 word tokens formed into 350 sentences. Of these 350 sentences, 2 were commands, 3 were statements with commands in parenthesis, and 345 were statements. There were, he says, no questions or requests.

Expository text is written with certain objectives in mind: to inform, to explain, to describe, to present information or to persuade. Heller (1995) lists the following seven common formats: definition, description, process, classification, comparison, analysis, and persuasion, to which we might add problem-solution, cause-effect and how-to-do (i.e.; instructions or procedures).

The genre embraces several rhetorical forms. These include, for example, the academic textbook, technical and scientific journals, technical manuals, newspaper and magazine articles or information (informative) leaflets written for the general public. As Alcarez Varó (2000: 125) points out, expository text:

> [...] es propio de una gran variedad de textos, que van desde la definición de un término técnico a las instrucciones para el uso de un instrumento electrónico, pasando por la conferencia académica, el ensayo literario, el artículo periodístico y el trabajo de investigación científica, tecnológica, jurídica, económica, etc.

In the university where this study was carried out, the most widely used type up to now has probably been the book of notes or *libro de apuntes* prepared by the subject lecturer, photocopied and made available to the student in printed book format.

Some expository texts attempt not only to inform or explain but also to persuade the reader why he or she should carry out a course of action. For example, an invitation to reconsider one's views regarding textbooks is implicit in the following sentence taken from an interesting article by Nathan, Long & Alibali (2002: 18), published in the journal *Discourse Processes*, on how the content and organisation of textbooks can influence teaching and learning:

> This raises the specter about the role that textbooks play in influencing curricula, enculturating teachers, and perpetuating inaccuracies about students' mathematical reasoning and development.

The same issue of *Discourse Processes* included an article by Dijkstra, Bourgeois, Petrie Burgio & Allen-Burge (2002: 71) with a more obvious attempt to convince the reader of the merits of the work being reported:

> This study has provided deeper insight in discourse deficits among dementia patients throughout conversations and on an utterance-by-utterance basis.

Scientific texts do not necessarily have to be written in the expository mode. A narrative approach may be more appropriate for science fiction or science history or for some texts whose purpose is to provide the general public with scientific information. However, Goldman & Bisanz (2002: 31) note that although the task of disseminating scientific information to the general public is carried out by a variety of genres, "as a class, these genres popularize the information exchanged among scientists".

Increasingly, many of the traditional forms mentioned above are also available in electronic format on the World Wide Web (WWW). In fact, the development of the WWW has led to the proliferation and availability of many specially written sites published by commercial, educational or governmental organisations which provide didactic materials of varying degrees of complexity aimed either at the interested public in general or at specific audiences and specific age groups. The WWW has resulted in more diversity of text type and has contributed to breaking down the barriers between the traditional genres of persuasion, exposition, narration and description so much so that exemplars of different genres may now exhibit much more similarity in terms of style, content, structure or intended audience. Goldman & Bisanz (2002: 32) point out that one result of this is that “the structural conventions and labels [for these genres] are less stable, consistent and informative in terms of guiding processing” than more traditional genres.

Within the genre of disseminating or popularising scientific information, Goldman & Bisanz (2002) distinguish between the functions of (i) raising public awareness and (ii) increasing public understanding of scientific information. The difference between the two depends on the author’s purpose. Texts aimed at increasing public understanding have a didactic purpose and, according to Goldman & Bisanz (2002: 32):

> [...] differ from genres that raise awareness in that they attempt to support informal learning by providing information sufficient for the public to achieve an understanding of the scientific concepts, phenomena, or processes that are discussed As such they contain more extensive science content [than genres that raise awareness].

Expository texts present particular difficulties to readers, whether in electronic form or hard copy format. We move on, therefore, to discuss some of these.

6.5.1 Why expository texts are hard to understand

For many people, reading informational expository texts “is found to be more complex” (Horiba 2000: 229) than reading narrative texts. There are several reasons for this.

Rhetorical structure

One concerns the rhetorical structure of the text. Rhetorical structure refers to the differences in hierarchical organisation found in different types of texts. Familiarity with a structure – and the consequent expectations about how the text elements are organised – helps guide processing, and the making of connections to the reader's schemas (Mannes & Kintsch, 1987; van Dijk & Kintsch, 1983). The rhetorical structure of expository texts tends to be organised in less predictable ways than narratives. Story narratives usually follow a structure based on a causal chain of events with intentional goal-directed actions, so when readers read narratives the most usual strategy employed is that of maintaining causal and referential coherence (Kintsch & van Dijk, 1978; van den Broek, Young, Tzeng & Linderholm, 1999), and the reader is concerned with explanations for the events as they unfold. Expository texts, on the other hand, follow a wider range of discourse structures (e.g., compare and contrast, cause and effect, problem and solution, argument and evidence, description (e.g., Anderson & Armbuster, 1984; Heller, 1995; Meyer, 1975; 1985)[63].

A number of such structure systems have been proposed. However, how such structures/genres are named and categorised is not as important as the reader's awareness of them or as important as his or her ability to recognise the different genres, and anticipate the knowledge structure represented by each. The important point is that different kinds of

[63] For example, Meyer (1985), in an attempt to systematise the structure of the major expository text genres, proposed a set of five 'top-level' rhetorical structures: collection or list, description, causal, comparative, problem/solution. Butt (1995), to give another example, identified 'text type' by function: narrative, recount, information report, discussion, explanation, exposition, procedure. For Butt, each text type has certain obligatory or common language structure and knowledge structure elements, and as such constitutes a genre.

rhetorical structures exist, and that recognition of knowledge structure and language structure is fundamental to text comprehension.

Research also suggests that the rhetorical organisation of expository texts can differ between languages (Kaplan, 1966; Purves, 1988). Given that familiarity with a text's rhetorical structure and organisation has been found to enhance memory and comprehension of expository text for native readers (Taylor & Samuels, 1983), for second language readers in English (Carrell, 1984; 1992) and for second language readers in French (Lee & Riley, 1990), it may well be the case that language-specific rhetorical structure will cause extra difficulties for non-native readers of expository texts (Connor, 1984; Horiba, 2000).

Local processing – fewer inferences

Secondly, expository texts frequently present concepts or relations that are unfamiliar to readers. Because the content is new and unfamiliar, readers can not draw on any background or general knowledge to help them understand, but must rely on the clues and information within the text in order to build up coherence relations and establish a meaning. This may result in readers carrying out more local processing; that is, at the sentence or phrase level. For example, a study by Coté, Goldman & Saul (1998) with 10-12 year-olds found that although the children activated their background knowledge to link the ideas contained in the text, these links were local; that is, they focused on connecting consecutive sentences but did not connect distant items in the text – which, in turn, led to fewer inferences.

As Vidal-Abarca (in press) points out, the tendency for readers of expository text to engage in local processing can also be accounted for by McDaniel & Einstein's (1989) Material Appropriate Processing (MAP) framework. After analysing many empirical studies McDaniel & Einstein (1989) conclude that when students read narratives they tend to connect ideas within an episode, which McDaniel & Einstein call *relational processing* (see also Einstein, McDaniel, Owen & Coté, 1990 and McDaniel, Einstein, Dunay & Cobb, 1986), and pay less attention to single sentences. Expository text, on the other hand, seems to entail an *individual-item* sort of processing; that is, readers of expository text focus on understanding each sentence on an individual basis without paying much attention to relating these to other sentences, especially those which are distant in the text. In other words, narrative texts seem to encourage one sort of reading while expository texts another. The individual-item style of processing adopted by many readers of expository texts may be the reason why these readers fail to make many inferences, resulting in low comprehension (Vidal-Abarca, 2004).

Reduced background knowledge

The ability to make inferences also depends to some extent on the reader possessing a relevant knowledge base (Barnes, Dennis & Haefele-Kalvaitis, 1996; Trabasso & Magliano, 1996) thus, one consequence of reduced background knowledge is that readers of expository text generate fewer inferences. Although research has shown that students do make inferences when they read expository texts, a study by Graesser, Robertson & Anderson (1981) found that nearly four times as many inferences are generated when reading narratives than when reading expository materials. Indeed, readers can generate many kinds of inferences when they have sufficient background knowledge of what the text is about (Graesser, Singer & Trabasso, 1994; Zwaan & Radvansky, 1998) which, it could be argued, is the case for most narratives. On the other hand, fewer inferences are generated when reading expository texts on unfamiliar topics (Coté, Goldman & Saul 1998; Goldman, Saul & Coté 1995; Graesser & Bertus 1998; Millis & Graesser 1994). Coté et al. (1998), also found that the participants in their study generated fewer elaborations when they read difficult texts than when they read easy texts, while Britton, van Dusen, Glynn & Hemphill (1990) also found that when more inferences were required to link the ideas in an expository text, the worse the texts were recalled.

Expository texts also tend to have cohesion gaps (Beck, McKeown & Gramoll, 1989). A cohesion gap arises when input from the text can not be linked to previous information or to the developing mental model, and they may occur at any of the levels of representation. Cohesion gaps at one level may have a ‘knock on’ effect to another level. For example, an L2 reader who is experiencing difficulties processing unfamiliar vocabulary or complex grammatical patterns, may, as a result, also have difficulty processing deeper levels of representation (Graesser, Person & Hu, in press). Alternatively, the reader may be able to draw on domain-knowledge or pragmatics in order to compensate. There is, in fact, a considerable amount of evidence in L2 reading, that readers with significant subject-specific knowledge can overcome linguistic shortcomings (see, for example, Bernhardt, 1991b; Urquhart & Weir, 1998). Quite possibly, however, cohesion gaps can only be filled in by background knowedge, because it is the background knowledge which provides the foundation on which the reader builds his or her mental model of the situation contained in the text (Bransford & Johnson, 1972). Deficits in background knowledge may also result in the reader confining their processing to the more shallow surface code or textbase levels (Graesser, Person & Hu, in press). In fact, without sufficient prior knowledge readers may not only fail to fill in cohesion gaps, they may not even notice them (McNamara, 2001; McNamara & Kintsch, 1996).

Thus, background knowledge plays a central role in the mechanisms readers use to construct inferences and in processing the relations that connect different sections or constituents of a text (Graesser, Wiemar-Hastings & Wiemar-Hastings, 2001). Urquhart & Weir (1998: 114) hint at the many implications of a greater or lesser degree of background knowledge:

> [...] background knowledge is not just an extra resource; it is, as it were, a filter through which we view all texts.

<u>Fewer inferences</u>

Vidal-Abarca & Martínez (2001) point out that difficulties in understanding a text are often attributed either to the readers or to the text. The text, it is said, may not be structured adequately or the ideas in it may be poorly expressed, while for their part, the readers may lack domain knowledge; i.e. knowledge about the content of the text, or have insufficient vocabulary, or fail to use appropriate comprehension strategies. Vidal-Abarca & Martínez (2001: 144) suggest that comprehension difficulties do not reside solely in the text, or solely in the reader but “en la inadecuación entre el texto y el lector, y más en concreto, en el proceso donde se conjuntan ambos elementos, las inferencias”.

One way of overcoming difficulties with inference generation would be by manipulating task requirements, so that readers are induced to process information they would not normally encode. For example, by incorporating questions into a text, Hannon & Daneman (1988) were able to induce adult poor comprehenders to make a greater number of knowledge-based inferences. An alternative would be to make the information in the text more explicit, thus reducing the need for inferences (see also Vidal-Abarca, 2004), Indeed, some researchers argue that writers have a responsibilty to readers to facilitate the creation of meaning. Patricia Wright (1995: 38-39), for example, referring to the design of instructional materials in computer science, suggests that:

> [...] one way of encouraging appropriate [reading] strategy selection is through careful design of the text ... Writers need to see themselves as catalysts for the strategies that their readers adopt; and they need to be aware of the design features that promote the selection of particular strategies.

In fact, one branch of the research into text processing, pioneered by Beck, McKeown, Sinatra & Loxterman (1991) and by Britton & Gülgöz (1991), has been concerned with how to write expository texts which reduce the need for the reader to make inferences. Further work in this area has been carried out by, for example, Linderholm, Gaddy, van den Broek, Mischinski, Crittenden & Samuels, 2001; McNamara and her colleagues (e.g., McNamara, 2001; McNamara, Kintsch, Songer & Kintsch, 1996; McNamara & Kintsch, 1996;) and Vidal-Abarca and his colleagues (Vidal-Abarca, 2004; Vidal-Abarca & Gilabert, 2003; Vidal-Abarca, Gilabert & Abad, 2002; Vidal-Abarca, Rouet & Gilabert, 2005; Vidal-Abarca, Sorian Ferrer & Miranda, 1996). Vidal-Abarca's work in particular has focused on text design which fosters the activation of the reader's background knowledge in order to connect with ideas in the text and encourage deep comprehension as well as improve subsequent recall, and hence learning.

Split focus

Yet another difficulty facing students reading expository texts in an educational context is the split focus nature of the task (Goldman 1997). Split focus refers to the reader needing to focus on understanding the text *and* learn from it. In a second language class, or if reading a text in the second language, the reader's focus may be even further 'challenged' by the additional complication of having to understand or learn target language features such as new vocabulary or particular grammatical patterns. In other words, the reader's focus may not only be split between: (i) having to understand the content and, (ii) having to learn the content, but also between (iii) having to process unfamiliar second language linguistic elements, and (iv) having to learn these.

Individual differences

Finally, while adult readers of narratives are probably more uniform, in the case of expository texts there are more individual differences between readers. In the words of Graesser, León & Otero (2002: 4):

> Readers dramatically vary in their knowledge of the subject matter, their cognitive strategies of coping with extremely difficult content, their criteria in what it means to comprehend, and their motivation to perservere in mastering the science content.

To this list we can add their knowledge of the second language. All of these learner factors will constrain what the reader can attend to effectively and influence how (and what) input is processed.

6.6 Reading authentic texts in an L2

All the texts used in this research are authentic in the sense that we have specified in the Introduction to this Chapter. One consequence is that their level of linguistic difficulty is not uniform and, even though the texts have been carefully selected, their language content can at times present a challenge to the readers. It could be argued that before asking students to read texts which are, by some definitions, too difficult for them, it would be of greater benefit to concentrate on the 'linguistic problem' (Alderson, 2000); in other words, to develop the students' *general* L2 proficiency, or to use texts which are not linguistically demanding. However, in answer to the first point regarding developing students' general proficiency in the TL, we have already noted (in Section 2.2) the importance of enhancing their reading comprehension abilities. As to using easier texts, there are a number of reasons why we believe using authentic, expository texts is more beneficial for our students.

1. Authentic texts provide a rich source of (comprehensible) input for readers

A fairly common pedagogical practice, widespread in published graded reading materials and in English language teaching coursebooks, is to use simplified texts which have either been written especially or are a modified version of an already existing text. Simplification is usually achieved by modifying in some way either vocabulary or grammar, or both. Examples of simplification of vocabulary might include the use of high-frequency lexis, avoidance of pronouns by repeating nouns or proper names, limited use of idiomatic phrases and colloquial expressions (Leow, 1993: 337; Yano, Long & Ross, 1994: 192; Young, 1999: 350), and repetition of vocabulary items. On the grammar side, morphology and syntax may be adjusted to provide shorter sentences and fewer clauses with more clearly marked grammatical relations (Yano, *et al.*, 1994: 192).

An example of a simplified, graded text, taken from an ESL resources page on the Internet called 'Boggle's World', is shown below. The website claims[64] that this text, and the exercise that accompanies it, are suitable for intermediate to advanced learners.

Easter Island

Out in the middle of the Pacific Ocean, there is an island that is totally isolated. That island is isolated; it is over 3000 km from other areas of land. It is called Easter Island.

Even though Easter Island is isolated, it contains one of the greatest mysteries of the world: the Moai statues.

[64] Source: <http://bogglesworld.com/teaching_articles1b.htm>
Date retrieved: 20 November 2005

> The Moai statues are large rock statues carved by an ancient people that inhabited the island. No one is sure why the islanders made the statues. There are about 900 statues around the island and they weigh about 14 tons.
>
> Of course there are many theories- some ridiculous and some reasonable. For example, some people think the statues were built by aliens. Others think they were built for religious reasons.
>
> We may never know because the culture that built them died out long ago. The culture died out because they used all of the resources of the island. Without the necessary resources, the people started fighting among themselves and soon the great civilization that built the stones died off.
>
> Source:
> <http://bogglesworld.com/graded_reading_materials/two_mysteries.doc>
> Date retrieved: 20 November 2005

In our view, this short text can hardly be considered a piece of genuine discourse. Rather, it is what Widdowson (1978: 89) would have called "a contrivance for teaching English" and it exhibits some of the main disadvantages of what Sweet (1899: 178), writing over one hundred years ago, called 'artificial systems', which, he claimed:

> […] tend to cause incessant repetition of certain grammatical constructions, certain elements of vocabulary, certain combinations of words to the almost total exclusion of others.

Other studies (e.g. Krashen, 1989: 28; Larsen-Freeman & Long, 1991: Nunan, 1991; Swaffar, 1985; Yano *et al.*, 1994) have shown that this type of simplification does not necessarily result in a more comprehensible text and, what is worse, that it can *inhibit* language learning. Larsen-Freeman and Long's (1991) research, for example, examined the results of thirteen studies carried out in the seven years between 1980 and 1987. Their conclusion is that:

> Input (linguistic) modifications are [not] necessary […] the very process of removing unknown structures from the input in order to achieve an improved level of understanding simultaneoulsy renders the modified samples useless as a source of new acquirable language items.
>
> (Larsen-Freeman & Long, 1991: 143-144)

While Krashen (1989: 28) reaches a similar conclusion: “Some research”, he writes, “bears on the use of simplification as a means of making texts comprehensible, and, taken as a whole, it is not encouraging”, and he goes on to cite Blau (1982) – whose research we have already referred to in Section 5.2 – who found that “simplification could impair comprehension by removing elements crucial to comprehension” (Krashen, *ibid.*).

Nuttall (1982: 32) makes a different, although related point. She warns that simplification can result in the removal of a text’s basic qualities as discourse. She also recommends (*ibid.*) not making the text entirely explicit, because this will prevent the students developing their capacity to infer, and suggests that text elements which challenge the students’ intelligence should be retained so that interesting questions can be asked.

Young (1999: 350) agrees that the research results on whether linguistic simplification increases comprehension “are inconsistent”, and also points out (Young, 1999: 361), together with Swaffar (1985: 17), that although simplification may help learners to understand the meanings of individual words, it does not necessarily help them to understand the conceptual connections between them. In other words, simplifying a text may help at the level of individual items of lexis but this is at the expense of understanding the global significance of the whole text. Moreover, simplification may result in the learner believing that “every word in a text is significant” (Young, 1999: 361).

Simplifying and shortening texts, therefore, far from benefitting the learner, can not only result in the elimination of elements that aid (text) comprehension, but result in impoverished input, comprehensible only at the superficial level. Instead, we should use, in the words of Swaffar (1985: 17):

> [...] linguistically authentic comprehensible input presented in a fashion which allows students to practice decoding message systems rather than individual words.

2. Motivation

As several researchers have pointed out (e.g. Ellis, 1994; Oxford & Shearin, 1994: van Lier, 1996), motivation is a key factor affecting learning, including language learning, and one of the principal elements of motivation is *interest*. Students are more likely to be interested in and motivated by texts whose information content is relevant to their courses of study. In this respect, Oxford & Shearin (1994: 23) comment that:

> Students' goals and interests must be the starting point if motivation is to be high and developmental progress to occur. Moreover, for motivation and progress to exist, instructional input to students must be challenging and relevant.

Obviously, reading materials should not be so complex as to cause frustration and failure. Texts, as Ellis (1994: 516) says, should "pose a reasonable challenge to the students – neither too difficult nor too easy". It has to be admitted, though, that the principle of authenticity has posed particular problems as far as grading texts is concerned (McGrath, 2002). Moreover, in any given group of learners there will be a range of TL proficiency levels and cognitive abilities so that what may be accessible for one student may be inaccessible for another. Despite these difficulties (experienced perhaps more by the teacher when selecting appropriate texts rather than by students), it is also the case that dealing successfully with authentic texts is, in itself, motivating. In the words of Leloup & Pontiero (1995):

> [...] when students realise they can successfully deal with and understand authentic texts, confidence in their own TL abilities soars.

3. Challenge: the role of the task

There is no doubt that authentic texts can pose a challenge to learners, especially those at the lower levels, and this challenge is usually seen in terms of the perceived linguistic and cultural difficulties inherent in the text. However, challenge is not only a factor of the input *text*, but also of the *task* the learners are required to carry out (Mishan, 2005). A fundamental principle behind the grading of tasks is to make them appropriate to the text, and to make them authentic. To quote McGrath (2002: 114) again, "the narrow concern with text authenticity that characterised the early years of the communicative movement has since given way to a concern for the nature of tasks".

According to Mishan (2005: 75), for a task to be authentic, it should, amongst other things; stimulate some affective and/or cognitive engagement with the text, approximate a real-life task, involve genuine and purposeful communication and reflect the original communicative purpose[65] of the text on which it is based.

By using *tasks* appropriate to the learners' level of proficiency, and with the proviso that comprehension of every word is not necessary,

[65] In the context of written text, communicative purpose refers to what the writer of the text wished to accomplish; for example, to transmit information, to persuade, to give instructions, and so on. Bhatia (1993: 146) points out that its original communicative purpose is a characterising feature of any text, thus, simplifying the text for language learning purposes changes the communicative purpose and hence damages the text's authenticity, thereby putting at risk what she calls the text's "generic integrity".

linguistically complex texts can be used. In fact, "[...] partial comprehension of text is no longer considered to be problematic since this occurs in real life" (Guariento & Morley, 2001: 348). Tomlinson makes a similar point. It is not necessary to understand all the words in a text, he says, although it does need to be "understandable enough to achieve a purpose for responding to it" (Tomlinson, 1998: 13).

<u>4. Authentic texts help to develop learner autonomy.</u>

To go back to the issues of autonomous learning and lifelong learning, which we touched upon in Section 2.2.2, Mishan (2005: 9) points out that in the language learning context "autonomy and authenticity are essentially symbiotic". This is so because the 'ideal' effective, autonomous learner will use a range of authentic sources (apart from written expository and narrative materials such as instructions, articles, textbooks, newspapers, magazines, novels, these may include television or radio programmes, cinema, music). Citing Fernández-Toro & Jones (1996: 200), Mishan (*ibid.*) notes that case studies on learner experiences in self-instruction suggest that learners benefit from interacting with authentic texts in autonomous modes. Moreover, as McGarry (1995: 3) points out:

> Activies based around authentic texts […] can play a key role in enhancing positive attitudes to learning, in promoting the development of a wide range of skills, and in enabling students to work independently of the teacher. In other words, they can play a key role in the promotion of learner autonomy.

Thus, exposure to authentic texts and familiarity with handling them and using them to achieve set objectives will help learners to build confidence in their own abilities. This is an important consideration in developing learner autonomy which, as we stated in Sections 1.2.3 and 2.2.2, is one of the aims of carrying out this research. The use of authentic texts also allows the learner to take full advantage of the technological resources that the ‘information era’ has brought with it and which we can expect to become ever more pervasive.

The mention of technology brings us to a consideration of some of the features of electronic texts which may bear upon reading comprehension.

6.7 Reading electronic texts

By ‘electronic text’ we mean any text read on a screen as opposed to on paper. However, the electronic texts used in this research were not *hypertexts*; that is they were not “information systems in which the contents are organized in an interrelated network with nodes that are documents and links that are the relations between these documents” (Salmerón, Cañas, Kintsch & Fajardo: 2005: 171). Electronic texts that incorporate hyperlinks and hypermedia introduce some extra complications for readers because they require skills and abilities beyond those required for the comprehension of conventional, linear print. As Winklemann (1995) argues, while print is static, e-text or hypertext is dynamic and malleable. Although some of the texts were taken from websites using hypertext, the students were not required to follow links or nodes to other sections. Students were not required, therefore, to navigate their way through the texts, to make decisions about the order in which to read different sections of text, or about whether or not to read links, they merely had to process the text in a linear fashion.

Several L1 studies (e.g. Kurniawan & Zaphiris, 2001; Muter & Maurutto, 1991) comparing reading hardcopy and reading electronic texts conclude that the processes readers engage in are very similar in both contexts, but that readers tire more quickly when reading online and that this can be 10%-30% slower than reading from hardcopy.

There is also evidence that some readers may experience a sense of disorientation when reading lines of electronic text in a single column due to loss of location (Kurniawan & Zaphiris, 2001), and that a 3-column format may be preferable because this requires shorter eye movements. When reading on paper, on the other hand, readers are able to keep track of where they are by following the lines of print (or even pointing to the words being read) with a finger or pencil.

An additional difficulty is the fact that electronic texts possess certain features which hard copy formats do not have. The page may be filled with flashing advertisements, messages from sponsors, changing graphics, special offers which suddenly appear, or other information which is superfluous to the text message itself. Indeed, the amount of information displayed can be overwhelming and wading through it all to get to the data one actually wants can prove a challenge, even to highly skilled readers. Reading informational web sites is a necessary part of what we might call the 'new' literacy, but if it is to be efficient, readers need an awareness and a degree of control over different processes, and it is not surprising that, at times, readers (both L1 and L2) may find that the benefits are outweighed by the costs in terms of time and effort.

Furthermore, anyone with the means can publish on the WWW and the linguistic and technical content is not always validated or reviewed as it would be for publication in a scientific journal, say. Naturally, then, sites have to be selected carefully and students must be taught to not simply accept what they read as given, but to adopt a critical stance towards the information that is presented. Evaluating what one reads is, of course, an aspect of literacy, but also depends on background knowledge and confidence in one's own abilities.

Despite these added difficulties there are several reasons for asking students to work with texts of this type. Firstly, their subject matter is relevant to the students' course of study, which should result in students being more interested and more motivated to read them than if their content were about more general topics. One of the long-standing criticisms made against many English language teaching coursebooks (e.g. Nuttall, 1982; Mishan, 2005; Tomlinson, Dat, Masuhara & Rubdy, 2001) is that they deal with over-familiar topics such as, to use Nuttall's (1982: 20) examples, 'The clothes we wear' or 'Transport', so that learners are required to read texts that carry no message for them. Yet, as Salaberri & Zaro (2004: 6) point out:

> Utilizar el inglés para efectuar trabajos, investigar temas o desarrollar la creatividad artística o intelectual de los alumnos de forma interdisciplinar, a partir de materias o temas transversales [...] incrementaría el grado de motivación y participación de los alumos al conectar con sus intereses específicos.

Of course, one can not predict with certainty the interests of any given group of students, nevertheless, if the group are all following the same course of study at university it seems reasonable to assume that topics related to their field of study *will* connect to their specific interests. Many of the texts we use (although not all) are chosen in consultation with the students' subject lecturers. In these cases we also expect the texts to reinforce the students' first language learning activities.

A second reason for using selected electronic texts is that they contain linguistic features (particularly vocabulary, but also grammatical structures and textual features) which have been identified as important for the students to be familiar with. This may be specialised technical or semi-technical lexis, but could also be low frequency words which do not occur very often in other discourse. Thus, when the focus of the lesson is on linguistic aspects, these texts provide real examples of language use, as well as of ways of organising content. When such texts form the basis of reading lessons, they may facilitate incidental learning of linguistic features.

Thirdly, working with this sort of text helps to familiarise students with handling authentic materials, and also with the vast resource bank available on the WWW. Some tasks require the students to carry out a search for, and identify, material relevant to a specific topic. Practising and developing these skills helps them to become better equipped with strategies for finding and evaluating relevant information to a specific task. Developing this kind of scientific literacy will, in turn, help them to cope better with academic and professional needs, as well as make more extensive use of the huge multimedia/electronic environment already in place but which is generally underused (Dillon & Gabbard, 1998).

Overall then, the WWW can provide a rich source of relevant reading materials which, depending on task specifications, require readers to engage in the types of reading our students are, and will be, required to read.

6.8 Summary of Part II

Part II has explored how lexical and syntactic variables, as well as some higher level processing and knowledge factors might bear on processing and comprehension. First, Chapter 3 discussed some general issues involved in discourse comprehension, such as how the situation represented by a text can be 'understood' at different levels of representation, how different sources of information contribute to the construction of the mental representation of a text, the reader's standards of coherence and the interactive nature of the processes involved in reading. Chapter 4 then addressed the complex issue of word recognition and described two small-scale experiments: the first was concerned with students' depth of knowledge of specific lexis, while the second investigated students' familiarity with English orthographic patterns.

Chapter 5 discussed comprehension difficulties at the sentence-level. It noted the conditions which must be met if readers are to have any chance of inferring unknown words from their contexts. The results of an experiment which examined the role knowledge of syntax and familiarity with syntactic patterns might have in the construction of meaning, suggest that having established local coherence (at the phrasal, clausal or sentence level) to their own satisfaction, readers may not integrate local meanings into a global representation. In other words, partial processing of L2 texts seems to be fairly normal reading behaviour.

In Chapter 6, the 'higher-level' processes of comprehension monitoring and inferencing were explored with reference to expository texts. In addition, the Chapter discussed how knowledge of text structure can influence the processing operations used by a reader and how certain characteristics of expository texts can make comprehension difficult. The Chapter also touched on an important topic when it comes to designing language learning/teaching materials; namely their authentic nature, and finally looked at some of the issues involved in reading electronic as opposed to hard copy formats.

Part III

Chapter 7

Comprehension strategies while reading expository texts in Spanish (L1) and English (L2)

7.1 Introduction

We concluded sub-section 2.4.5 by stating that our underlying aim in conducting this research was to enhance our students' comprehension of expository texts written in English and to improve their learning from such texts (as well as, indirectly, improve their knowledge of English – at least within their own subject areas). In more specific terms, the principal objective was to provide students with the reading skills and strategies necessary to meet their academic and future professional needs when confronted with expository texts. The purpose of Part III of this study is to report on the main experimental research we have conducted, as well as the classroom interventions carried out, in order to achieve this goal.

There are, of course, many factors which can be taken into account when discussing reading comprehension (for example, text genre, text topic, task requirements, language proficiency, domain knowledge of the readers, and so on). One factor which seems to be frequently overlooked, however, is what the readers themselves bring to the reading process in terms of existing text processing strategies. As noted in sub-section 1.2.4, without any knowledge of the text processing strategies students use, or how they use them, we will never be able to get to the root of any problems or difficulties they might have.

Furthermore, although there is already a considerable literature on the subject of comprehension strategies, only a relatively small amount of the research has used university students with low L2 proficiency. Li & Munby's (1996) two subjects, for example, had achieved TOEFL scores of 615 and 617 (roughly equivalent to CEF level C1 or C2), while Block's (1986) study was carried out with students who, although they were placed in remedial reading classes, had been judged by their reading teachers as 'fairly fluent', and were about to begin university courses in which English was the medium of instruction (Block, 1986: 467). The current level of English of the participants in our study would prevent them from being accepted onto a tertiary level course in their specialisations taught entirely in English. In addition, the task requirements in our study were not the same as those of other research in this area – and task requirements are one of the variables which influence the choice of processing variables.

It was therefore decided that the most useful place to start this research would be to find out, on the basis of empirical observation, what text processing operations students used, what mental processes they engaged in, as they carried out tasks using L1 texts and to see how this compared with how they handled similar tasks using L2 texts. In this Chapter, therefore, we describe the first stage of our research; namely the preliminary study to investigate the use of text-processing strategies by native Spanish university students reading expository texts in both English and Spanish. The specific research questions explored in this Chapter, then, are those numbered 1-3 in sub-section 1.2.3; namely:

1) What comprehension strategies are used by the readers reading expository texts in L1 and L2 while carrying out information-transfer type tasks?

2) Are the comprehension strategies used by the readers when reading in their L1 similar or different to those used when reading in their L2?

3) Are the readers aware of the strategies they use while reading and do they have control over these strategies?

The rest of this Chapter is organised in the following way: first we briefly recap on the principal characteristics of comprehension strategies as discussed in Chapters 2 and 3. After that, we consider the methodology used in this part of the research: the participants, the factors influencing the choice of tasks and texts and the methods of data collection employed. In Section 7.3 we describe the procedure used to identify the comprehension strategies from the subjects' protocols, and after that, in Section 7.4, report on the problems we found with the identification of strategies. These problems are classified into two types: those concerning the identification of the comprehension strategies from the transcripts, and those problems arising from the subjects themselves and their different approaches to the same tasks. Section 7.5 presents the answers to the first set of research questions, while the final Section offers a brief discussion of these results.

7.2 Comprehension strategies

In sub-section 2.3.1 we discussed the concept of strategic competence within the broader notion of communicative competence, concluding that, for our purposes, the term ‘strategies’ referred to the resources employed by readers in their attempts to understand a text and construct meaning. A wide range of behaviours can be included under this general characterisation, including both cognitive and metacognitive strategies, and we noted that the distinction between these two is, on occasions, somewhat blurred. We also made the point that strategies are frequently used in combination, and furthermore, that some strategies used by readers to read and comprehend written texts may be specific to language activities (translation, paraphrasing or searching for an unknown word), while others (such as knowledge integration, reasoning, the use of logic or common sense, inference generation) may also be more generally employed in other types of complex cognitive activities. Finally, in Chapter 3, we introduced the idea of low-level, automatic, memory-based processes, such as resonance, as well as the idea that readers engage in more controlled, strategic processes in an active attempt to explain the meaning of a given text.

7.3 Methodology

7.3.1 Subjects

The subjects in this small, preliminary study were seven second-year students (3 female, 4 male) from the School of Design Engineering (ETSID) studying Technical Industrial Engineering and specialising in either Chemical, Electronic or Mechanical Engineering. They were not selected or rewarded in any way but were those who volunteered to participate when the nature and purpose of the study was explained to them. Although they can be considered as representative of the overall student body, the small sample used means that caution should be exercised when generalising conclusions.

All the subjects were native speakers of Spanish. In addition, one of them gave the regional language (Valencian) as his L1. In all cases, however, Spanish was the language of instruction in their lectures and the language they used for coursework except in their foreign language classes. On average they had been studying English for seven and a half years. The Oxford Quick Placement Test (QPT) was administered to all participants prior to the reading sesssions. Scores ranged from 15 to 31 giving an average of 22.4 which corresponds to CEF level A2 or ALTE level 1. According to the ALTE website, and as we saw in Chapter 2, with respect to reading for study purposes a learner at ALTE level 1:

> Can understand the general meaning of a simplified textbook or article, reading very slowly.

while a learner at level 2:

> Can understand basic instructions and messages, for example computer library catalogues, with some help.

It is not until the learner has reached level 4 that he or she:

> Can read quickly enough to cope with the demands of an academic course.[66]

Table 7.1 summarises the basic personal information for each subject. For purposes of reference and comparison, subjects are identified by a number (indicated by the symbol '#' followed by the corresponding number), with #1 having the highest level of English proficiency based on the QPT scores and #7 the lowest. The second column of Table 7.1 shows each subject's score on the QPT with, in column 3, the ALTE level to which the score corresponds.

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[66] Source: <http://www. alte.org/can_do/study.cfm>

The vocabulary size of four of the subjects was measured using an instrument available online[67] which, its designers claim, is appropriate for learners of a 'medium' level. We should note, however, that the ALTE level 1 corresponds to a level lower than 'medium'. This, together with the inconsistencies shown between the QPT score and the vocabulary size as measured with the online tool (for example between Subjects #1 and #4), suggest doubts about its validity. We have, nevertheless, included the scores in Column 4 for interest.

Column 5 shows the number of hours per week each student reported they spent reading material other than coursework in both Spanish and in English. Columns 6, 7 and 8 show, respectively, the number of years each student had already studied English, their gender, and their age to the nearest full year.

(1) *Subject*	(2) *QPT mark*	(3) *ALTE level*	(4) *Estimated vocabulary size*	(5) *Approximate number of hours per week spent reading material unrelated to degree course*		(6) *Years studying English*	(7) *Sex*	(8) *Age (years)*
				Spanish	English			
#1	31	3	4000-4500	4	0	7	F	19
#2	30	2	7500-8000	3-4	0	7	M	19
#3	25	2	--	4	0	7	F	19
#4	22	1	7500-8000	5	0	7	F	19
#5	18	1	--	2	0	9	M	20
#6	17	1	2000-2500	13-15	0	8	M	19
#7	15	0	--	0	0	8	M	19

Table 7.1. Participant information.

67 English Language Proficiency Assessment
Accessed at: <http://www.educ.goteborg.se/usam/pforum/elpa/voctest.html>
Date retrieved: 5 March 2003

7.3.2 Choice of tasks

We have already noted in earlier Chapters how the numerous variables in any given reading situation may influence, in many subtle ways, the processes or operations a reader may use to understand a text. Some of the factors which contribute to the type of reading and, as a consequence, the mental operations employed by the reader, are the reader’s interest in the topic, his or her interest in the task, the structure and requirements of the task itself (Kintsch, 1998; Otero, 1998) and, hence, the reader’s goals, as well as characteristics of the text such as coherence and genre or characteristics of the setting or location.

In order to make the activity as authentic as possible, tasks and texts were required which (a) were typical of an academic environment, and (b) required the typical reading processes used in that environment. Two types of information-transfer tasks were chosen. Each type of task was given to each participant twice, first in English, then in Spanish, so that altogether each subject carried out four tasks using two texts in English and two in Spanish. The first task in each language required the participants to take notes on specific topics contained within the texts. The second task required the participants to label diagrams using information contained in the texts. The order and type of tasks are shown in Table 7.2, but there is no reason for this order other than that of convenience. We considered Task 1 to be the most demanding (in terms of language and cognitive demands) and Task 4 to be the least taxing. As the later sessions were timetabled to be carried out when the exam period was approaching, we felt it would be fairer to give the readers the easier tasks nearer this time.

Task number	Task type	Language of the text
1	note-taking	English
2	labelling a diagram	English
3	note-taking	Spanish
4	labelling a diagram	Spanish

Table 7.2. The order and type of task.

It was expected that the tasks would involve the participants in the type of careful and expeditious reading described by Urquhart & Weir (1998: 123) and shown in Table 7.3.

	Global	Local
Expeditious	A. Skimming quickly to establish discourse topic and main ideas. Search reading to locate quickly and understand information relevant to predetermined needs.	B. Scanning to locate specific information; symbol or group of symbols; names, dates, figures or words.
Careful	C. Reading carefully to establish accurate comprehension of the explicitly stated main ideas the author wishes to convey; propositional inferencing.	D. Understanding syntactic structure of sentence and clause. Understanding lexical and/or grammatical cohesion. Understanding lexis/deducing meaning of lexical items from morphology and context.

Table 7.3. Matrix of reading types (Urquhart & Weir, 1998: 123).

In other words, the tasks would require the reader to understand the overall gist of the text as well as identify and extract relevant, specific details which could be expressed in linear note-form in short, two- or three-word phrases which did not need paraphrasing or transforming into other written or numerical forms. From our knowledge and classroom observation of the participants, it was thought that they would be more likely to produce notes in a linear format (as opposed to, for example, a skeleton or mind map format), and also that these would be easier to compare. The way in which the information could be written down was an important consideration; we did not want the note-taking process to be complicated by having to paraphrase or re-write the ideas as this would have involved production processes. Rather, for the purposes of the tasks, we wanted each point to be relatively straightforward and able to be 'lifted' straight out of the text in two- or three- word phrases, or transferred directly in the labelling tasks. We also wanted a finite number.

A source of some concern was that the instructions might prove a little too demanding. Apart fom carrying out the task itself, subjects were requested to say what they were thinking as they read, talk about what they did to understand, *and* say what they did to complete the task. It was this third requirement which we thought might prove too much and, indeed, with the exception of two subjects (#2 and #5) who occasionally mention this aspect, the transcripts do not report the students' thoughts on how they set about completing the tasks, only on what they did to understand the text.

7.3.3 Choice of texts

Once the kinds of tasks had been decided upon, the next issue was to select suitable texts. Several factors needed to be taken into account:

- length
- subject matter
- linguistic difficulty
- density of information

· salience of information (i.e. suitability for the task with respect to identification and transferability)

Length

The length of the texts was constrained by several factors. The first, to which all the others were, to some extent, subordinate, was time. As this study was carried out during normal teaching days, texts could not be so long, so difficult, or so information-dense as to require longer than sixty minutes, which was the length of time the participants could normally only spare from their timetables for each session.

Participants had to be able to read the text, comment on the process, make notes or complete diagrams all within this time. Moreover, the audio tapes used lasted 45 minutes each side, and although participants were able to turn them over to continue (and did on occasions), the recordings also had to be transcribed and analysed. These purely practical considerations limited the length and kind of text which could be used.

Text topics and difficulty

Given that motivation is one of the factors influencing the processing of information, we wanted topics which would interest the subjects, be relevant to their studies without being too subject-specific to any one specialisation (chemical, electrical or mechanical engineering) but about which they could be expected to have some background knowledge.

After selecting a number of potentially appropriate texts on the basis of length, topic and language level (the latter was an intuitively-based decision based on the experience of the researcher in choosing suitable texts), the next step was to look more closely at the information that could be extracted from the text and transferred to a note format. This was done by carefully reading each text and taking notes in a linear format of relevant information in accordance with task requirements. The researcher and a colleague produced sets of notes independently. These were then compared to see whether what each had decided was relevant to the task, matched up with what the other had identified as important and how this had been noted. After comparing the notes taken, a set of *performance criteria* were established which represented the relevant information it was felt a reader could reasonably be expected to identify in order to complete each task.

The two English language texts eventually decided on were taken from sites on the World Wide Web, while the Spanish texts were originally published in the *Futuro* supplement of the newspaper *El País*. The titles are shown in Table 7.4. Appendix C1 shows the source of each text together with the number of words each contained. Appendix C2 includes the instructions for each task, while the full texts are given in Appendix C3.

Text Nº.	*Texts written in English*
1	Introduction to Materials Selection
2	Rosetta Spacecraft Design
	Texts written in Spanish
3	Nuevos Ojos en el Espacio para la Primera Luz
4	El Hallazgo de un Gran Objeto más allá de Plutón Replantea la Idea de Planeta

Table 7.4. The titles of the texts used.

We have already noted (in Section 6.7) some of the extra difficulties which electronic texts can present to readers. For these reasons, as well as for ease of administering the tasks and in order to maintain a uniform format between all four texts, a twelve-point Times New Roman font was used in a single column. In addition, hypertext links were removed so that the text was presented in uniformly black ink on a white background. Two short sections in Text 1 (*Introduction to Materials Selection*) were removed; they contained no important information from the point of view of task requirements and it was felt their inclusion would only add to the time required to complete the task. Finally, the beginning of the fifth line of each text was numbered in order to make referencing easier.

In the light of the discussion above in Section 7.2.1 (and in Chapter 2) regarding the L2 proficiency level of the participants, it could be argued that the English-language texts would be *a priori* inaccessible to them. However the choice seems justified in that it is this sort of text (density of information, lexical range) which these students are expected to handle as part of their coursework and which they will need to deal with in the future. Moreover, the English and Spanish texts needed to have an equivalent level in terms of linguistic and informational demands.

7.3.4 Data collection

Two methods were used to obtain data in this study: think-aloud protocols and retrospective interviews.

<u>Think-aloud protocols</u>

Given that comprehension strategies are essentially unobservable, it is necessary to 'penetrate' as it were into the thoughts of the readers. One way of gaining insight into these processes is to ask readers to say what they are doing as they do it. The idea underlying this method of eliciting introspective data is that it provides direct access to the activities readers engage in as they process a text and shows what information is attended to, what operations are carried out, and what choices are made (Cohen, 1998; Ericsson & Simon, 1993). As Davies (1995:39) puts it:

> Introspective methods are thus seen to have considerable potential for providing insights, rather than firm generalizations, into the knowledge sources and strategies readers use in different reading tasks.

In this study, subjects were given a short training session, during which it was explained that they were required to read a text sentence by sentence and then verbalise as much as they could about what they were thinking as they read, and about what they did to understand, and to do this in whatever language (Spanish or English) they were thinking in at the time. Following Olshavsky (1977) and Block (1986) a red dot was inserted after each sentence to remind the readers to do this. Once the researcher and the reader were satisfied they were able to verbalise their thoughts adequately, they were given the task-instruction sheet for the first text. After making sure they understood what was required they were given the text and left alone. Their think-aloud protocols were spoken into a tape recorder and were later transcribed for analysis. Altogether a total of four texts+tasks (two in English, two in Spanish) were given to each subject, spread over a total of four sessions (1 text+task per session, with the exception of the first when the training text was also used). For each participant, Sessions 2, 3 and 4 followed the same pattern as Session 1, minus the training text.

Retrospective interviews

The interviews provided an opportunity to clarify or extend any issues arising from the transcriptions of the think-aloud protocols and to discuss with the subjects their own views on which processes and strategies they used in both L1 and L2 reading. They were rather loosely structured, although all began with the same general questions (How do you think the way you read in English differs from the way you read in Spanish?; Can you describe the sort of things you do when you don't understand parts of a text?). Subsequent questions were more focused on each individual's responses to these initial questions and to examining each subject's transcriptions and developing any issues or inconsistencies arising from them. Unfortunately, the interviews were carried out some time after the final reading sessions (usually about 3 weeks after). In hindsight it would have been more effective to have held the interviews immediately following the final session while the activity was still fresh in the subjects' minds, but work or study commitments on both sides rendered this impossible.

7.4 The identification and classification of the comprehension strategies reported in this study

Over the years, a number of taxonomies have appeared in the literature (for example, Block, 1996; Davies, 1995; Munby, 1978; Olshavsky, 1977; Sarig, 1987; Tang, 1996, to name a few), thus one method of identifying the strategies and processes reported by the subjects (and possibly the most straightforward) would have been to have taken an existing classification, examined the students' protocols, and noted whether any strategies reported as being used by the subjects coincided with those listed. This course was rejected, however, for several reasons.

Firstly, there seems to be little consensus concerning the terminology used or, indeed, what it is that is classified. Block (1986), for example, grouped strategic behaviour into two broad classes[68]: GENERAL STRATEGIES and

[68] There are so many different names for strategies and strategy-types that, at times, it becomes difficult to remember whether one is referring to a category or to an example of a specific type of strategy. In an attempt to facilitate identification between general classes of strategy and specific strategies, in the discussion which follows and later in Sections 7.5 and 7.6, we have used UPPER CASE to refer to the former, while the latter are *italicised*.

LOCAL STRATEGIES. Sarig (1987), on the other hand, identified four types of what she called reader 'moves': (1) TECHNICAL-AID MOVES AT A LOCAL LEVEL (e.g., *skimming, using a glossary*, (2) CLARIFICATION AND SIMPLIFICATION MOVES (e.g., *paraphrasing*), (3) COHERENCE-DETECTING MOVES (e.g., *predicting upcoming text*), and (4) MONITORING MOVES (e.g., *leaving an utterance deemed 'hopeless'*). Bernhardt (1991a) identified what she called 'elements' that caused the correct or incorrect construction of meaning of a text and categorised them into TEXT-DRIVEN ELEMENTS (e.g., *recognition of words, recognition of syntactic features*), or CONCEPTUALLY-DRIVEN ELEMENTS (e.g., *metacognition*). Davies (1995) grouped strategies into five main categories, CONTROLLING READING PROCESS, MONITORING READING PROCESS, INTERACTING WITH TEXT, UTILISING SOURCE OF TEXTUAL AND LINGUISTIC KNOWLEDGE, and UTILISING SOURCE OF EXTERNAL BACKGROUND KNOWLEDGE, while Jiménez, García & Pearson (1996) classified three main strategies. These could be TEXT-INITIATED STRATEGIES (e.g., *using text structure, focusing on vocabulary*), READER-INITIATED STRATEGIES (e.g., *invoking prior knowledge*) or INTERACTIVE STRATEGIES (e.g., *confirming, inferencing*). Other researchers (such as, Hosenfeld, Arnold, Kirchofer, Laciura & Wilson, 1981; Kletzien, 1991) have preferred to compile a list of observed or reported behaviours. Given so much choice, one is left wondering whose list to take and on what grounds.

A second reason we preferred not to use an existing classification but to develop our own, was that it was not our intention to formulate a complete list of strategies, but rather to identify the text-processing operations our students reported using while carrying out the reading tasks assigned them in a specific reading situation. In other words, given the specific nature of the tasks and the context of this study, it seemed preferable to attempt an original identification rather than trying to fit our students' strategies into a taxonomy based on a different reading situation. This is not to say, of course, that taxonomies can not be generalised, but ultimately, it was felt that developing our own classification would lead to greater understanding of the processes involved. This Section, therefore, describes the procedure employed to identify the comprehension strategies from the subjects' protocols. The strategies themselves are discussed in Section 7.5.

Once the first seven think-aloud protocols had been transcribed, they were examined in order to identify which, if any, strategies had been used. This involved reading them carefully, analysing the contents and either recognising (and confirming) the use of a strategy which was explicitly mentioned as in:

[19] <<[…] entonces yo lo que hago es leer otra vez la frase>>[69] (#2 *Materials*)[70]

[20] <<[...] aunque hayan varias palabras que no sepa su significado, he intentado deducir sobre el contexto el significado [...]>> (#6 *Materials*)

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[69] As noted in Footnote 6, Chapter 1, the readers' introspections (reflections or explanations), are placed between carrots (<<...>>). In accordance with the transcription notation used, two suspension points (..) indicate a pause in the tape of more than 3 seconds. Three suspension points enclosed within square brackets ([...]) indicate that a portion of the reader's reflections has not been cited (as it contributes nothing to the point in question). In addition, all extracts from student protocols are numbered in square brackets.

[70] For reasons of space, the titles of the texts have been abbreviated in the following way:

Materials	= Introduction to Materials Selection
Rosetta	= Rosetta Spacecraft Design
Nuevos Ojos	= Nuevos Ojos en el Espacio para la Primera Luz
Plutón	= El Hallazgo de un Gran Objeto más allá de Plutón Replantea la Idea de Planeta

Or infer the strategy from the description of what the reader reported he or she was doing or thinking at that moment. Ellis (1994), cited in Cohen, 1998: 13, notes that there are times when 'high inference' on the part of the researcher is sometimes needed in order to interpret which strategy is being used and when. Extracts [21] and [22] provide examples of how the researcher has needed to interpret the operations. Extract [21] is fairly straightforward; Subject #3 has tried to use both the similarity to her L1 and the context to work out the meaning of a word

[21] <<*Compromises* se parece mucho al castellano y me da a entender compromiso, pero dentro de la frase no tiene .. no tiene significado, entonces no sé lo que es>>
(#3 *Materials*)

Extract [22] is much more complex and also shows that strategies are often used in combination, or in "constellations of skill and knowledge" (Alderson, 2000: 15, also cited earlier in Chapter 2). In this extract, Subject #2 draws on his linguistic knowledge, he uses the context, he monitors and revises his comprehension and appears to activate what he knows regarding carrying out repairs in order to predict upcoming text content. He also tries to integrate what he is reading with what he knows about the subject. The extract refers to lines 23-24 of the text *Introduction to Materials Selection*.

> *It is also advisable to estimate the remaining life of the equipment so that the repair is not over-designed in terms of the corrosion allowance.*
>
> Introduction to Materials Selection, ll. 23-24

[22] <<*It is also advisable* .. *advisable* debe ser .. *advise* es yo me sé la palabra *advise* que es avisar, como anuncio, entonces, con la terminación -*able*, pues, que también es importante estimar, calcular, lo que le falta de ..

> *remaining* es lo que le queda de tiempo, no sé .. del .. claro porque, yo por ejemplo, sin leerlo ya sé más o menos por donde va, porque sé que me va a hablar, sin leerlo eh, de que .. no te va a salir, o sea, igual, la reparación te sale más cara que lo que vas .. que comprar uno nuevo, entonces supongo que será eso, que también es importante calcular lo que le queda de vida al equipo para que .. no pues no era eso .. he quedado mal .. para que la reparación .. *over-designed* .. aquí no sé .. pues que igual luego interesa que hay que tener en cuenta la reparación que se hace y lo que le queda de vida, teniendo en cuenta lo que le falta de .. *allowance* es .. permitividad, creo que es permitir, entonces .. que igual lo que le queda de .. para permitir al corrosión es muy pequeño, entonces igual haría falta hacer un .. comprar uno nuevo y no sale rentable arreglarlo si luego sólo va a resistir dos años más, entiendes?, pues eso, *corrosion allowance* pues *allow* es .. permitir, entonces en este caso permite la corrosión, que consigue paliar los efectos o sea, la corrosión en este material.>> (#2 *Materials*)

The processs was, therefore, one of examining, interpreting, comparing, evaluating and categorizing reported or inferred strategies. An initial list was formulated based on descriptions of the processes the participants reported they engaged in. As more and more transcripts were analysed this provisional list was added to until approximately 50% of the transcripts had been reviewed at which point the list was compared to Block's (1986) and Tang's (1996) classifications. Although sometimes described in different terms, many of the strategies reported by the subjects in our study coincided and were consistent with those mentioned in these other studies, while two which had not been identified in the subjects' transcripts up to that point were added as it was found that the existence of a strategy on the list facilitated its identification. However, if no examples of these added-on strategies were found during the analysis, they were eliminated from the list. Thus, the strategies reported here include only those which were identified as being used by the subjects in this study. We have not attempted to compile a complete taxonomy of comprehension strategies.

Using this modified list the remaining transcripts were analysed and coded while those which had already been processed were reviewed and recoded. Twelve of the twenty-eight transcripts (i.e. 43%) were randomly selected and given to an assistant to be coded independently. Agreement on strategy use between the researcher and the assistant coder was 81%.

7.5 Problems with the identification of strategies

Researchers have shown that think aloud protocols are reasonably valid reflections of normal comprehension activities (Chi *et al*, 1994; Ericsson & Simon, 1993; Trabasso & Magliano, 1996: Zwaan & Brown, 1996). Despite the 'psychological validity' (Urquhart & Weir, 1998: 94) of this method of obtaining data, however, it is by no means perfect. For example, it is possible that the think aloud task itself may cause readers to increase the amount of attention and effort they expend on a text (Coté, Goldman & Saul, 1998; Kaakinen & Hyönä, 2005). Moreover, there are some difficulties which should be mentioned. The first set of problems we describe concerns the identification of the comprehension strategies from the transcripts. The second set arises from the subjects themselves and their different approaches to the same tasks.

7.5.1 Difficulties concerning the identification and classification of the comprehension strategies

We have already mentioned the need for inference on the part of the researcher when it comes to recognising strategy use. Another complicating factor is the fact that, again as noted by Ellis (1994), the use of any one strategy may be more or less observable and may also be more or less specific. What we have called 're-reading', for example, is not only used more frequently than the number of reported occurrences indicate[71], but the purpose for re-reading can be different on different occasions. One way it is used is in order to clarify the meanings of individual words:

[23] <<Este párrafo me ha costado un poco entenderlo, pero lo de leerlo varias veces y .. pararme en algunas palabras para entender su significado lo he entendido.>> (#5 *Materials*)

What we do not know here is what the reader did when he re-read the words in question. He might have translated them, or worked out their meaning from the context, or tried to relate what he did understand to other sections of the text or to his background knowledge. Nor do we know whether he was really successful in establishing the meaning of these words or whether he understood the general gist of the paragraph in question.

Another function of re-reading is to better assimilate the information contained in a sentence or phrase:

[24] <<Necesito releer detenidamente esta frase porque es muy larga y hay muchos datos en sólo cuatro líneas.>> (#1 *Nuevos Ojos*)

[25] <<La siguiente frase para entenderla realmente es conveniente leerla un par de veces, puesto que es muy larga, con muchos comas y datos.>> (#3 *Plutón*)

While a third seems to be to facilitate the integration of the information in the focal sentence with the existing mental representation of the text:

[26] <<[...] entonces lo he tenido que releer para asegurarme de que era el significado que yo habia entendido.>> (#1 *Nuevos Ojos*)

[71] This became clear while observing the students carrying out the task and was later confirmed in the interviews.

There are other areas where some degree of interpretation is required. One of these is in distinguishing on the one hand between the subjects' use of the metacognitive strategy of monitoring comprehension and applying an appropriate strategy, and on the other their straightforward commenting on whether or not they have understood while carrying out the task.

In broad terms, we have taken 'strategy' as referring to a means employed by a reader to resolve a problem encountered while reading. As a result, simply being aware of whether one understands or not does not, in itself, constitute a strategy. Nevertheless, the task instructions in this study asked the readers to comment on when they didn't understand. Thus, we have taken remarks such as:

[27] <<En la primera frase lo entiendo practicamente todo.>> (#3 *Materials*)

[28] <<Del segundo punto no sé lo que quiere decir pero habla sobre algún control remoto de los instrumentos.>> (#6 *Materials*)

not as examples of strategy use but as comments complying with the task requirements. On the other hand, we have interpreted remarks like:

[29] <<La siguiente frase también la entiendo pero .. *purchasing* no tengo ni idea de lo que es, tampoco puedo deducirlo por las frases, ni por similitud ni nada.>> (#3 *Materials*)

as recognising that comprehension has broken down in some way, and resulting in the application of a strategy (in this case, using the context) to try to establish the meaning. The fact that this further strategy has failed to produce a result is immaterial, the attempt has been made.

A further difference which should be mentioned is the distinction between the three 'translation strategies' we have identified. What we have called 'Using L1 or L2 to understand words or short phrases'[72] is used to clarify the meaning of individual words and consists, basically, in recognising cognates or looking for similarities between the L2 word and an L1 word (to give just three examples from the protocols, *thermal* → térmico; *vary* → varía; *envisaged* → *visage* [in French] → cara). As the last example shows, this does not always result in a correct result.

What we have called 'Literal translation' is normally used for longer phrases or clauses which the reader has not understood and, almost as a final resort, translates in to Spanish:

[30] <<Lo he entendido bien .. pero .. gracias al traducirmelo al castellano porque me resulta más fácil.>> (#1 *Materials*)

Nevertheless, this strategy frequently consists of attempting to construct the significance of the phrase by building it up out of the individual meanings of each constituent word, instead of trying to understand the idea behind the words, and sometimes includes a tendency on the part of the reader to impose the syntactic sructure of his or her L1. Literal translation does not always result in comprehension and the participants were aware of this:

[31] <<Cada palabra, o sea, la traducción directa al castellano la entiendo, pero lo que la frase en si me quiere decir, no, no la entiendo.>> (#3 *Materials*)

In the retrospective interview, Subject #1 commented that when reading English texts the procedure she normally tried to follow was to first try to

[72] 'L2' here, refers to *any* second or foreign language (L2, L3 or L4 and so on) used by the reader to clarify the meaning of the target word.

understand the text directly in English. If she was unable to understand, she would 'convert' the meaning into Spanish, and if that failed she would translate literally. 'Converting' or 'summarising' a portion of text is one of the strategies the participants used most frequently, and in many cases it appears to be an almost habitual response. As Subject #2 described it in his interview, 'converting' consisted in *leer las palabras en inglés pero entender en castellano* (see also Chapter 1, p. 11). However, in order to convert, the reader must have understood enough of the phrase to form a general idea of what it is about and then to add (or elaborate) details. The following extracts show how Subjects #1, #6 y #7 reported dealing with the portion of text below from the English text *Rosetta Spacecraft Design*:

> · *subsystem reliability maximised by a comprehensive redundancy, including 'hot' redundancy (backup units actually on standby) for functions which are essential for a continuous, uninterrupted operation during critical mission phases.*
>
> Rosetta Spacecraft Design, ll. 44-46

We will start with #7 whose lack of vocabulary did not allow him to capture the meaning of the sentence.

[32] << El siguiente punto, no sé tampoco de lo que se me está hablando. Hay algunas palabras que me indican algunas pistas, pero .. por ejemplo, nada más empezar el texto me dicen *subsystem* será subsistema, no .. pero al final de la frase, al final del texto, me dice también *during critical misión phases*, será durante las fases críticas de la misión, pero es que entre medias de esas dos no hay .. no veo ninguna pista que me ayude a enlazar una con otra, para saber perfectamente de lo que me están hablando.>> (#7 *Rosetta*)

[33] << No entiendo mucho lo que quiere decir el principio de la frase, pero, hombre, lo que es la base de la frase entiendo que necesita .. hay unas funciones que son esenciales para que la .. para que puedan funcionar en caso de que haya un momento crítico y necesite .. no sé,

hacer cosas que normalmente no haría porque, no sé, porque es un momento crítico.>> (#1 *Rosetta*)

[34] << En el noveno punto habla sobre los sistemas que son principales y vitales para que pueda funcionar esta misión, y no se interrumpa por ninguna circunstancia que lo pueda producir..>> (#6 *Rosetta*)

These examples also indicate how Subject #7 was more ‘word-bound’ (Grabe, 1991), while Subjects #1 and #6 focused on the main ideas in the passage.

7.5.2 Difficulties arising from individual characteristics of the subjects

1) Some subjects are better at articulating their thought processes than others, as the following examples taken from the transcripts show. The first (extract [35]) is from subject #1 who was generally quite clear in her verbalisations. The second is from #2 who, although he verbalized a lot (and provided some useful data), did so in a rather jumbled way (see, for example, extract [22]). The third is from reader #5 whose transcripts are usually somewhat ‘sparse’. All the examples refer to the same chunk of text: lines 15-16 from *Rosetta Spacecraft Design*.

> *During the long cruise to the comet the dormant instruments must be heated to ensure their survival.*
>
> Rosetta Spacecraft Design, ll. 15-16

[35] <<En Mission requirements entiendo que, bueno en el primer punto habla de que, en la nave, en la lanzadera tienen que haber diferentes cualidades con .. tiene que tener los suficientes instrumentos para que sea lo mejor posible al cometa, y que bueno, los que vayan dentro puedan sobrevivir, por eso dice quedeben .. deben calentar el .. la lanzadera para supervivencia. A lo mejor significa la supervivencia de la lanzadera, no de los que van dentro, porque igual no van ahí dentro.>>
(#1 *Rosetta*)

[36] <<Durante el largo crucero hasta el cometa, durante el largo viaje hasta el cometa, vale, que durante el largo camino hasta llegar al cometa, los instrumentos .. eh.. deben ser calentados, bueno, no sé por qué, pero bueno, supongo que será que al calentarlos estarán mejor protegidos, o lo que sea, o porque el espacio es muy frio, no sé, para asegurar su supervivencia, o sea, para asegurar que cuando lleguen hasta .. no vaya a ser que monten toda la misión, y cuando lleguen a la altura del cometa, lo que tiene que .. hacer las medidas va a estar estropeado, entonces tienen que asegurarse que lleguen en el perfecto estado.>> (#2 *Roseta*)

[37] <<En este punto, ha habido palabras que no .. he entendido, porque no me sé el significado, pero lo que es el contexto de la frase más o menos lo he entendido.>> (#5 *Rosetta*)

2) The transcripts only reflect what subjects do when they do not understand, they do not indicate the processes readers engage in when understanding takes place, when comprehension is immediate. This is to be expected. If comprehension has not broken down the process remains largely automatic, so Subject #5, who never seems to experience much difficulty in comprehending (!), is able to claim that:

[38] <<He entendido la frase con solo leer.>> (#5 *Materials*)

and

[39] <<En este punto .. lo he entendido bien sin tener que hacer nada.>> (#5 *Rosetta*)

3) It seems reasonable to conclude, therefore, that the protocols do not always reliably tap unconscious comprehension processes (Graesser, Millis & Zwaan, 1997: 166).

4) Nor do the transcripts show whether subjects really have understood or not. When the subjects (claim they) understand without a problem they merely say "Entiendo" usually without explaining how. Yet it does seem doubtful that Subject #5 is able to understand chunks of text which the other readers have problems with. Thus, reported strategy use could be influenced by the amount of effort the participants are prepared to put into the activity of reporting or to the extent to which they are prepared to admit to having difficulties.

5) In fact, not everything they do is mentioned. Perhaps they found that the speaking requirement slowed down or interferred with their thought processes in some way, but there are some silences on the tape when presumably something is going on in the reader's mind which is not being reported on. There is a clear example of this when during one of these silences understanding suddenly comes to Subject #2. He is reading the text *Introduction to Materials Selection* and trying to work out the meaning of the word 'codes' which appears in line 33. In the transcript there is a long silence of approximately ten seconds which have been marked by two sets of two points (.. ..). The context is the following:

> *Most chemical process equipment is designed and fabricated to the requirements of specific pressure vessel and piping codes. These codes include only approved materials and establish the basis for and the setting of allowable stresses.*
>
> Introduction to Materials Selection, ll. 32-34

[40] <<*These codes* .. Codes debe ser lo que estás .. lo que te .. el ámbito donde te puedes mover, te reduce el espacio, una forma de reducir el espacio de elección porque como está hablando después de que incluye .. .. serían como reglas, yo creo, porque incluye sólo materiales aprobados y establecidos para la base de la creación.>>
(#2 *Materials*)

6) While the readers are talking about what they are doing, they are doing it. In other words, in being asked to talk about how they comprehend, they engage in comprehending and thus develop thoughts which they otherwise might not do. Put another way, it may be the talking about it which leads to comprehension, or this may distort the process in some other way.

7) Finally, as our concern was in getting access to subjects' thoughts, and given their generally low level of proficiency in English, it was felt that they would be better able to articulate what they were doing in their L1, hence they were given the choice of reporting either in English or in Spanish. We did wonder whether asking them to make notes in English would perhaps have forced them to carry out their introspections in English but all elected to report in Spanish. Perhaps, by being able to report in Spanish they were encouraged to understand in Spanish, however, we believe they would have done this anyway (as evidenced by the transcripts and interviews. See the discussion on the use of L1 below).

Before presenting the strategies identified in the students' protocols one final comment is in order. Given the difficulties outlined above, we should bear in mind that although we can take a particular transcript, count the different strategies used and the number of times each is reported as being used and conclude that in any given text+task, *n* number of strategies were employed and that of these *x*% were Strategy A, *y*% were Stratgey B, *z*% were Strategy C and so on, these figures do not necessarily represent the complete picture. With different texts and different tasks the readers may have employed different strategies. The final sentence of one of the Spanish texts is especially appropriate here:

> Porque la naturaleza siempre será más variada, y sobre todo, enormemente más interesante, que esas muletas que empleamos para caminar a través de ella y que llamamos clasificaciones.

El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta, ll. 94-96.

7.6 Results and discussion

7.6.1 Classification of Strategies

With respect to establishing our own framework of strategies then, as reading is an interactive process between the information contained in the text, the reader's knowledge and the context of the reading situation, one could suppose a 3-way classification of strategies according to these three general criteria. Such a scheme results in the following broad categories:

TEXT-BASED STRATEGIES,
READER-BASED STRATEGIES, and
CONTEXT-BASED STRATEGIES.

Another 3-way classification is obtained if strategies are classified according to what students do to understand the text; that is, what they do to establish meaning, what they do to control their reading, and what they do to complete a task. This would give:

MEANING-BASED STRATEGIES
CONTROL-BASED STRATEGIES, and
TASK-BASED STRATEGIES.

In fact, whatever classification is adopted, many strategies fit quite easily into more than one general class. Would the application of grammatical knowledge, for example, be a READER-BASED STRATEGY or a TEXT-BASED STRATEGY? Davies (1995), for example, includes it in his category of *Utilising Textual Knowledge* (a TEXT-BASED STRATEGY), yet it seems to us that grammatical knowledge is a characteristic of the reader, not of the text. Similarly, *Re-reading* could be placed perfectly reasonably in the category of CONTROL-BASED STRATEGIES (which is where Davies (1995) puts it), yet readers usually re-read sections of text when the information contained in the focal sentence has not been assimilated or understood. As such it could equally as well be classed as a MEANING-BASED STRATEGY.

In the end, seven broad categories were identified, each of which reflects a different function or source. However, we should bear in mind the warning above, and note that these categories are not mutually exclusive. *Reading on*, for instance, has been classified as a METACOGNITIVE STRATEGY as, in general, it is used as a conscious means of manipulating the text or an aspect of the reading process; for example, when the reader consciously decides to continue advancing through the text in order to search for more information – perhaps to ascertain the significance of the focal sentence or perhaps to decipher the meaning of an individual word or phrase. However, *Reading on* may also be thought of as a TASK-BASED STRATEGY in that, although the reader may not fully comprehend a given portion of text, he or she decides (i) that it is not relevant to current task requirements and can safely be ignored, or (ii) it is important but is too difficult/requires too much effort to establish the meaning, and must be skipped if the rest of the task is to be completed.

Moreover, *Reading on* could further be classed as a TEXT-BASED STRATEGY; in those cases where the reader picks up on textual clues (such as the structure, questions, lists or headings) which indicate the sort of information which is to follow. To give an illustration of this last use of *Reading on*, consider Student #1's comment from her protocol for the Spanish text *El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta*. The extract is the opening sentence (in the form of a question) of a new paragraph, and the reader picks up on this to predict the general content of the text immediately following.

> *¿Qué se les ha perdido a los astrónomos planetarios en el Cinturon de Kuiper?*
> El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta, l. 28.

[41] <<En este párrafo se supone que nos va a explicar por qué están los astrónomos tan interesados en el cinturón de Kuiper, porque hace una pregunta aludiendo a eso.>> (#1 *Plutón*)

Another strategy which could be placed in more than one of the categories is *Paraphrasing or summarising*. This reflects both interpretation processes and integration processes of information arising from the text.

Finally, what I have called TRANSLATION STRATEGIES, as well as STRATEGIES USING LINGUISTIC KNOWLEDGE, INTEGRATION STRATEGIES, INTERPRETATION STRATEGIES and TEXT-BASED STRATEGIES are used, in general, to resolve comprehension problems at a local or global level and could all be placed in one very broad category of MEANING-BASED STRATEGIES. Doing so, however, would not give much indication of the purpose behind the strategy use (other than to derive meaning from the text, which seems to be too general to be useful). We have, preferred, therefore, to classify the strategies on the basis of more specific functions. Thus, the category labels are to be regarded as descriptive terms indicating not the primary purpose underlying the use of the strategy - which would be to establish meaning – but the principal source or function indicative of a more concrete purpose behind strategy use.

7.6.2 Results for Research Question 1

> What comprehension strategies are used by the readers reading expository texts in L1 and L2 while carrying out information-transfer type tasks?

Twenty different reported strategies were identified. These are shown in Tables 7.5 and 7.6. Table 7.5 shows the twenty strategies divided into the seven categories, each of which reflects a different function or source.

Table 7.6 (on pp. 265-275) is more detailed. It includes the names of each identified strategy, a brief description of its function, and some examples of use taken from the students' protocols.

Meaning-based strategies					**Metacognitive Strategies** (for monitoring or controlling reading)	**Task-Based Strategies** (used to complete the task)
Translation Strategies	**Strategies Using Linguistic Knowledge**	**Integration Strategies**	**Interpretation Strategies**	**Text-Based Strategies**		
Using L1 or other L2 to understand words or phrases	Using grammatical structure to establish meaning	Using context	Speculating, interpreting, or hypothesising about the significance of a word or phrase	Using textual clues	Monitoring or evaluating comprehension	Searching for specifc information (scanning)
Mental translation (converting the idea to Spanish)	Using other linguistic knowledge to establish meaning	Connecting information from previous sections of text	Paraphrasing or summarise (L1 only)	Identifying key words or phrases (or unimportant words and phrases)	Revising or confirming hypotheses	
Literal translation		Integrating the focal sentence with the developing mental model		Predicting	Re-reading, reading more slowly or with greater attention	
		Using background subject knowledge			Reading on	
		Using general knowledge or experience				

Table 7. 5. Reported strategies classified according to their function and source.

Strategy	Description/Funtion	Examples from the transcripts
Using L1 or other L2 to understand words or phrases	Using L1 or another L2 to establish or clarify the meaning of individual words or short phrases.	[..] tienen mejor fabricación que los cast materials que son, cast, en este caso podemos pensar en un primer momento, tiene que ver con casto, y entonces igual .. si yo pienso que los cast materials deben ser los materiales sin mezclar con otros, los materiales puros, como si dijéramos (#2: *Materials*) *Purely* he supuesto que es 'puramente', pero deduciendo por su semejanza al castellano (#3: *Materials*) Data supongo que es fecha, por el valenciano (#3: *Rosetta*) No sé lo que quiere decir, porque *spectrum* que pensaría que sería 'espectro', *issues* por el francés 'tissues' puedo pensar que sean 'tejidos' y 'fibras' (#4: *Materials*)

Table 7. 6. Strategies identified from the protocols.

Continued on pp. 266-275

Strategy	Description/Funtion	Examples from the transcripts
Mental translation (converting the idea to Spanish)	The reader 'converts' or summarises a section of text into his or her L1 in order to clarify the meaning or understand better.	*[Source text] A system based mainly on alloy materials which, if correctly designed and fabricated, will require minimum maintenance and will function reliably.* (*Materials*, ll. 83-84) *A system* .. pues basado en la principal, *alloy materials*, vale, aleaciones que están correctamente diseñados y fabricados tendrán una muy, una *minimum*, una muy pequeña manutención, que se tiene que mantener muy poco, *and will function reliably*, *rely* es confiar, entonces será .. puedes confiar en ella, que será muy buena. (#2) *[Source text] This tube contains two large, equally sized, propellant tanks, the upper one containing fuel, and the lower one containing the (heavier) oxidiser. A total amount of at least 1578 kg propellant will be accommodated.* (*Rosetta*, ll. 73-75) La línea 72 habla que este tubo tiene en la parte superior un depósito como de carburante, y en la parte inferior tiene como un contenedor oxidante, o como un catalizador .. y habla al final que el combustible serán 1578 kg y, nada más. (#6)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Literal translation	The reader translates longer phrases or sentences word by word (sometimes imposing L1 syntax).	[...] pues creo que sí que entiendo la idea, pero me lo tengo que traducir al español para entenderlo mejor (#1: *Materials*) De la siguiente frase lo que es palabra por palabra lo entiendo, o sea, la traducción al castellano, salvo 'payload' que lo llevo arrastrando desde hace ya tiempo, pero en realidad lo que me quiere decir la frase no lo entiendo, entiendo la traducción al castellano, pero lo.. el significado de la frase no (#3: *Rosetta*)
Using grammatical structure	Using knowledge of grammar to establish meaning.	[...] *seldom* [...] es que esa palabra la sabía .. *seldomly* supongo que tendrá que ver con ... *be all found in a single material* si, porque dice *can* .. no pone *cannot* sino *can* así que tiene que ser algo positivo, ¿no?, eligiendo la estructura sintáctica. (#2: *Materials*)
Using other linguistic knowledge	Using other linguistic knowledge (discourse markers, punctuation, morphology) to establish meaning.	De la segunda frase *spacecraft* no .. supongo que por deducción, por escomposición de la palabra *space* que es espacio, puede ser una nave espacial o algo así (#3: *Rosetta*) En la siguiente frase o*utstanding* [...] vale, *out* significa fuera, y *standing* pues permanecer de pié, entonces, tampoco es que le encuentre mucha.. mucho sentido dentro de la frase (#3: *Materials*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Using context	The reader uses the local context to clarify or establish the meaning of a word or phrase.	Cuando dice *which are added to enhance* supongo que será para mejorar, ya que luego dice las propiedades, entonces como tiene que ser una finalidad, por el contexto supongo que significará eso. (#4: *Materials*) Y *field* creo que es 'campo', pero dentro de la frase no me concuerda, no le encuentro sentido a la frase. (#3: *Materials*)
Connecting information from previous sections of text	The reader explicitly tries to connect or relate information which has occurred previously in the text with the focal sentence.	No entiendo mucho la frase, pero por las frases anteriores, y por todo el texto más o menos si que entiendo lo que quiere decir. (#1: *Materials*) [...] y tienes que ir, cada vez que lees una cosa que está entre comitas, saber que se refiere a lo de antes. (#1: *Nuevos Ojos*) Este párrafo vuelve a hacer mención de *Alan Dressler*, donde tienes que pensar en el párrafo anterior para saber quien es. (#5: *Nuevos Ojos*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Integrating the focal sentence with the developing mental model	The reader explicitly tries to integrate or relate the information in the focal sentence with the developing mental model in episodic memory.	También he entendido esta bien, porque tiene mucho .. tiene, se nota que va unida a la anterior. (#1: *Materials*) Ah bueno, si supongo que las anomalías, ya ya , ya lo entiendo , cuando un planeta recorre su órbita, hay anomalías, pero por qué? Porque hay otro cuerpo, que por la ley de la gravedad universal, pues supongo que dos cuerpos que estén cerca se atraerán el uno al otro, el más grande atrae al otro y supongo que eso hará que haya órbitas que se que las órbitas no sean elípticamente perfectas. (#2: *Plutón*)
Using background subject knowledge	The reader uses domain knowledge to establish or clarify meaning or to elaborate on or extend the information in the text.	Vale, aquí lo que dice es que, a mediados del Siglo XX, o sea, mil tal tal tal, el astrónomo Gerald Kuiper dijo que existía, o sea, predijo, por sus cálculos supongo, que había un enjambre, cuando dice enjambre es de abejas, pero es en sentido figurado, se refiere a un mogollón de cuerpos situados todos juntos, o más o menos .. cuando se dice juntos en cosas del espacio, separados pero bastante cerca .. Plutón es el último planeta, por eso se coge como referencia. (#5: *Plutón*) Este punto hace referencia a planetas, entonces, para entenderlo, te acuerdas de los planetas en la situación en la que están. (#5: *Plutón*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Using general knowledge or experience	The reader uses general world knowledge or experience to establish or clarify meaning or to elaborate on or extend the information in the text.	Se supone que el tiempo de vida que le dan a la lanzadera es de 11 años, y pone en la trayectoria heliocéntrica, que supongo que tendrá que ver algo pues, con el helio que hay en el espacio o algo, pero no lo sé cierto. (#1: *Rosetta*) yo creo que es importante que [los *subsystems*] vayan ahí ya que .. si esa es la parte que va a estar más protegida, mejor equipada para todo, ya que esa parte es esencial para la misión, seguramente lleven ahí los controladores del resto de la nave, para que en ningún momento .. para que por lo menos vayan en el mejor sitio posible, el que menos riesgo haya que se rompan. (#2: *Rosetta*) la vida del .. de la nave que se va a enviar es de .. de once años, en una trayctoria heliocéntrica, o sea, dando vueltas al sol. (#2: *Rosetta*) En la siguiente frase *novel* no me sé la traducción directa, pero como .. se oye [...] ha ganado el premio Nobel, me da a entender que es una categoría elevada, eh .. de prestigio, entonces puede ser una metodología .. unos métodos de proceso de .. de gran prestigio, de gran calidad o algo así. (#3: *Materials*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Speculating, interpreting, or hypothesising about the significance of a word or phrase	Establishing a provisional meaning which may be modified later 'downstream'.	En la siguiente frase, *track* no sé lo que significa, por deducción puede ser aguantar, soportar, algo así, soportar el ataque de asteroides o algo así, por deducción un poco, inventándomelo también otro poco, creo que podría ser eso (#3: *Rosetta*) *Novel processing* .. *novel* no sé, en este caso *novel* es nuevos ¿no?, productos novel, en nuevos procesos (#2: *Materials*) [...] voy a pensar que está relacionado, a no ser que posteriormente me de cuenta de que no. Así que me quedo con ese significado, y ya veré si lo modifico posteriormente, que estaba equivocada (#4: *Materials*)
Paraphrasing or summarising (L1 only)	The reader summarises, comments on or explains the focal sentence in order to clarify or consoldate comprehension.	Es una frase simple que deja claro que .. que el telescopio no está diseñado para .. para cuando lo lancen repararlo o algo, está claro. (#1: *Nuevos Ojos*, ll. 57-59) Luego nos habla, del precio que pueda tener el nuevo observatorio .. que según se nos quiere hacer entender, va a ser mucho más barato que el del Hubble por que, no va a tener, coste de mantenimiento como el, actual telescopio. (#6: *Nuevos Ojos*, ll. 49-59)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Using textual clues	The reader uses the structure of the text, his or her expectations about the structure, or other textual clues.	Entiendo el significado de la frase porque también está bién ... esquematizado, pone *the task usually requires three stages* y luego a parte ya me da los tres *stages*. Entonces, al estar bien planteado, bien esquematizado, pues lo entiendo mejor. (#1: *Materials*) En esta frase le doy más importancia a lo que es la base de la frase, que es lo que está entre las comas (#1: *Nuevos Ojos*) De todas formas, el título me da la pista que necesito. (#7: *Rosetta*)
Identifying key words or phrases (or unimportant words and phrases)	The reader identifies words or phrases which he or she considers important or, conversly which can be ignored or skipped.	Al releer la frase esta, evito las expresiones innecesarias, como 'según se cree' para ... leer la frase de una forma más corta, y acabar antes, y entenderla rápidamente. (#1: *Nuevos Ojos*) A parte, ahora le doy más importancia a Alan Dressler, porque estoy viendo que es, es un protaganista en este texto porque ya, porque está .. porque hay varias que son cosas que dice él. (#1: *Nuevos Ojos*) En la siguiente frase, la entiendo .. todo, lo entiendo todo menos *aging* que lo considero importante, que no lo puedo deducir dentro de .. de la frase, y consideraría que .. que tendría que buscarlo en un diccionario, porque es.. es importante para el texto y para la frase. (#3: *Materials*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Predicting	The reader predicts upoming text content or how the text will be organised	En este párrafo se supone que nos va a explicar por qué están los astrónomos tan interesados en el cinturón de Kupier, porque hace una pregunta aludiendo a eso. (#1: *Plutón*) y ahora el texto irá viendo cuales son las diferentes casos en los que... en los que se probará.. no sé, pensará en un material para cada caso y luego se verá cual es el mejor, no? (#2: *Materials*) Está claro que en este texto y ya sé que prácticamente voy a obtener toda la información para que me den el dibujo, pero lo harán al final, pero ya me iré quedando dónde están las cosas. (#2: *Rosetta*)
Monitoring or evaluating comprehension	Monitoring comprehension or evaluating understanding. Commenting on the process or strategy being used. Deciding on strategy use. Referring to difficulties. Reporting on awareness of accomplishment or failure to understand.	Creo que sé de qué va la idea, pero no logro entenderla [...] no logro.. unir la idea que creo que hay en el principio con lo de lo que hay después. (#1: *Materials*) Esta frase no la entiendo muy bién, porque hay palabras sueltas que no entiendo, no sé conectarlas entre sí. (#3: *Rosetta*) no llego a unir las palabras para coger un significado claro. (#4: *Materials*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Revising or confirming hypotheses	The reader realises a previously established meaning may not be correct.	*cast alloy steels* no sé lo que es, la deducción que había hecho anteriormente de *cast* me parece que es errónea, porque aquí en esta frase no .. no le encuentro sentido, ese sentido. (#3: *Materials*) Antes había deducido que *data* podía ser algo de fecha, pero leyendo la frase de *the data rate need to be* .. hasta el final, pues no es fecha, porque no tiene sentido. (#3: *Rosetta*)
Re-reading, reading more slowly or with greater attention	This strategy reflects various behaviours, including reading more slowly or more carefully. It is used when information can not be assimilated easily.	Lo entiendo todo, pero tengo que.. separar la frase para .. para entender cada idea.. cada idea que da, o sea [...] tengo que leerlo poco a poco para saber cada idea. (#1: *Materials*) La siguiente frase es bastante larga, por lo que o se lee muy lentamente y entendiéndola paso a paso, o hay que leerla varias veces para poder.. captar todo lo que me expresa la frase. (#3: *Nuevos Ojos*) La siguiente frase, pues lo mismo, dos veces mejor que una, y si lo haces una, o sea, si lo lees una vez, que sea no muy rápida. (#3: *Plutón*)

Table 7. 6 (continued). Strategies identified from the protocols.

Strategy	Description/Funtion	Examples from the transcripts
Reading on	Despite not understanding a portion of the text, the reader continues reading in order to either understand the general idea of the focal sentence or ignore it. It is also used when the reader picks up on textul clues about what is to follow.	Este párrafo lo entiendo quitando de algunas palabras técnicas que no sé, pero más o menos puedo intuir de lo que se trata. (#5: *Nuevos Ojos*) No tengo una idea concreta de lo que puede significar, pero.. no creo que .. no creo que me vaya a influir mucho en el significado de.. bueno, puede ser.. no sé, es dudoso, igual si que influye, pero bueno, va, entiendo la frase. (#3: *Materials*) Todo bien hasta que en la línea 84 dice 'rising labor costs' no sé lo que quiere decir, por el contexto por ahora tampoco la he entendido. No he llegado a entender lo que significa, pero de todas formas la idea del párrafo si que creo que la he cogido, con lo cual, no es importante para entender lo que significa el párrafo. (#4: *Materials*)
Searching for specifc information (scanning)	The reader looks for specific information in order to complete the task or to clarify details.	Bueno, aquí se acaba el texto. Ahora voy a buscar la información que me pide. (#2: *Plutón*) La siguiente frase he tenido que recurrir a párrafos anteriores para recordarme de quien era Mather. (#3: *Nuevos Ojos*)

Table 7. 6 (continued). Strategies identified from the protocols.

7.6.3 Results for Research Question 2

> Are the comprehension strategies used by the readers when reading in their L1 similar or different to those used when reading in their L2?

In order to answer this question, first the number of different strategies used by the participants when reading English texts was compared with the number of different strategies used when reading Spanish texts. Table 7.7 shows that of the twenty different strategies, thirteen (65%) were used to process both Spanish and English texts, fourteen different strategies were used when reading Spanish texts and nineteen when reading English texts.

Total number of different strategies reported for all texts	*Number of different strategies used for English (L2) texts*		*Number of different strategies used for Spanish (L1) texts*		*Number of different strategies used for both L2 and L1 texts*	
	Nº.	**%**	**Nº.**	**%**	**Nº.**	**%**
20	19	95.0	14	70.0	13	65.0

Table 7.7. The number of different strategies used for L2 and L1 texts.

Given that, by their very nature, the three TRANSLATION STRATEGIES *(Using L1 or other L2 to undestand words or phrases, Mental translation*[73]*, Literal translation*) are used exclusively when processing L2 texts, and one (*Paraphrasing or summarising*) is used exclusively when processing texts in Spanish, the result suggests that, in general terms, there is a certain

[73] Mental translation could be regarded as a form of paraphrasing in that the reader frequently attends only to the main points of the text segment in focus.

consistency or correspondence between the strategies used for processing the texts and carrying out the tasks in the two languages.

This can also be seen from Table 7.8 (pp. 278-279) which shows for each strategy (i) the reported frequency of use (i.e., the number of times used) as a percentage of the total frequency of use of all strategies in the four texts (L2+L1), (ii) the reported frequency of use in L2 texts only, as a percentage of the total frequency of use in all texts, (iii) the reported frequency of use in L1 texts only as a percentage of the total frequency of use in all texts, (iv) the reported frequency of use in L2 texts, and (v) the reported frequency of use in L1 texts.

Again, with the exception of the three TRANSLATION STRATEGIES, *Paraphrasing or summarising* – which accounts for nearly half (46.4%) of the total reported use of all frequencies of strategy use for texts in Spanish, even though only three of the seven subjects report having made use of this particular strategy – and *Using grammatical structure*, and *Using other linguistic knowledge*, all the remaining strategies have been drawn on to some degree by the subjects when reading both the L1 and L2 texts.

Closer examination of the types of strategy used and the frequency the strategy was reported as being applied, indicates that text and/or task factors have influenced the use of certain strategies. The influence of text factors and task factors can be seen more clearly from the data presented in Tables 7.9 and 7.10.

Table 7.9 (pp. 283-284) shows the reported frequency of use of each strategy for all texts, for both English texts together, and for both Spanish texts together, while Table 7. 10 (pp. 285-288) presents the frequencies and percentage of strategy use for each text individually.

Strategy	(i) *% of frequency of use in all texts*	(ii) *Use in L2 texts as a % of use in all texts*	(iii) *Use in L1 texts as a % of use in all texts*	(iv) *% of frequency of use in L2 texts*	(v) *% of frequency of use in L1 texts*
Using L1 or other L2 to understand words or phrases	8.9	8.9	0.0	12.7	0.0
Mental translation (converting the idea to Spanish)	13.8	13.8	0.0	19.6	0.0
Literal translation	0.8	0.8	0.0	1.2	0.0
Using grammatical structure	0.2	0.2	0.0	0.3	0.0
Using other linguistic knowledge	1.6	1.6	0.0	2.3	0.0
Using context	9.4	8.4	1.0	11.9	3.2
Connecting information from previous sections of text	1.6	0.6	1.0	0.8	3.6
Integrating the focal sentence with the developing mental model	2.9	1.5	1.4	2.2	4.8
Using background subject knowledge	2.8	0.9	1.9	1.3	6.4
Using general knowledge or previous experience	2.5	1.3	1.2	1.8	3.9

Table 7. 8. Reported frequency of use of each strategy in all texts, English (L2 texts and Spanish (L1) texts.

Strategy	(i) *% of frequency of use in all texts*	(ii) *Use in L2 texts as a % of use in all texts*	(iii) *Use in L1 texts as a % of use in all texts*	(iv) *% of frequency of use in L2 texts*	(v) *% of frequency of use in L1 texts*
Speculating, interpreting, or hypothesising about a word or phrase	10.2	9.6	0.6	13.6	2.0
Paraphrasing or summarising (L1 only)	13.7	0.0	13.7	0.0	46.4
Using textual clues	1.2	0.9	0.3	1.3	0.8
Identifying key words or phrases (or unimportant words	1.9	0.8	1.1	1.2	3.6
Predicting	0.8	0.3	0.5	0.5	1.6
Monitoring or evaluating comprehension	14.8	12.8	2.0	18.1	6.7
Revising or confirming hypotheses	1.6	1.6	0.0	2.3	0.0
Re-reading or reading more slowly	6.6	2.9	3.7	4.2	12.3
Reading on	2.7	2.3	0.4	20.0	1.2
Searching for specifc information (scanning)	1.9	0.8	1.1	1.2	3.6

Table 7. 8. Table 7. 8. Reported frequency of use of each strategy in all texts, English (L2 texts and Spanish (L1) texts.

Frequency of strategy use is approximately the same for two of the INTEGRATION STRATEGIES: *Integrating the focal sentence with the developing mental model* (which is also evenly spread across the four texts), and *Using general knowledge or previous experience*.

For three of the four METACOGNITIVE STRATEGIES, reported frequency of use is higher for the English texts; a situation we would expect given that readers are more usually aware of breakdowns in comprehension when reading in their L2. The rather surprising exception is *Re-reading or reading more slowly*, which is reported as being used more frequently for Spanish texts than for English texts. Table 7.10 indicates that the Spanish text *Nuevos Ojos en el Espacio para la Primera Luz* accounted for 35.7% of all uses of this strategy, so presumably readers found the amount and density of information contained in the text hard to assimilate at a first reading. This is confirmed if we look at the subjects' protocols for this text. The three extracts which follow are illustrative:

[42] <<Entiendo bien la frase, pero al ser frases largas, al ser una frase larga, y tan solo con una coma, pues tengo que releerla varias veces para .. para entenderlo bien lo que me dice>>. Subject #1.

[43] <<La siguiente frase es un lio entre adjetivos, cifras de centésimas, cuadracentésimas y todo eso que para entenderlo hay que leerlo varias veces.>> Subject #3.

[44] <<En esta frase, recuerda el telescopio Hubble, y además da mucha información.>> Subject #5.

Six strategies are reportedly used more frequently for the L1 (Spanish) texts than for the L2 (English) texts: *Connecting information from previous sections of text*, *Using background subject knowledge*, *Identifying key words or phrases*, *Predicting*, *Re-reading or reading more slowly*, and *Searching for specific information*. In some ways this is unexpected. L1 reading is usually a more automatic process with fewer breakdowns in comprehension, and L1 readers are usually less aware of the operations they engage in than L2 readers. We have already commented (above) on the higher use of *Re-reading or reading more slowly*, and some observations regarding the reported use of the remaining five strategies seem in order.

Two of the strategies used more in carrying out the tasks in L1 are what we have classed as INTEGRATION STRATEGIES. They are *Connecting information from previous sections of text* and *Using background subject knowledge*. A speculative explanation for the higher use of *Connecting information from previous sections of text* in the L1 reading tasks, is that, as we discussed in Section 3.3.7, text comprehension requires the integration of information across sentences which, in turn, requires temporarily holding information in WM. The manipulation of information from the text in more familiar terms (i.e., the reader's L1) may have facilitated the carry over of information, as well as encouraged resonance processes. It may be the case, then, that the readers simply had the information more available and were able to use the strategy more successfully. It is this which is reflected in their protocols. A similar explanation might apply to the greater use of *Using background subject knowledge*. In other words, reading in their L1 has facilitated the retrieval of information stored in LTM. On the other hand, text factors may also have been at work. It can be seen from Table 7.10 that for the two Spanish texts and for one of the English texts the use of *Using background subject knowledge* is very nearly equivalent, while its use is only reported once for the *Materials* text.

Identifying key words or phrases and *Predicting*, are both TEXT-BASED STRATEGIES. One of the L1 texts, *Nuevos Ojos en el Espacio para la Primera Luz*, accounts for 56.2% of the total use of the first of these, and we have already noted that this was an information-dense text with a lot of data and proper names. As they worked their way through the text, some of the subjects realised that they would need to pay more attention to some of the people mentioned in the text. To give just one example:

[45] <<A parte, ahora le doy más importancia a Alan Dressler, porque estoy viendo que es, es un protagonista en este texto porque ya, porque está .. porque hay varias que son cosas que dice él.>> Subject #1.

The use of *Predicting* also depends on characteristics of the text. This strategy was used for one of the L2 texts and the second of the L1 texts (*El Hallazgo de un gran objeto más allá de Plutón Replantea la Idea de Planeta*). To take the L1 text, lines 46-47 include a question: "Pero, ¿no es Plutón mismo un planeta?" The subjects responded to this in their protocols with the following comments:

[46] <<Y ahora viene una pregunta, y nos dicen, ¿pero no es Plutón mismo un planeta? Y supongo que ahora contestará.>> Subject #1

[47] <<[leyendo] vale, ahora van a .. estoy seguro, convencido, de que van a empezar con lo de que cuando se descubrió Plutón unos decían que no era, otros que si era .. entonces van a ver, si Plutón es un planeta, porque Quaoar no, supongo.>> Subject #2

With respect to the last of the strategies which was reported as being used more frequently for the L1 texts; namely, *Searching for specific information*, Table 7.10 shows that it appears to be the nature of the task (labelling a diagram) based on the Spanish text *El Hallazgo de un Gran Objeto más allá de Plutón Replantea la Idea de Planeta* which is what has led to its high frequency of use. Indeed, this text alone accounts for nearly 44% of the total use of this strategy (see, for example, Subject #2's protocol for this task in Appendix D).

	All texts	*English texts (L2)*		*Spanish texts (L1)*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**
Using L1 or other L2 to understand words or phrases	76	76	100	0	0
Mental translation (converting the idea to Spanish)	118	118	100	0	0
Literal translation	7	7	100	0	0
Using grammatical structure	2	2	100	0	0
Using other linguistic knowledge	14	14	100	0	0
Using context	80	72	90.0	8	10.0
Connecting information from previous sections of text	14	5	35.7	9	64.3
Integrating the focal sentence with the developing mental model	25	13	52.0	12	48.0
Using background subject knowledge	24	8	33.3	16	66.7
Using general knowledge or previous experience	21	11	52.4	10	47.6

Table 7. 9. Reported frequency of use of each strategy in English (L2) and Spanish (L1) texts.

	All texts	*English texts (L2)*		*Spanish texts (L1)*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**
Speculating, interpreting, or hypothesising about a word or phrase	87	82	94.3	5	5.7
Paraphrasing or summarising (L1 only)	117	0	0	117	100
Using textual clues	10	8	80.0	2	20.0
Identifying key words or phrases (or unimportant words and phrases)	16	7	43.75	9	56.25
Predicting	7	3	42.9	4	57.1
Monitoring or evaluating comprehension	126	109	86.5	17	13.5
Revising or confirming hypotheses	14	14	100	0	0
Re-reading or reading more slowly	56	25	44.7	31	55.3
Reading on	23	20	87.0	3	13.0
Searching for specifc information (scanning)	16	7	43.75	9	56.25
Totals	**853**	**601**	**70.5**	**252**	**29.5**

Table 7. 9 (continued). Reported frequency of use of each strategy in English (L2) and Spanish (L1) texts.

		English texts (L2)				*Spanish texts (L1)*			
	All texts	*Materials*		*Rosetta*		*Nuevos Ojos*		*Plutón*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**
Using L1 or other L2 to understand words or phrases	76	39	51.3	37	48.7	0	0.0	0	0.0
Mental translation (converting the idea to Spanish)	118	53	44.9	65	55.1	0	0	0	0.0
Literal translation	7	3	42.9	4	57.1	0	0	0	0.0
Using grammatical structure	2	2	100	0	0	0	0	0	0.0
Using other linguistic knowledge	14	6	42.9	8	57.1	0	0.0	0	0.0

Table 7. 10. The total number of reported frequencies of use of each strategy for each text.

		English texts (L2)				*Spanish texts (L1)*			
	All texts	*Materials*		*Rosetta*		*Nuevos Ojos*		*Plutón*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**
Using context	80	48	60.0	24	30.0	4	5.0	4	5.0
Connecting information from previous sections of text	14	5	35.7	0	0.0	6	42.9	3	21.4
Integrating the focal sentence with the developing mental model	25	8	32.0	5	20.0	7	28.0	5	20.0
Using background subject knowledge	24	1	4.1	7	29.2	7	29.2	9	37.5
Using general knowledge or previous experience	21	9	42.9	2	9.5	6	28.6	4	19.0

Table 7. 10. The total number of reported frequencies of use of each strategy for each text (continued).

		English texts (L2)				*Spanish texts (L1)*			
	All texts	*Materials*		*Rosetta*		*Nuevos Ojos*		*Plutón*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**
Speculating, interpreting, or hypothesising about the significance of a word or phrase	87	45	51.7	37	42.5	2	2.3	3	3.5
Paraphrasing or summarising (L1 only)	117	0	0.0	0	0.0	45	38.5	72	61.5
Using textual clues	10	1	10.0	7	70.0	0	0.0	2	20.0
Identifying key words or phrases (or unimportant words and phrases)	16	4	25.0	3	18.8	9	56.2	0	0.0
Predicting	7	3	42.9	0	0	0	0.0	4	57.1

Table 7. 10. The total number of reported frequencies of use of each strategy for each text (continued).

		English texts (L2)				Spanish texts (L1)			
	All texts	*Materials*		*Rosetta*		*Nuevos Ojos*		*Plutón*	
Strategy	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**	**Freq.**	**% of total**
Monitoring or evaluating comprehension	126	53	42.1	56	44.4	11	8.7	6	4.8
Revising or confirming hypotheses	14	6	42.9	8	57.1	0	0.0	0	0.0
Re-reading or reading more slowly	56	15	26.8	10	17.9	20	35.7	11	19.6
Reading on	23	13	56.6	7	30.4	1	4.3	2	8.7
Searching for specifc information (scanning)	16	3	18.75	4	25.0	2	12.5	7	43.75
Totals	**853**	**317**	**37.2**	**284**	**33.3**	**120**	**14.0**	**132**	**15.5**

Table 7. 10. The total number of reported frequencies of use of each strategy for each text (continued).

7.6.4 Results for Research Question 3

Are the readers aware of the strategies they use while reading and do they have control over these strategies?

Table 7. 11 shows the results for reported strategy use and frequency comparing the four metacognitive strategies (*Monitoring or evaluating comprehension, Revising or confirming hypotheses, Re-reading or reading more slowly* and *Reading on*) with the rest.

	All texts	*Metacognitive strategies*		*Other strategies*	
Strategy use	**Freq.**	**Freq.**	**% of total**	**Freq.**	**% of total**
English texts (L2)	601	168	28.0	433	72.0
Spanish texts (L1)	252	51	20.2	201	79.8
Totals	853	219	25.7	634	74.3

Table 7. 11. Reported frequency of metacognitive and other strategies as a percentage of total frequency.

The pattern here indicates that readers are more aware of their metacognitive processes, and use them more frequently, when reading in L2 than in L1; a result we would expect given that L1 reading is normally a fairly automatic process while in L2 reading comprehension is more likely to break down causing the reader to be more aware of processing problems and the mental operations he or she engages in to overcome them.

The results also show that in L2 reading the four metacognitive strategies account for almost one third of the total frequency of use of all strategies, suggesting that, in general terms, the subjects are aware of the strategies they use and can and do control their use providing they understand enough of the situation described in a text to apply the strategy.

7.7 Conclusion

In this Chapter, we have described an experiment designed to identify the reading comprehension strategies employed by a group of learners in the context of a specific task to be carried out while reading expository texts, and their awareness regarding their use of such strategies in both Spanish (their L1) and English (their L2).

In general, the subjects showed greater awareness of the strategies they used, and when they applied them, when carrying out the tasks in their L2. Nevertheless, an important point to be made is that when reading in an L2, readers do not 'switch off', as it were, their L1, rather they make use of it as a tool to understand, to clarify the meanings of words, to establish the meanings of sentences, to help with the formation of propositions and to integrate these into a macrostructure of the text.

However, in order to use one of the translation strategies, or, indeed, any strategy, the reader must understand enough of the text to be able to apply it successfully. Lack of understanding, in fact, is the principal cause of Student #7's inability to establish the significance of a phrase. He seems to be aware of what strategies he could use, but due to poor L2 proficiency is unable to make them work. Thus, although he looks for clues in the text, tries to link ideas, and even uses headings, he is unable to form a foundation on which to build a representation of the meaning. The long extract below, from his protocol for the *Rosetta Spacecraft Design* text, is illustrative of his difficulties:

[48] <<[...] no hay nada que me de una pista de lo que se me habla.

[...]

<<En el siguiente punto, me hablan un poco del diseño .. o sea, de sobre cómo se ha diseñado, no es que lo entienda perfectamente el .. el .. el pequeño texto siguiente, pero 'design' sí que sé que es *diseñar*, y 'requirements' también sé lo que es, por lo que se me da una pista de lo que se me habla, de todas formas tampoco hay muchas pistas, si no es por el título, tampoco lo hubiese sabido, porque hay muchas palabras que no entiendo, y el texto no queda claro.

[...]

En el siguiente punto, aunque no lo tengo claro, hay palabras que se parecen al castellano, como por ejemplo, 'thermal', que me recuerda a *térmico*, *diseño térmico*. Luego sé de lo que se me habla en este punto, pero no sé lo que se me dice en concreto. También hay una palabra que sale que es temperatura, luego sé que se está hablando del térmico, del diseño del térmico.

El siguiente punto no está nada claro, 'able' no sé lo que significa. 'Autonomously' no sé lo que significa, me parece a una palabra en castellano que es *autonomía*, ¿no?, 'flybys' tampoco sé lo que es .. 'far' tampoco, 'ground' tampoco. No sé, hay muchas palabras que no entiendo y se me nubla el significado.

El siguiente punto, pues bueno, más de lo mismo, aquí por ejemplo en este punto es que no sé ni de lo que se me está hablando, porque no hay una pista, no hay una palabra que se parezca al castellano .. no hay dos palabras .. no entiendo que haya dos palabras que estén relacionadas, que me indiquen .. está hablando de esto .. no.>> (#7 *Rosetta*)

Of course, Student #7 is not the only reader who found that lack of word knowledge impeded comprehension; all the participants experienced this problem to some degree. The following comment, by Student #3, is just one more example:

[49] <<En la siguiente frase vamos, no entiendo nada, porque sigo sin saber lo que es ‘accuracy’, ‘manoeuvring’ y ‘vicinity’, entonces, como no entiendo las palabras, y son básicamente toda la frase, pues no puedo entender la frase.>> (#3 *Rosetta*)

Many, if not most, reported instances of strategy use show combinations of two or more strategies. For example, Student #3’s think-aloud protocols, as extracts [50] and [51] show, contain numerous instances where, in order to clarify the meaning of a word or phrase, she reports using translation, inferring from the context, or drawing on grammatical or subject knowledge, all combined with a degree of speculation.

[50] <<Para el cuarto punto, eh, ‘compromises’ se parece mucho al castellano y me da a entender *compromiso*, pero dentro de la frase no tiene .. no tiene significado, entonces no sé lo que es.>> (#3 *Materials*)

[51] <<[...] ‘on board’ supongo que es *a bordo*, por ‘on’ que es *encima*, *en*, y ‘board’ parecido al castellano y me lo he inventado un poco, pero tampoco creo que sea muy .. muy importante, quizás.>> (#3 *Rosetta*)

Finally, while language aspects appear to have influenced the use of some strategies, other instances of strategy use have been largely determined by the nature of the task, characteristics of the text (other than the language in which it was written), as well as the motivations of the readers and their attitudes to the task in hand.

Chapter 8

Constructing meaning and knowledge acquisition from expository texts

8.1. Constructive reading activities

Much of the research into reading has been carried out on subjects reading in their first language (L1), under laboratory or near-laboratory conditions. Although this allows variables to be strictly controlled, it also raises questions about the 'naturalness' of some of the activities. How a reader processes a single word or a single sentence presented on a computer screen may, for example, be different to what he or she would do when reading the same sentence contained in a longer text. In other words, in a laboratory situation, the reader's responses might be limited by the nature of the task. It could also be argued, of course, that classrooms are 'unnatural' but, as Urquhart & Weir (1998: 237) point out, as long as we are aware of this, it "is something we have to live with".

Our concern in this study was to explore activities that would induce students to process texts more deeply, enhance their understanding and encourage learning of the text topic, reflect authentic reading tasks and at the same time fit naturally into standard classroom procedure. This last objective seems particularly important given the unavoidable time constraints existing in the university where this research was carried out, or, indeed, in any other educational institution. Clearly, allocating the number of hours required to train approximately 150 students on an individual basis is impracticable. Large group training on the other hand, if it works successfully, could be an effective and efficient method of enhancing students' comprehension of expository texts, their learning of declarative knowledge from the texts, as well as their awareness of how-to-read such texts; i.e., their procedural knowledge. In this sense, the teaching of reading comprehension involves raising awareness of how each reader goes about the reading task, the different reader behaviours and strategies available and how to use them, and the processes involved in understanding and actively constructing meaning. Reader-specific responses to a text can be allowed and even encouraged. Moreover, as Urquhart & Weir (1998: 171) point out, teaching reading also involves:

> […] structured feedback as to why responses were acceptable or not, some instruction in how to arrive at the desired response, in addition to more global instruction in how to set about the task, alternative strategies which might prove helpful, etc.

The study reported in this and the following Chapter attempts to answer the second set of research questions stated in sub-section 1.2.3:

4) Can the benefits of self-explaining texts can be extended to students with an elementary/lower-intermediate level of English as a second language, reading expository texts in English?

5) Can readers with this level of English be instructed to self-explain L2 texts in a classroom situation as a group rather than individually, and will this group instruction improve the individual comprehension and learning of the participants?

6) Self-explaining can be operationalised in different ways. Are different forms of self-explaining; that is, different constructive

activities, more, less, or equally effective in achieving the stated goals in our teaching-learning situation?

We begin by describing the constructive activities in which students were given training, and which foment the kind of knowledge building termed by Wittrock (1974, 1989) *generative learning*. In generative learning, rather than concentrating on facts, learners are encouraged to construct meaning through analysing ideas, thinking about how different 'items' or 'units' of information relate to each other, and integrating those ideas and relations with what they already know. Thus, constructive activities encourage active engagement with the text. They allow the reader to go beyond the information on the page, and build a deeper comprehension of the situation or events described in the text by encouraging the use of higher order learning processes such as inference generation, integration of content and the construction of a coherent situation model.

Three constructive approaches were adopted: Self-explaining, Note-taking and Asking Questions. We do not wish to imply that these generic approaches to text comprehension are necessarily the best or most effective. Nevertheless, they do involve a core of cognitive and metacognitive processes that cut across domains. These processes include monitoring, selecting, elaborating, transforming, organising, and evaluating (Mayer, 1996; Weinstein & Mayer, 1986). Each approach is explained further below. The experiment itself is described in Chapter 9.

8.2 Self-explaining

Self-explaining a text has already been described and exemplified in sub-section 1.2.1. To briefly recap, however, self-explaining is the process of generating explanations to oneself. By explaining the content of a piece of written discourse, the integration of new information into existing knowledge (learning) is facilitated (Chi, De Leeuw, Chiu & Lavancher, 1994). Self-explanation has been shown to improve not only the acquisition of problem-solving skills when studying worked-out examples, but also that it can promote the learning of declarative knowledge from expository text (e.g., Bielaczyc, Pirolli & Brown, 1995; Chi & Bassok, 1989; Chi, De Leeuw, Chiu & Lavancher, 1994; Magliano, Trabasso & Graesser, 1999). These studies report that readers who either explain the text spontaneously, or when prompted to do so, understand more and construct richer mental models of the text topic.

However, much of the research into self-explaining involves an individual reader, working alone with a researcher, reading a sentence aloud and then explaining what he or she has understood (e.g., Ainsworth & Loizou, 2003; McNamara, 2004). As explained above, we were interested to see whether the benefits of self-explaining seen in the comprehension and learning of students taught individually, could be extended to a relatively large class of second language readers tutored as a group.

8.3 Note-taking

One of the difficulties of reading in academic situations is that the student does not always know the purpose behind reading a text. In other words, students may be asked to read a text with no other apparent reason than to read it; that is, because they have been asked by their tutor to do so. One possible consequence of this is that the students simply work their way through the text without noticing or paying much attention to what they understand. As we noted in our discussion of split focus (in Section 6.5.1), this can be exacerbated in an L2 situation, where the student may be unsure whether he or she should read for content information or linguistic information. It is important, therefore, for students to take notes with a particular purpose in mind, to select relevant information, to make connections, to relate concepts to their prior knowledge and experience and transform the information into their own words (e.g., Van Meter, Yokoi & Pressley, 1994; Peverly, Brobst, Graam & Shaw, 2003). In this way, one of the advantages of note-taking is that it encourages readers to reduce and represent information in an organised way which is amenable to subsequent review. The underlying goal of note-taking, therefore, is to identify the main ideas and information relevant to a particular purpose, and to structure this information in such a way as to make it memorable and/or to facilitate its retrieval. Clearly, then, as Fajardo (1996) points out, note-taking is a highly complex task, involving a combination of different skills.

By 'notes' we do not refer simply to a list of the main points in a given text, or to what Nwokoreze (1990) calls "verbatim transcript"; i.e., copying phrases or sentences directly from the text, but to a somewhat broader system of organising and recording information. This may include the basic linear form, but also make use of abbreviations, mind maps, conceptual networks, diagrams, drawings, and so on. Indeed, the participants in this research were shown several formats and encouraged to develop their own systems for taking notes. They were encouraged to regard their notes not simply as a means of storing superficial details from the text, but to think about what they wrote, and to interact with their notes (Wittrock, 1990).

Furthermore, and as we noted in our investigation into the use of comprehension strategies described in Chapter 7, L2 reading is not a monolingual process. Several other studies have shown that when adult learners read L2 materials they frequently use some sort of translation[74], even those with a high level of proficiency (e.g. Block 1986; Li & Munby 1996), thus a case can be made for allowing students to take notes on L2 materials in their L1. One reason is because having to make notes in one's L2 may encourage copying from the source text, while being able to use one's L1 may encourage learners to think more about the information they wish to record and use their own words to do so. In other words, being able to take notes in one's L1 can facilitate the difference between superficial and deep processing (Elshout-Mohr, van Daalen-Kapteijns & Sprangers, 1988). To apply an observation by Kern (1994: 441) regarding mental translation, permitting students to take notes in their L1 "may facilitate the generation and conservation of meaning by allowing the reader to represent portions of L2 text [...] in a familiar memory-efficient form".

L1 notes from an L2 text are not 'translations'. For one thing, the notes only require attention to the relevant main ideas, and may include items of information from the reader's own background knowledge. Moreover, they may include abbreviations or shorthand which is only meaningful to the writer. A further advantage of L1 notes is that they avoid the production errors which may occur when writing in one's L2. The participants in this study were allowed, therefore, to take notes in either English or in Spanish.

The advantages of taking notes while studying science subjects are neatly summed up by Campanario (2001b)[75]. They include the fact that notes:

[74] In the context of reading comprehension we could broadly define *translation* as 'using the first language to understand a text written in the second language'.

[75] Actually, Campanario refers here to *esquemas* whose main purpose, he says (2001b: 5.4), is to show the logical structure between the main ideas. In our use of the term *notes* we refer to a broader, more generic concept. The advantages enumerated by Campanario are still applicable, however.

- Present a synthesis of the most important ideas in a text.
- They enable the learner to visualise the global and/or logical structure.
- Notes can show the structure of classes and sub-classes, as well as the relationships between different elements.
- Notes can act as a summary.

To these, we may add the following points:

- Writing note aids monitoring understanding and comprehension, as it encourages the reader to transform and evaluate (in short, to actively process) the information.
- Writing notes encourages students to *organise* their knowledge, and recognise how each complex idea unit, principle, or concept in a text are related to each other and to previous knowledge.

8.4 Asking questions

Research into strategic processes in reading has "yielded numerous strategies that facilitate the acquisition of knowledge from text" (Ozgungor & Guthrie, 2004: 437). One such strategy is *elaborative interrogation*, described by Willoughby & Wood (1994: 139) as "[...] a higher-order questioning strategy that uses 'why' questions (e.g., 'Why would that fact be true?') in order to encourage students to connect new information in their own richly developed knowledge base".

Thus, as opposed to shallow questions which are more conducive to learning facts, higher-order questions (such as, Why ...?, How ...?, What would happen if ...? , What are the reasons for ...?) go beyond superficial details and require the learner to elaborate infomation (for example, to connect new and prior knowledge) in order to answer them.

Many other studies in the literature suggest that question generation is a fundamental component of the cognitive processes operating at deep conceptual levels, such as in the learning of complex materials (Collins, 1985; Graesser, Singer, & Trabasso, 1994; Palinscar & Brown, 1984; Schank, 1986), and in text comprehension (e.g., Collins, Brown, & Larkin, 1980; Graesser, Person, & Huber, 1992; Graesser & Clark, 1985; Hilton, 1990; Kintsch, 1998)[76].

In question asking tasks, readers ask questions about each sentence (or a section) of the target text (Olson, Duffy & Mack, 1985). In the case of narrative texts, it seems that readers can generate many classes of questions and inferences (Graesser, Singer & Trabasso, 1994; Zwaan & Radvansky, 1998). In fact, both Hoey (1983), and in a second language context, Widdowson (1984), suggest that treating a text as if it were one half of a dialogue, and asking questions of the text, is one way of testing it's coherence. Thus, each sentence written by the author anticipates an imagined question, comment or expectation from the reader. The next sentence is the response to the reader's imagined question. Hoey (1983: 170-171) explains the idea in the following way:

> The writer initiates his discourse with a first sentence ... The reader scans the first sentence and forms expectations as to the information that might follow. No harm is done by representing these expectations as questions. The writer then offers a further sentence as an answer to one or more of his or her questions (or expectations).

[76] Indeed, Graesser, Olde, Pomeroy, Whitten, Lu & Craig (2004: 6) suggest that "[...] any given cognitive or behavioral task can be decomposed into a set of questions that a person asks and hopefully answers."

As a brief and simple example of dialogue between a reader and writer, below is a short extract from pages 144-145 of L. Frank Baum's *The Emerald City of Oz* (a sequel to the *The Wizard of* Oz), together with, in upper case, what might be a reader's questions:

> After leaving the Whimsies, Guph continued on his journey and penetrated far into the Northwest.
>
> [WHY?]
>
> He wanted to get to the country of the Growlywogs, and in order to do that he must cross the Ripple Land, which was a hard thing to do.
>
> [WHY HARD?]
>
> For the Ripple Land was a succession of hills and valleys, all very steep and rocky, and they changed places constantly by rippling.
>
> [WHAT DO YOU MEAN?]
>
> While Guph was climbing a hill it sank down under him and became a valley, and while he was descending into a valley it rose up and carried him to the top of a hill.

Hoey (1983: 171) goes on to say that if for any reason the reader's questions are not answered or do not satisfy the expectations that have been created, the reader:

> [...] retrospectively has to re-create the question that it [the sentence] is answering, and if this is in turn impossible, the reader assumes that the sentences are in fact unrelated and seeks a relation elsewhere in the discourse.

With respect to technical texts, however, it is much more difficult to generate good questions. According to Craig, Ghoulson, Ventura, Graesser and the Tutoring Research Group at The University of Memphis (2000: 242), who cite research from several countries (e.g., Buseri, 1988; Ohlsson, 1995; Good, Slavings, Harel, & Emerson, 1987; Nickel & Fenner, 1974), questions from university students are generally speaking “infrequent and unsophisticated”. Graesser and Person (1994), in a study with North American high school and university students, classified students’ questions according to Bloom’s (1956) taxonomy of educational objectives. They found that the vast majority (92%) of questions asked by the students referred to simple facts. Only 8% required any sort of reasoning. Graesser & Person (1994: 131) concluded that:

> Given that most students have not mastered effective question-asking skills, then there should be benefits in learning after they are taught how to ask good questions.

There are several reasons why students may find it difficult to ask deep-level questions on expository texts. One is that teaching programmes in the L1 designed to train readers (whether children or adults) to ask deep-level questions are relatively rare (Alvermann & Moore, 1991). As Campanario (2001a) observes, referring to the teaching of science in secondary schools in Spain: “Casi siempre es el profesor el que pregunta en clase. Rara vez permitimos que los alumnos formulen preguntas con absoluta libertad”.

As regards the English as a foreign language reading lesson, Bernhardt (1991a, 1991b), Nuttall (1982) and Urquhart & Weir (1998) present a not unsimilar picture. Bernhardt suggests that many texts are specially written to illustrate aspects of lexis or grammatical structure rather than to teach comprehension, and points out that students do “not learn how to use or interpret printed discourse for meaning ... [and] ... are rarely asked to display nonteacher-mediated understanding” (1991b: 182) by, for example, asking their own questions of a text.

It would seem, then, that learners are rarely required to generate their own questions, but merely answer those asked by the teacher or provided by the textbook. As a result, not only are students not given the opportunity to practice formulating their own questions, what models they are given rarely, if ever, go beyond a superficial level.

In our discussion earlier (Section 6.6) about the use of authentic materials, we cited a text about Easter Island which seems typical of the sort of text widely used for 'teaching' reading comprehension in the English as a foreign language class. Accompanying the *Easter Island* text are nine questions which are shown below as they appear on the same webpage[77]:

> *Easter Island*
>
> What does the article talk about?
> Where is Easter Island?
> What mystery is located on Easter Island?
> How many statues are there?
> How much do they weigh?
> Why did they build the statues?
> What are to [*sic*] theories about why the statues were built?
> (1)
> (2)
> What happened to the culture that built the statues?
> Why did that happen?

Fig. 8.1. Questions on the 'Easter Island' text.
Source: <http://bogglesworld.com/graded_reading_materials/two_mysteries.doc>
Date retrieved: 20 November 2005

[77] The blurb accompanying this activity states that it is suitable for many levels and ages. The context in which we came across the text was that of an EFL class for Spanish children aged 13-14.

We can note immediately that all these questions are factual, referring to explicit information in the text. What is not clear is whether their purpose, in the words of Williams & Moran (1989: 225), is “to check comprehension, facilitate comprehension or simply ensure that the learner reads the text”. The problem with this type of material (the text + questions) is that they focus on linguistic aspects such as the frequency and the meanings of individual words, but contain little of interest (other than the fact that the Moai statues exist), and fail to provide any practice in developing control over global coherence, integration of information and inferencing. They may, therefore, encourage more shallow, more superficial and more local processing strategies at the expense of comprehension processes more appropriate to uncover meaning at deeper levels.

The web site claims that the materials “[...] have been teacher tested with excellent results on the following groups of students:

(1) Intermediate to advanced university students.
(2) Intermediate to advanced high school students.
(3) Advanced middle school students.
(4) Elementary school teachers in intensive training programs.
(5) Corporate managers in intensive training programs.
(6) Adults in a language institute setting.”

What the web site does not say, is what it means by “excellent results”. If, as we suspect, it refers to the students getting the answers correct, then the activity is a good example not of a reading comprehension lesson, but simply of one based on a text. Rather than authentic, the task is merely ‘pedagogical’ (e.g. Nunan, 1989).

Tomlinson, Dat, Masuhara & Rubdy (2001: 97) comment that many materials writers appear to assume that most adult learners “do not want and would not gain from intellectually demanding activities whilst engaged in learning the target language". These nine questions form a fine example of an intellectually *un*demanding activity, and one which we believe Sweet (1899: 180) would consider an example of "unnecessary triviality". Answering this type of question hardly seems to reflect a real-life reading purpose.

Out of curiosity, we asked a group of forty of our own students to evaluate the materials on a scale from 1 to 5 where '1' meant "I did not find the materials interesting or useful and would definitely not like to do this sort of exercise again", '3' corresponded to "I found the materials neither especially interesting or useful, nor completely useless" and '5' meant "I found this very useful and would like more exercises of this kind". The results are shown in Table 8.1. The first row shows the rating scale. Although this was from 1 to 5, two students rated the materials as 1·5. The second row shows the number of students who voted for each value on the scale.

Easter Island evaluation							
Rating	1	1.5	2	3	4	5	Total
No. of students	0	2	19	13	6	0	40

Table 8.1. Class evaluation of the *Easter Island* reading resources shown above.

Students were also asked to give reasons for their rating. Positive comments, given by those who rated the materials with a '4', included the fact that they were very easy and interesting. These students wanted to know more about the statues. Students who gave low ratings also wanted to know more about the statues, but said they had found the materials too easy and boring. Moreover, the questions were trivial and the text was poorly written.

If this sort of activity is the norm for reading comprehension, it is not surprising that students (and perhaps many teachers) are satisfied if they (or, in the case of teachers, their students) can answer shallow questions and inferences which refer to explicit facts in the text (cf. Dillon, 1988; Graesser & Person, 1994).

A second reason why asking questions about expository texts, and answering them, is difficult, is that the topic may be unfamiliar. As a result, readers do not always know what they have understood or, indeed, whether they have understood. In other words, they do not always know what they don't know, and as a result may not realise when they don't understand (Miyake & Norman, 1979; Otero & Campanario, 1990; Otero & Kintsch, 1992). The concepts and relations that expository texts present to readers may well be new to them. By definition, therefore, readers have limited domain knowledge which would help guide their processing of the text, and they must depend on the information contained within it. Thus, readers may not know enough about the topic to be able to generate the questions or inferences which might help them understand. In the words of the title of an article by Miyake & Norman (1979): "To ask a question one must know enough to know what is not known". Several other studies suggest that the benefits of question asking are greater when readers are knowledgeable about the topic (e.g., Willoughby, Wood & Khan, 1994; Willoughby & Wood, 1994; Woloshyn, Pressley, & Schneider, 1992).

Thirdly, readers may be unfamiliar not only with the general domain (e.g. chemistry or electricity) and the specific topic of the text (e.g. galvanic corrosion), but also with the conventions or mechanisms underlying, for example, the presentation of evidence, or the norms of argumentation (Dunbar, 1995; Duschl & Hamilton, 1997, cited by Goldman & Bisanz, 2002), as well as the socio-historical context of the research in question (Goldman & Bisanz, 2002).

However, several L1 studies have shown that students can be explicitly trained to ask good questions (i.e., questions that require deep inferences and explanations) and, moreover, that such training leads to improvements in the comprehension, learning, and memory of technical materials (Beck, McKeown, Hamilton & Kugan, 1997; Davey & McBride 1986; Gavelek & Raphael 1985; King, 1994; Palincsar & Brown 1984). Many of these studies used training procedures which formed part of the standard classroom activities and the training was developed over a number of sessions. In the Davey and McBride (1986) study, for example, students were given five training sessions distributed over two weeks.

If question-asking aids text comprehension and learning in a first language, presumably it will also serve the same functions in a second language. We were interested in exploring procedures that would both encourage students to ask deep-level questions (Bloom 1956; Graesser et al. 1992), while at the same time being ecologically valid; i.e., fitting naturally into the context of the second language class.

It also seems to be the case, however, that answering the questions generated is as important as asking them because in this way students are encouraged to clarify concepts or relate ideas to prior knowledge (King,1995; King & Rosenshine, 1993).

The following Chapter describes how groups of students were trained in the three constructive activities discussed above.

Chapter 9

The main experiment

9.1 Introduction

Given the relatively complex nature of the experiment, we first provide (in Section 9.2) an overview of its basic design, components, organisation and time schedule. This can also be seen in tabular form in Tables 9.1a and 9.1b. We then describe the reading materials that were used and explain the procedure employed in selecting both the training texts and the target texts. This seems the most appropriate place to include this item as many of the other components to be described (such as the participants' background knowledge of the text topics, or the design of the questions used in the final post-training task), were dependant on the reading materials. Following that (in Section 9.4) we explain how comprehension and learning were assessed post-training through the design of two sets of comprehension questions requiring written answers and a free recall task. We also explain how a set of 'performance criteria' was constructed which was used to measure the amount and relevance of the information students included in their answers to the comprehension questions.

Having established the basis on which assessment took place, we go on to describe the participants in the study, and from there to a description of the training procedures given to each group, first in general terms followed by the specific interventions carried out with each condition. Section 9.9 explains the procedure used in administering the post-training tasks, while in Section 9.10 we describe how the results were analysed. The results themselves are presented in Section 9.11, and our conclusions in Section 9.12. The final two sections of this Chapter consist of a general summary and a brief discussion of some of the implications of the research.

9.2 Overview of the experiment

An initial group of 140 undergraduate students were tested for their (a) general English proficiency level, and (b) background knowledge of the subject matter of two target texts which they were going to read after completing training in self-regulated reading. The test of background knowledge consisted of a free writing activity on the topic of the texts.

Partly on the basis of their score in the English test, and partly depending on the class to which they were going to attend, the participants were otherwise randomly assigned to one of four groups (3 experimental and one control) with between 30-33 subjects in each group. Each of the experimental groups received training in a different constructive activity (and, hence, increased awareness of and practice in using reading strategies such as comprehension monitoring, inference generation or elaboration) over a period of six weeks. The control group read the same training texts as the members of the experimental groups but were not given any explicit training in self-regulating their reading or in the use of reading strategies. During Week 7 (that is, one week after finalising the six-week training period), all participants were tested on their reading comprehension of the two target texts, as measured by written answers to a series of questions. Students were able to refer to the target texts as they carried out this activity.

	Texts selected			
Week 0	Students tested for English level and groups established (N = 30-33). Background knowledge of (i) composite materials, (ii) PV cells and (iii) RTGs ascertained			
	Self-explaining group (N = 31)	**Note-taking group** (N = 30)	**Asking questions group** (N = 33)	**Control group** (N = 32)
Week 1	Introduction to self-explaining: definition, examples, advantages, modelling. *Training text 1+2*	Advantages of note-taking explained: examples of formats given. Notes in L1/L2. *Training texts 1+2* Discussion and modelling.	Introduction to asking questions: good vs. bad, shallow vs. deep, model questions, inferencing. *Training texts 1+2* Discussion and modelling.	*Training texts 1+2* Writing answers to comprehension questions.
Week 2	Second attempt: as week 1 but with different texts and examples.	*Training texts 3+4* Students make notes. Discussion and modelling.	*Training texts 3+4* Students write questions. Discussion and modelling.	*Training texts 3+4* Writing answers to comprehension questions.
Week 3	Abandoned (after small group interviews)	*Training text 5* Students make notes. Discussion and modelling.	*Training text 5* Students write questions. Discussion and modelling.	*Training text 5* Writing answers to comprehension questions.

Table 9.1a. Summary of procedure (Weeks 0-3).

	Self-explaining group	Note-taking group	Asking questions group	Control group
Week 4	--	*Training texts 6+7+8* Note-taking. Discussion and modelling.	*Training texts 6+7+8* Writing questions. Discussion and modelling.	*Training texts 6+7+8* Writing answers to comprehension questions.
Week 5	--	*Training text 9* Note-taking. Discussion and modelling.	*Training text 9* Writing questions. Discussion and modelling.	*Training text 9* Writing answers to comprehension questions.
Week 6	--	*Training text 10* Note-taking. Discussion and modelling.	*Training text 10* Writing questions. Discussion and modelling.	*Training text 10* Writing answers to comprehension questions.
Week 7	--	*Target texts* + answering questions.	*Target texts* + answering questions.	*Target texts* + answering questions.
Week 10	--	Free recall (as Week 0)	Free recall (as Week 0)	Free recall (as Week 0)
Week 14	--	Free recall (as Week 0)	Free recall (as Week 0)	Free recall (as Week 0)
Week 15	--	Comprehension questions as Week 7 (but no text)	Comprehension questions as Week 7 (but no text)	Comprehension questions as Week 7 (but no text)

Table 9.1b. Summary of procedure (Weeks 4-15).

In addition, the participants' long-term learning of the subject matter of the texts was assessed through a free recall activity (exactly the same free writing activity which the students had carried out in Week 0, prior to the commencement of training to test their background knowledge of the text topics). This was given to the students twice; first in Week 10 (3 weeks after reading the target texts), and again in Week 14 (7 weeks after reading the target texts). One week later (Week 15) the students were again given the same set of questions as at Week 7 and asked to write the answers. This time, however, the target texts were not present. Tables 9.1a and 9.1b show the basic design and the time schedule of the experiment in tabular form.

9.3 The reading materials

9.3.1 Text selection

The type of expository text we use in this study falls into the category of texts aimed at increasing public understanding of scientific information. With the exception of the first training text, all of them were taken from what Goldman & Bisanz (2002: 25) would classify as special informational web sites on science topics.

A substantial body of research supports the view that prior knowledge facilitates reading comprehension and learning at all levels[78]. With respect to comprehension, Rayner & Pollatsek (1989: 265) comment that:

> [...] everyone agrees that real-world knowledge has to actively intervene in reading for comprehension to take place; the question is, how?

[78] For example, acquisition of new knowledge, (Garner & Gillingham, 1991), integration of old and new knowledge (Kintsch, 1988).

However, active knowledge construction requires more than a knowledge base and strategic processing operations. Affective factors, such as interest in the text topic and interest in learning are now recognised as making substantial contributions to knowledge acquisition (Hidi & Baird, 1986; Schiefele, 1991, 1996; Wade, 1992). Readers with low interest in a text, may not process the text efficiently (Krapp, 1999).

The effect of interest on comprehension and learning may be especially apparent when students are required to use self-regulated, constructive reading activities because these are demanding processes that require extra attention and effort. In this sense, self-regulated reading might result in greater learning or comprehension for those individuals who are interested in the materials. On the other hand, it also seems to be the case that when a reader has high domain knowledge and the information in the text seems to support what they already know, they may not bother processing the text very deeply (Kintsch 1998; Otero 1998).

Assuming that interest does motivate readers to carry out constructive reading activities (see also our earlier discussion of interest in sub-sections 6.6 and 6.7), the text topics chosen for this research were all themes that were included in the participants' study programmes but which they would *not* be studying during the duration of the experiment in order to avoid additional learning taking place.

In addition, this experiment required that all participants had the same (or a very similar) knowledge base. In this sense it was easier to select topics about which all the participants could be expected to have minimal familiarity (and thus control this variable) than topics about which there might be a range of domain knowledge.

Thus, despite the advantages for reading comprehension of a prior knowledge base, we felt that both the comprehension and learning of students with *low* background knowledge of the text topic could be enhanced by engaging in self-regulated constructive reading activities. First, readers would be encouraged to monitor their comprehension, evaluate what they had understood and elaborate on the propositions and ideas arising from the text, especially on those which were only partially understood. Second, they would be encouraged to build links between different sections of the text. Third they would be encouraged to focus on the important information, and reject the irrelevant details.

9.3.2 Text readability

In addition to topic (un)familiarity and interest, in Chapters 5 and 6 respectively of this study we have already seen how lexical familiarity or density and syntactic complexity or predictability, as well as coherence, cohesion and amount of new information, can be sources of difficulty for second language readers. One approach to ensuring potentially appropriate texts are not too difficult for the intended readers is to apply one of the several formulae used to estimate text readability. For example, one common readability formula (shown below) is the Flesch, which was first used in 1948, and which gives a notional reading-ease (RE) score out of 100:

$$RE = 206.835 - (0.846 \times NSYLL) - (1.015 \times W/S)$$

where NYSLL is the average number of syllables per 100 words and W/S is the average number of words per sentence. Another typical readability formula is the Fog Index:

$$\frac{\text{No. of words}}{\text{No. of sentences}} + \frac{\text{No. of 3-syllable words}}{\text{No. of words}} \times \frac{100}{1} \times 0.4$$

A result of 16+ indicates that a text is suitable for postgraduate level, 13-16 indicates undergraduate level, while 12- or less indicates that the text is easy.

Cruder measures exist; for example, the average number of words per sentence, or the average length of the words (since word length in English is roughly related to word frequency. Thus a text with fewer long words is assumed to be easier to read than a text with more long words. In practice, of course, this is not necessarily the case, but presumably this is a view which arises from the perception that simple English is written with short words in short sentences. However, as Alderson (2000: 73-74) points out:

> [...] readability formulae give only crude measures of text difficulty, and are rarely suitable for second- or foreign-language readers, even of English texts.

The reason they are unsuitable is because most readability formulae attempt to determine levels of reading by measuring vocabulary and sentence structure only (Davies, 1984)[79]. This is a limited number of factors considering the range of variables that can affect text difficulty and the interactive nature of the reading process.

As with the texts used for the preliminary study, therefore, the researcher selected the texts based on his own experience of choosing and designing suitable materials, and bearing in mind such factors as interest, length, topic, information density, as well as linguistic aspects.

---

[79] Some research with L2 readers suggests that often the lexical and conceptual difficulties are greater than the syntactic difficulties (e.g. Alderson, 1984; Alderson & Richards, 1977).

9.3.3 Training texts

A total of ten training texts were used varying in length (from 113 words to 1608 words) and complexity. Nine were in English and one in Spanish. The first four training texts and the last one were presented to the students on paper. Training texts Nos. 6-9 (inclusive) were presented electronically. Table 9.2 shows the title of each text, the week in which it was used, its assigned number and the number of words. The complete texts are included in Appendix E2, while Table E.1. (in Appendix E) shows the source of each text.

Week used	Text Nº.	Training text	Nº. of words
1	1	Mini DV camcorders	234
	2	Travel and the environment	306
2	3	Plastics	233
	4	Batteries	351
3	5	Indoor air pollution	850
4	6	Galvanizado en caliente y en frio	119
	7	Corrosion theory	684
	8	Galvanic corrosion	474
5	9	Putting it together – composite materials	1608
6	10	Introduction to materials selection	955

Table 9.2. The training texts used.

9.3.4 Target texts

The target texts were selected in a broadly similar way to the training texts but with some important differences. As we have already noted, text topic has an important effect on comprehension, especially when it engages background knowledge. In order to avoid this sort of text bias, two texts were chosen for their unfamiliar topics in order to avoid testing existing background knowledge rather than information gained through reading. Moreover, the second of the two texts was itself divided into two parts each with its own topic. It should also be noted that the general topic of Target Text 1 (composite materials) was the same as Training Text 9 (although there were considerable differences in content), as we were interested to see whether, and how, the effects on learning and recall of constructive reading were reflected in students' answers to the comprehension questions at Weeks 7 and 15 and in the free recall activity at Weeks 10 and 14. The length of the texts reflects the sort of (shorter) text length which students may frequently find in academic and technical articles of this type published on the WWW.

Table 9.3 shows the title and number of words for each of the target texts. Table E3, in Appendix E, indicates the source of each of the target texts, while the complete texts can be found in Appendix E4.

Target texts	**Nº. of words**
Composite Materials in Aviation	512
Electrical Power Supply and Distribution Subsystems	1059

Table 9.3. The target texts.

9.4 Assessment of comprehension and learning

9.4.1 The post-training tasks

The success of the different constructive activities in which students were trained was assessed through a transfer task; that is, the students in the experimental condition were expected to apply (transfer) the procedural knowledge they had gained during training to a new task. The new task was presented to the students in the week following completion of the training (Week 7) and consisted of reading two target texts and completing written answers to a series of questions on the topic of each text. The texts could be referred to when answering the questions. Long-term learning was assessed in two different ways. Firstly, through a free recall task which simply asked the participants to write what they knew about the topic of each text. This was, in fact, a repetition of the task used to evaluate their background knowledge of the text topics, chosen, as explained above in section 9.3.1), precisely for their high degree of unfamiliarity. However, it was expected that after reading the target materials, the students would have developed some knowledge structures of the target text topics in semantic memory. That is, they would have learned something about them. The purpose of giving the students the free recall task was simply to ascertain what they could remember. The task was given twice; the first time three weeks after reading the target texts (Week 10) and again seven weeks after (Week 14). The written instructions given to the students are shown in Figure 9.2 below (in sub-section 9.5.2).

In addition, at Week 15 (one week after carrying out the second free recall task), students were required to complete the written answers to the target text questions again. On this second occasion, however, they were not able to refer to the texts. The purpose behind this task was to ascertain whether the questions might act as cues and evoke information that had been stored but that had not been recalled in the free writing task.

9.4.2 How the questions were designed

Comprehension and learning of declarative information occurs when the ideas or concepts suggested by the text are mapped onto existing knowledge, or when new information is integrated with existing knowledge creating new knowledge structures. The process of integration is stimulated, encouraged and facilitated when readers engage in the active construction of what they are learning (Chi, De Leeuw, Chiu & Lavancher, 1994).

Given that the purpose of this research was to explore ways of facilitating understanding and learning, and to encourage readers to relate information to prior knowledge and apply their logical reasoning and common sense, the questions (and free recall tasks) were designed to test whether this had occurred. As we saw in Chapter 3, the sources of information from which a reader constructs meaning include:

- the focal sentence; i.e., the segment of text actually under scrutiny
- other segments of the text
- the prior reading cycle, information from which may still be held in WM
- the developing representation of the text in episodic memory
- general or domain-specific background knowledge
- logical reasoning and/or common sense

The sets of questions used in the final task were designed to tap into these different sources of information and required different processes in order to answer them appropriately.

In addition, and again as we discussed in Chapter 3, most researchers into discourse comprehension agree that there are several, interdependent levels of comprehension that may contribute to a reader's mental representation of a text. According to McNamara (2004), it is impossible to isolate one level of comprehension from another due to the high degree of interplay between them, however, it is possible to ask questions which depend to a greater or lesser extent on a certain level of representation. Generally speaking, questions which refer to explicit information in a text can be used to assess the reader's surface or textbase levels of representation. Questions that involve understanding of ideas or information which is implicit in a text or which refer to background knowledge can be used to assess comprehension at the situation level.

In order to devise the questions in a principled way, we adopted a similar procedure to that described by Chi, et al. (1994) whereby each sentence of the target texts was coded as to what type of information it contained. In our scheme, however, the sentences were coded in a slightly different way. The first category of sentence was a straightforward state of affairs or fact ("factlet" in Chi et al.'s (1994) terminology). For example, the second sentence from Target text 1 (*Composites are materials that are combinations of two or more organic or inorganic components*) was classified as a straightforward fact.

Other classes of sentence were those which described either the behaviour, the structure or the properties of a text element or the relationship between elements. In addition, sentences were also coded as to whether they developed or referred to an idea from another sentence in the text. For example, the first sentence of paragraph 11 of Target text 2 states: *Since they remain thermally hot, RTGs present advantages and disadvantages*. The immediately following sentence develops the idea: *The Cassini spacecraft employs much of its RTGs' radiant heat inside its thermal blanketing, to warm the spacecraft and propellant tanks*. Thus, the second of these sentences was cross-referenced, as it were, to the first.

The purpose of the coding was to enable us to ascertain what knowledge might be needed in order to answer a question about the sentence, and where that knowledge might be found. In other words, could a question be answered from information obtained directly from the sentence or from previous or later sections of the text? Was the information presented explicitly or would the answer have to be inferred? Could the answer be obtained through a search of background knowledge or the use of logical reasoning?

Four types of question were designed based on where the reader could generate the answer. Category 1 questions required 'verbatim' answers which could be found explicitly stated in the text. An example of a Category 1 question, together with the sentences from the text which contain the answer, is shown in Table 9.4.

Category 2 questions were similar to what Chi et al. (1994) term 'comprehension inference questions'[80] which, like Category 1 questions, were based on information stated explicitly in the text but which in order to answer them fully required the reader to integrate material from two or more lines of text or across non-consecutive sentences or paragraphs, or to interpret the information to some degree. Table 9.4 contains an example of a Category 2 question.

Category 3 questions could be regarded as a sub-category of Category 2 in that part of the answer was stated explictly in the Target text, but part had also been explicitly given in one of the earlier training texts. We were particularly curious to see whether any of the groups would remember more of this previous information. If this proved to be the case, it would suggest that the information had been encoded differently and was more readily accesible. An example of this type of question is given in Table 9.4.

[80] Chi et al. (1994) note that "[...] most of the work in the comprehension literature assesses understanding by this sort of comprehension-inferencing question [...] in that the questions require either paraphrases, explicit comparisons, or integration of information within and across paragraphs. Thus, these questions require comprehension inferencing of varying degrees, but all the knowledge needed to make the inferences is presented in the sentences."

Category 1 Verbatim questions Text 2, Q3. Apart from supplying power, what other function can solar panels have? *In addition to generating electrical power, solar arrays have also been used to generate atmospheric drag for aerobraking operations.*
Category 2 Comprehension inference questions, type A Text 2, Q8. Why should solar panels not exceed a certain size? *Farther than about the orbit of Mars, the weaker sunlight available to power a spacecraft would require panels larger than practicable because of the increased launch mass and the difficulty in supporting, deploying, and articulating them.*
Category 3 Comprehension inference questions, type B Text 1, Q5. How can composite materials be manipulated in order to obtain specific properties? *By carefully choosing the reinforcement, the matrix, and the manufacturing process that brings them together, engineers can tailor the properties to meet specific requirements. (From Training text 9).*
Category 4 Knowledge inference questions Text 1, Q11. Some composite materials absorb moisture. Why is this a problem?

Table 9.4. Examples of each type of question and the corresponding lines of text needed to answer them.

Category 4 questions ('knowledge inference'), are also based on the study reported in Chi et al. (1994). Answering these questions required the generation of new knowledge as the answers were not contained in the text. Rather, the reader had to make use of prior knowledge (domain or general), common sense, or logical reasoning in order to generate new knowledge (see Table 9.4 for an example of this type of question).

Eleven questions were devised for Text 1 and nine for Text 2 giving a total of twenty questions for the two texts. Table 9.5 shows which question from each of the Target texts belonged to which category.

Question type	*Questions from Text 1*	*Questions from Text 2*
1. Verbatim	6	3
2. Comprehension inference, type A	4, 9, 10	1, 2, 4, 5, 6, 8, 9
3. Comprehension inference, type B	1*, 3*, 5	
4. Knowledge inference	2, 7, 8, 11	7

* Part of the answers to Questions 1 and 3 of Text 1 could be found verbatim in the Target text.

Table 9.5. The classification of the questions into their corresponding categories.

There was a further factor which was taken into account when designing the questions. Constructive (or meaningful) learning occurs when learners make sense of their experiences, so one major measure of learning is to test whether what has been learned can be used to solve new problems (Mayer, 2002). Text 1 questions which require the reader to show his or her understanding of the underlying design requirements or function of an item or the relationships between the elements of a situation mentioned in the text are numbers 2, 4, 7, 9 and 10 (although the answers to questions 4, 9 and 10 are partly available in the text), and Question 11, which involves the application of general principles. Text 2 questions requiring some degree of understanding of the situation or the application of general principles are 2, 4, 5, 7, 8 and 9 even though the information to answer these (with the exception of question 7) is contained in the text.

9.4.3 Performance criteria

An important part of question design is a consideration of what constitutes an acceptable answer. In order to be able to assess the participants' comprehension and learning, it was necessary to establish what information (propositions, ideas, concepts) readers could be expected to comprehend and learn from the target texts. Thus, a set of what we called *performance criteria* were established for each of the texts. The contents of the students' answers on the comprehension questions were measured against this standard.

The performance criteria consisted of the relevant and irrelevant information available to the reader for any given question from one or more of the following sources:

(i) explicit information in the text,
(ii) the generation of inferences,
(iii) background knowledge,
(iv) the application of common sense or logic.

The items, or 'units' of information, in the performance criteria were established independently by the researcher and a colleague whose L1 was English. The process consisted of carrying out the tasks as the students would be expected to do them (i.e. reading the texts and answering the questions). The answers were compared and an initial set of perfomance criteria were formulated based on the relevant items mentioned in our answers and also on what we thought would constitute incorrect or irrelevant items. For example, Question 3 of Text 1 asks ‘What are some of the problems with manufacturing composites?’ Most of the relevant information is contained in paragraph 3 of the text, lines 15-18:

> However, despite their strength and low weight, composites have not been a miracle solution for aircraft structures. Composites are hard to inspect for defects. Some of them absorb moisture. Most importantly, they can be expensive, primarily because they are labor intensive and often require complex and expensive fabrication machines.

Relevant or correct items here are that composites:

- can be expensive
- are labour intensive
- often require complex and expensive fabrication machines.

However, one of the earlier training texts was also about composite materials and stated that the raw materials from which some composites are made are expensive. This fact, therefore, was also included as a correct item in the performance criteria.

On the other hand, the texts also stated that:

- composites are hard to inspect for defects
- some of them absorb moisture
- their repair is difficult (in paragraph 5 of Target Text 1)

These items of information were considered to be incorrect answers to Question 3 as they did not refer to their *manufacture* but to their subsequent *performance* and *maintenance*. Figure 9.1 shows the performance criteria for Question 3 of Text 1. The first column shows the relevant information and, preceded by an 'X', the items which were identified as being irrelevant or incorrect. The numbered columns correspond to each students' identification number. If in their answer the student included an item of information, the relevant box was ticked. Thus, to give a real example, Subject 1 in the note-taking condition answered Question 3 as follows:

3. Problemas:	- Absorben humedad
	- De primeras son caros
	- Su reparación es complicada y cara

and thus answered with one correct item of information and two incorrect items. Figure 9.1 shows how the student's answer was marked on the Performance Criteria Mark Sheet.

The task of establishing the performance criteria was fairly straightforward, and agreement between the researcher and his colleague on what constituted relevant and irrelevant items was 93%. Differences of opinion were discussed until unanimous agreement as to whether to include them or not was reached.

	Subject No.					
Q. 3	1	2	3	4	5	etc
Expensive						
labour intensive						
require complex and expensive machinery						
raw materials are expensive	✓					
X hard to detect defects						
X absorb moisture	✓					
X repair is difficult	✓					

Fig. 9.1. An example of the Performance Criteria mark sheet for question 3 of Text 1, completed for Student 1 from the Note-taking group.

Nevertheless, the list of performance criteria thus established was not assumed to be necessarily final. Although, in this context, the researcher and his colleague could be regarded as expert readers, and therefore the items in the performance criteria could be taken as representing all the relevant information a reader could be expected to identify in order to *fully* complete each task, as Nuttall (1982: 126) warns us: “Every teacher of reading has to be prepared for the occasion when a student interprets the text more effectively than the teacher”. It was always possible, therefore, that the students might pick up on information that we had missed.

9.5 Participants

9.5.1 General information

Although we might expect a given group of students of the same nationality to have more or less the same general reading proficiency in their L1, they may not be so homogeneous when reading in their L2 (Bernhardt 1991a). Thus, there are potentially many variables in a study of this nature. In order to control the number somewhat, all the participants in this study were native Spanish students from the same broad cultural and educational background. Three students who were not of Spanish origin attended lectures and carried out the tasks of the group to which they were assigned, but their results were not taken into account in this study.

The participants, none of whom had participated in any of the previous research reported in this thesis, came from a range of socio-economic categories, and not all of them were originally from the city where this study was carried out. Nevertheless, in broad terms their educational achievement was very similar; they were all first-year university students studying Technical Industrial Engineering, specialising in either Chemical Engineering, Electrical Engineering, Electronics or Mechanical Engineering. The mean ages of the four original groups was very similar. With respect to their L1, 32 of the original 143 participants gave Valencian as their first language (this being the language they mostly spoke on a regular basis outside the lecture room) and Castillian Spanish as their second, however, all participants were following courses given in Spanish and this was the language used in lectures, for coursework and for assignments in all their subjects except foreign languages (where the target language was mostly used). Thus, all the participants may be considered native speakers of Spanish.

One of the aims of this research was to explore the effects of training a group of students to read strategically; that is, training them not through individual sessions but on a group basis, under normal class conditions. Thus, we did not want the students to alter their behaviour in any way by, for example, completing the tasks more, or less, assiduously because they felt they were 'under observation' or in order to receive extra credit or some other reward. Consequently, the students were not told they were participating in a research programme. Rather, the reading texts and tasks were presented as if they were standard materials for the course. Permission to use the results was subsequently obtained from all the participants and the aims and general results described to them.

Initially, the groups were composed of between 30-33 members, however for various reasons a small number of students were not able to attend all the training sessions. When this occurred the student concerned was not excluded from participating in the rest of the programme – such a course would have been unethical as the students had the right to attend lectures and the researcher the duty to provide conditions for learning to take place. However, in order to ensure that the data was obtained from subjects who had received the same treatment, the results of those students who missed one or more of the sessions were excluded from the final analysis. Moreover, in order to balance the groups, the results of one participant from each of the other conditions who had scored the same mark on the initial English proficiency test, were also excluded. Having scored the same mark was the only conditioning factor. In other respects the participant whose results would be excluded was chosen arbitrarily.

At Week 7, when the target texts were read and the reading comprehension questions completed, the Note-taking, Asking Questions and Control groups all comprised 26 ‘valid' participants. Table 9.4 shows the composition of the groups as regards gender and average age. Work with the Self-explaining group had to be abandoned after the second training session for reasons we explain below, thus the data for this group refer to the initial 31 members.

Group	Female	Male	Total	Average age
Self-explaining	9	22	31	20.2
Note-taking	6	20	26	20.6
Asking questions	6	20	26	20.7
Control	4	22	26	20.3

Table 9.6. Composition of the 4 groups showing gender and age.

9.5.2 Background knowledge of the target text topics

Prior to training (at Week 0), the background knowledge of the target text topics was assessed through the free writing task shown in Figure 9.2. To make sure no misunderstandings took place, the instructions were given first in English, and then in Spanish. It was anticipated that the students would have substantially reduced domain knowledge and, in many cases, would be unable to write down more than a few general ideas about the text topics. The meaning of 'RTGs' was explained to the students as 'radioisotope thermoelectric generators'.

Furthermore, this activity was not seen as a production exercise, we were interested *not* in how well students could express themselves in fluent, connected sentences, but only in what they knew about the topic. Thus, students were told that jotting down their ideas in the form of a list would be acceptable and, moreover, that they need not worry if they were unable to write much.

1. Write one or two short paragraphs about composite materials. Give some examples, discuss their applications and some of their advantages and disadvantages. If you feel you are unable to express your ideas in English you may write down the points you want to make in note form.

2. Write one or two short paragraphs each about (i) photovoltaics in interplanetary space missions and (ii) RTGs. Include as much relevant information as you can; for example, applications, how each system works, problems, solutions, etc. If you feel you are unable to express your ideas in English you may write down the points you want to make in note form.

If you wish you may use the rest of this sheet to plan your work. Use the other side for the final version.

Fig. 9.2. The free writing task.

Some examples of what the students wrote are reproduced in Figure 9.3 as they were written. These have not been chosen entirely at random, but range from the student who, like most (91%), stated they knew nothing about the topics (Example 1), to the few who displayed some knowledge of the text topics.

Example 1
I know nothing about it.

I know nothing about it.
I know nothing about them.

Example 2
I don't know what composite materials exactly are. I imagine they are those kind of irons which are more resistaints to water for example.

I think that photovoltaics are used for provide energy to the spaceships.
I don't know what radioisotope thermoelectric generators are.

Example 3
The space shuttles use photovoltaics boards in order to readch other planets. This knd of combustible is better than petrol because it may explode.

Example 4
Agua oxigen, amoniaco, acid sulfuric,

Example 5
La mayoriá de los materiales son compuestos de otros materiales tales como silicio, hierro, aluminio y todo junto forman compuestos que podemos utilizarlos para construir edificios (cemento) y demás.

Las photovoltaics en misiones espaciales se utiliza sobretodo para probar nuevas tecnologias que utilizando la luz solar o la U.V. se consigue electricidad.

Example 6
Photovoltaics provide the spacial stations of its necessary energy in order to work correctly. It's an advantage because its oil combustile cannot be filled up in the space.
Radiation emites energy because the atomic structure of the isotopes is desestabilised. Using a nuclear plant. This energy can be turned into electricity.

Figure 9.3. Examples of students' knowledge of the target text topics.

9.5.3 English proficiency level

On average the participants had studied English for seven and a half years before starting university, and during the period in which the study was conducted none of them took extra English classes outside the university. Given the large number of students to be tested (approximately 140) it was decided to use a multiple choice test which was quick and easy to administer. Although widely used, multiple choice tests are not, perhaps, the most obvious type of test to use in order to assess foreign language proficiency in a study concerned with reading comprehension. Firstly, they do not seem to reflect natural ways of language processing. We do not usually read a sentence and then decide which of three or four alternative meanings is the one that best corresponds to the proposition contained in the target sentence. Secondly, according to Oller (1979: 233), the design and preparation of sound multiple choice tests for most classroom needs “is sufficiently challenging and technically difficult to make them impracticable”. However, test design has advanced considerably in the twenty-five years since Oller’s observation, and the use of computer technology has greatly facilitated the task of compiling reliable test items.

Thus, the same commercially available 40-item, paper and pen format of the Quick Placement Test (QPT) described in Section 2.4, and which we have been using to assess incoming students’ level of English for the past four years, was used. Although this meant that most of the subjects in this study had already completed one QPT test, a previously unseen version was administered to them. The *User Manual* (The Chancellor, Masters and Scholars of the University of Cambridge, 2001) accompanying the test specifies that it assesses reading, vocabulary and grammar (p. 2). A further advantage of this test is that marks are linked to the CEF and ALTE proficiency levels (see Table 2.11 in Chapter 2).

The publicised standard error of measurement for the 40 item test is ± 3 points (*User Manual*, p. 9). This margin of error means that if a testee's score is at the very top of a band they might be better placed in the level immediately above. Likewise, if a testee's score is at the bottom of a band, it might be more appropriate to place them in the immediately preceding level. Given that our purpose in testing the participants was to ensure that the experimental groups and the control groups were evenly balanced with respect to English proficiency level and, moreover, that the groups were representative of the average annual intake of students, any student who scored either 28 or above, or 19 or less, was excluded from the analysis. It was also felt that any student who scored less than 19 would find the texts and reading tasks too linguistically challenging.

The mean QPT scores for the groups participating in this study (3 experimental groups plus 1 control group) are shown in Table 9.7. The test was carried out during Week 0, prior to training. It can be seen that the scores are similar to those for the average intake shown earlier in Table 2.12 (Chapter 2), and within the standard error of measurement. It should be noted, however, that the scores for the Note-taking, Asking Questions and Control groups are the average from the final 26 students per group, while the score for the Self-explaining group is the average of the initial compositon of 31 students (see below for the reasons). It should also be noted that the students in the control condition had a slightly higher score overall, however for practical reasons (principally to do with class times and attendance) the groups could not be balanced more evenly.

Group	*Average score*	*No. of students in group*
Self-explaining	23.77	31
Note-taking	23.65	26
Asking questions	24.17	26
Control	25.08	26

Table 9.7. Average QPT scores of the 4 groups at Week 0.

9.6 Training procedures for the self-explanation condition

9.6.1 General procedure

The general aim behind the training of the participants in this condition was to get them to self-explain texts in small groups of 2 or 3. Training was to take the form of first modelling self-explanation and then asking the students to do the activity for themselves while monitoring their progress. In the event, however, work with this group had to be abandoned. Nevertheless, in the next sub-section we describe the specific procedures that were carried out. This is followed by a brief discussion about the reasons for the failure of the training of this group.

9.6.2 Specific procedures

Week 1

Step 1. The class were shown examples of low and high self-explaining in Spanish. Spanish was used first because it was felt that the students would find it easier to understand what was required without the additional effort involved when working in English. The examples used were taken from the think-aloud protocols from the study into comprehension strategies reported in Chapter 7. A segment from the Spanish text *El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta* (see Appendix C3) was projected on to a large screen and shown to the students. After reading it they were first shown Subject #5's low self-explanation followed by Subject #2's high self-explanation. Students were not told at this stage that one was an an example of low self-explaining and the other of high self-explaining. The differences between the two protocols were elicited and discussed. In particular, it was pointed out how Subject #2 had related the information in the text to his background knowledge (for example, "[...] en nuestro caso el sol", or "[...] sería como en química, como el hidrógeno"). The portion of text together with the examples of self-explanations are shown below in Figure 9.4.

Example 1

El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta

Pero, ¿no es Plutón mismo un planeta? • En los años noventa, esta pregunta pareció lo bastante importante como para que la Unión Astronómica Internacional (IAU, siglas en inglés) revisase su definición. • El dictamen, emitido en 1999, determina que un planeta es "un objeto en órbita alrededor de una estrella, que sea más pesado que Plutón y más ligero que la estrella más pequeña". • Se trata, evidentemente, de acabar con la polémica salvaguardando la condición planetaria de Plutón, pero descalificando a todos los cuerpos menores que él, descubiertos o por descubrir. •

(ll.44-50)

#5
1) Este punto tiene una pregunta, pero no tiene ninguna complicación.
Este punto no tiene ninguna dificultad.
Este punto no tiene .. con leerlo se entiende bien.
El siguiente punto está bastante claro, no tiene dificultad ninguna.

#2
2) Vale, aquí está tratando de responder a la pregunta, lo que quiere decir que en los años 90, al descubrir Plutón aparecieron muchos problemas porque había gente supongo que diría que era un planeta, y habría otra gente que no, entonces se remitieron a las normas que habían impuesto como condiciones mínimas para ser planeta, y se revisó su definición.

Vamos a ver lo que es un planeta "un objeto en órbita alrededor de una estrella", o sea, en nuestro caso el sol, "que sea más pesado que Plutón y más ligero que la estrella más pequeña", que sea más pesado que Plutón y más ligero que la estrella más pequeña, esto lo encuentro un poco una tontería, porque se trata de medirlo con respecto a Plutón, bueno, sería como en química, como el Hidrógeno, pero bueno. Bueno, esto es una norma que han puesto para ver si llega a ser un planeta, o llega a ser un satélite etc.

Figure 9.4. The first example of self-explaining shown to the students.

Step 2. Examples of low and high self-explaining from an English text were shown to the students (see Figure 9.5). Lines 1-6 from the Rosetta Spacecraft Design text were projected onto the screen. First, Subject #5's low self-explanation was shown, then Subject #2's high self-explanation. Again, the differences between the two were discussed and Subject #2's tendency to use the following strategies were highlighted and listed on the blackboard:

- to monitor and revise his comprehension (for example, regarding the meaning of *rendez-vous*).
- to use context as well as linguistic knowledge to establish the meaning of unknown words (e.g. *Rosetta Lander* and *Surface Science Package)*.
- to elaborate on the information given in the text (for example, *make in-situ measurements* becomes "[...] hacer medidas sobre el cometa tal que viene .. medir la velocidad que lleva, su tamaño y todo esto").

Example 2

Introduction
The Rosetta mission is an interplanetary mission whose main objective is to rendez-vous with and make in-situ measurements of comet 46 P/Wirtanen, in August 2011. • The spacecraft will also carry the Rosetta Lander (Surface Science Package) to the nucleus and deploy it onto the comet's surface. • The Lander is provided by a German-led consortium of European institutes. •

Rosetta Spacecraft Design, ll. 1-6.

#5
3) Este punto .. se entiende bien.
Este punto, lo tengo que leer dos veces para entender todo el significado.
Este punto lo entiendo bien.

#2
4) Bueno .. *The Rosetta* .. ok, pues a ver, el principio .. *Rosetta* es el nombre del de la nave que van a mandar para allá, interplanetaria misión interplanetaria, cuyo principal objetivo es *to rendez-vous*, eso es francés .. *and make in-situ, in-situ* es en el momento .. *measurements of comet* .. *rendez-vous* en este caso será yo creo, puede ser, no tengo ni idea, por el contexto, eh.. encontrarse, al ser *with* es con algo, entonces puede ser, el objetivo es encontrarse, o sea, llegar y.. y hacer medidas sobre el cometa tal que viene .. medir la velocidad que lleva, su tamaño y todo esto, y todo eso será en el 2011. La nave, que también llevará el Rosetta Lander, 'lander' es .. *surface science package* eso .. bueno, claro, después, después de leer esto yo..creo que *rendez-vous* sí debe ser encontrarse, porque .. los *landers* son que aterrizan, *landing* es aterrizaje, *to land* es aterrizar en tierra, entonces esto es un .. *surface science package* debe ser .. un dispositivo para hacer un estudio sobre la superficie del mismo cometa, igual que en .. no lo sé *to the nucleus* eh .. entonces esto quiere decir que la nave llevará también al.. al esto de aterrizaje Rosetta, que se situará sobre la superficie, y lo llevará al .. núcleo .. y *deploy*, *deploy* no sé lo que es, que será dejar. Lo llevará hasta la superficie del cometa.

The Lander is provided el *lander* .. el *lander* en este caso llaman a la nave que aterrizó en la tierra, en la superficie, ha sido provisto, o sea, lo han llevado a cabo un consorcio de alemanes .. de la .. del instituto europeo, o sea, que lo han hecho los alemanes, pero.. eh.. en conjunto con la .. con los institutos europeos de .. de .. astronautas, vale.

Figure 9.5. The second example of self-explaining shown to the students.

Step 3. It was pointed out that student #2 explained the text to himself. Self-explaining was defined as reading text (aloud or silently) to oneself and after each sentence explaining to oneself the meaning, or elaborating on the information in the text in order to clarify understanding.

Step 4. Students were told that they were going to self-explain a text together with the researcher. A third text, in English, was projected onto the screen (see Figure 9.6).

This short text focuses on the corrosion of the ancient Egyptian monuments through the action of tourists. The text acts as an introduction to a teaching unit which introduces the students to some of the wider issues which may be involved in solving engineering problems. This text was *not* used with the other two experimental groups or with the control group, and was used here because it is both linguistically quite difficult and because it touches on many complex issues. In order to understand it a reader needs to apply general knowledge, logical reasoning and common sense rather than draw on domain knowledge. Although it can be read at a superficial level, we wanted to show students that by elaborating on the situations mentioned in the text, by thinking about them and self-explaining them, a richer understanding could be reached. It was hoped that this would give the students the confidence and willingness to try the technique of self-explaining for themselves.

Egyptian Monuments and Tourism

It has been shown that there is a direct relationship between corrosion and tourism. However, tourism is an important part of the Egyptian economy, and even if increasing numbers of tourists are putting the monuments in danger, it is unlikely that tourists will be banned from visiting them. Preservation and exploitation, therefore, must go hand in hand if both the monuments and the tourist industry are to survive in the long term. This dilemma highlights a very important issue which all engineers must be aware of nowadays; namely that the solutions to problems are often not simply engineering solutions; political, economic, cultural and social factors also have to be taken into account, as well as those of sustainability.

Figure 9.6. The third example of self-explaining shown to the students.

The whole text was first read aloud by the researcher. Then, rather than give the students an explanation, each sentence was read again and the explanations elicited from the students themselves through questions. In other words, the researcher modelled the sort of elaborations a reader might carry out or the kind of questions a reader might ask when self-explaining the text, to which the students were required to provide reasoned answers. These could be in Spanish or in English and were discussed and developed in class. Figure 9.7 shows each portion of the text followed by the question or questions (in upper case) corresponding to that portion.

Egyptian Monuments and Tourism

It has been shown that there is a direct relationship between corrosion and tourism.

1) WHAT DOES 'THERE IS A DIRECT RELATIONSHIP BETWEEN CORROSION AND TOURISM' MEAN? WHAT IS THIS RELATIONSHIP?

2) HOW MIGHT TOURISM BE CAUSING CORROSION OF THE EGYPTIAN MONUMENTS?

3) HOW HAS IT 'BEEN SHOWN'?

However, tourism is an important part of the Egyptian economy,

4) WHY IS TOURISM IMPORTANT FOR THE EGYPTIAN ECONOMY?

and even if increasing numbers of tourists are putting the monuments in danger, it is unlikely that tourists will be banned from visiting them.

5) IN WHAT WAYS MIGHT TOURISM ENDANGER THE MONUMENTS? (a repetition of question 2 in order to go a little deeper into the answers).

6) WHY WILL TOURISM BE ALLOWED TO CONTINUE?

Preservation and exploitation, therefore, must go hand in hand if both the monuments and the tourist industry are to survive in the long term.

7) WHAT DOES THIS MEAN? EXPLOITATION OF WHAT AND IN WHAT WAYS?

8) HOW MIGHT THE MONUMENTS BE PRESERVED?

This dilemma highlights a very important issue which all engineers must be aware of nowadays; namely that the solutions to problems are often not simply engineering solutions; political, economic, cultural and social factors also have to be taken into account, as well as those of sustainability.

9) WHAT DOES 'SUSTAINABILITY' REFER TO? SUSTAINABILITY OF WHAT?

10) CAN YOU GIVE SOME EXAMPLES OF POLITICAL, ECONOMIC, CULTURAL AND SOCIAL FACTORS WHICH WOULD NEED TO BE CONSIDERED IN ANY SOLUTION TO THE PROBLEM OF CORROSION OF THE MONUMENTS?

Figure 9.7. The first text and questions used to model self-explaining.

Step 5. Training Text 1 was projected onto a screen. Although this text is much more straightforward than the first, the researcher again first read the whole text aloud while the students followed on the screen, and then modelled the sort of elaborations and questions a reader might ask when self-explaining the text (beginning with the title) in order to show how one can go beyond the explicit information. Figure 9.8 shows the text together with the researcher's questions (in upper case) corresponding to each portion. As with the previous text, the students were required to generate the explanations which were discussed in class.

MiniDV Camcorders

1) FROM WHICH TWO WORDS MIGHT 'CAMCORDER' BE DERIVED?

2) SO WHAT DOES A CAMCORDER DO?

MiniDV stands for Mini Digital Video and there are two choices: pocket- or full-size.

3) GIVE SOME EXAMPLES OF OTHER OBJECTS WHICH ARE 'POCKET-SIZE'.

Both record video and sound onto MiniDV cassette tapes. Standard tapes last 60 minutes. The advantages of a pocket-size camcorder are obvious,

4) WHAT ARE THE ADVANTAGES?

but there are disadvantages, too. Firstly, the smaller the camera, the smaller the LCD viewing screen, which makes reviewing and editing your tapes more difficult. Moreover, many of the camera's functions (editing, focus, exposure, etc.) are controlled by onscreen menus, so the smaller the screen the harder they are to see.

5) ARE THERE ANY OTHER ELECTRICAL DEVICES WHICH HAVE THE SAME OR A SIMILAR PROBLEM?

In addition, the control buttons are smaller and closer together making them harder to press.

6) ARE THERE ANY GROUPS OF PEOPLE FOR WHICH THE SMALL SIZE OF THE SCREEN OR BUTTONS MIGHT BE MORE OF A PROBLEM?

Another disadvantage of the pocket-size models is that they usually have smaller optical-zoom magnification. There are two kinds of zoom: optical and digital. The former magnifies the image through the lens, while the latter simply enlarges the size of the pixels resulting in reduced image quality. Digital zoom specifications are often very high (200x, 300x), while optical zoom numbers are much lower (10x-25x).

Nevertheless, if picture quality is important, you should pay more attention to the optical zoom capabilities.

7) WHY DO POCKET-SIZE MODELS HAVE SMALLER OPTICAL-ZOOM MAGNIFICATION? DOES IT HAVE TO DO WITH THE SIZE OF THE LENS?

There are also two types of image stabilization – the process which reduces or removes completely a shaking or unsteady picture. Again, the two types are optical and digital, and again optical is better as the digital system can result in reduced picture quality. Most digital cameras, though, use digital image stabilization.

8) HOW DO EACH OF THESE IMAGE STABILIZATION SYSTEMS WORK?

9) IF OPTICAL IMAGE STABILIZATION IS BETTER, WHY DO MOST CAMERAS USE DIGITAL STABILIZATION?

Figure 9.8. Training text 1 and questions used to model self-explaining.

Step 6. The students were put into pairs and Training Text 2 was distributed on hardcopy. The students were asked to first read each sentence of the text individually, and then to discuss in pairs what they had understood as well as to write down any questions they asked of the text or ideas on which they elaborated.

The researcher discreetly monitored each student pair while they carried out the task. However, it quickly became apparent that no student read aloud and that the pairs tended simply to agree *that* they had understood, rather than discuss *what* they had understood or elaborate on any of the information suggested by the text.

Step 7. Training Text 2 was displayed on the screen. It was first read aloud by the researcher, then the text together with the researcher's own questions were projected (see Figure 9.9) and explanations elicited from the students.

Travel and the Environment

Imagine a transportation alternative that got commuters and travelers to their destinations efficiently,

1) WHAT DO TRAVELLERS WANT OR EXPECT FROM A TRANSPORT SYSTEM? IN OTHER WORDS, WHAT IS AN 'EFFICIENT' TRANSPORT SYSTEM?

was more environmentally friendly than automobile and airplane transport, and didn't require using vast areas of countryside. Imagine a travel option that reduced congestion on our highways. Sound too good to be true? For moving people and products from one place to another, perhaps it's time for us to make rail transport a more widely accepted transportation alternative.

2) IS RAIL TRANSPORT EFFICIENT?

3) HOW IS RAIL MORE ENVIRONMENTALLY FRIENDLY?

For a long time now, road and air travel have been more popular choices than trains.

4) WHY HAVE THEY BEEN MORE POPULAR?

But as we struggle to contend with overcrowded road infrastructure, look for alternatives to an airline industry that is going through some struggles of its own, and consider ways to address the huge environmental impact of these more popular transportation methods, perhaps our answers lie with rail transport.

5) WHAT SORT OF 'STRUGGLES' OR PROBLEMS IS THE AIRLINE INDUSTRY CURRENTLY EXPERIENCING?

6) IN WHAT WAYS DO ROAD AND AIR TRAVEL DAMAGE THE ENVIRONMENT?

Many major cities have passenger rail systems that provide efficient, economical service. Light rail and subway transit reduce air pollution, since the prime movers are electric motors. Even diesel-electric locomotives produce less air pollution compared to auto travel.

Cities such as Boston, New York, Philadelphia, Chicago, Los Angeles and San Diego have found the use of rail transport systems reduces vehicle congestion on streets and highways. In the last two or three years, these cities' systems have accommodated significant increases in passengers as commuters have realized that they can save both time and money when they use rail, as well as reducing stress. One indirect advantage to commuting by rail is that, because you use it less, your car will last longer.

7) HAS THE INTRODUCTION OF THE TRAM (*TRANVIA*) IN VALENCIA MADE TRAVELLING TO THE UNIVERSITY EASIER?

8) HOW MIGHT RAIL TRANSPORT REDUCE COMMUTER STRESS?

For intercity travel at distances of 450 to 800 kilometres, rail travel offers travel times that are competitive with air travel. What's more, commuter services often connect to downtown rail stations, eliminating long, time-consuming trips to airports that are often located far from city centres.

9) WHY IS RAIL NOT SO COMPETITIVE WITH AIR OVER DISTANCES LONGER THAN 800 KILOMETRES?

10) WHAT ABOUT DISTANCES SHORTER THAN 450 KILOMETRES?

11) WHAT IS THE SITUATION OF RAIL TRANSPORT IN SPAIN?

Figure 9.9. Training text 2 and questions used to model self-explaining.

Week 2.

Step 8. Students were first reminded of what self-explaining involved. After putting the students in pairs and distributing Training Text 3 (Plastics), students were asked to read each sentence of the text individually, and then to discuss, in their pairs, what they had understood as well as to write down any questions they asked of the text or ideas on which they elaborated. Again, the researcher monitored each student pair while they carried out the task, and again it became apparent that, with very few and occasional exceptions, the pairs did not expand on the ideas in the text, but merely agreed that they had understood. The exceptions included deciding on the materials that were used before plastic, naming different kinds of plastics, and identifying the items in the classroom made from plastic. These were, however, noted by the researcher, who then shared them with the rest of the class as examples of the sort of elaborations which could be made.

Step 9. The students remained in their pairs. After giving out copies of Training Text 4 (Batteries), they were asked to work in the same way as with the previous text and, again, their activities were discreetly monitored by the researcher.

9.6.3 Discussion

It became apparent that while working in pairs in a classoom situation these students found it very difficult to self-explain a text. In the days immediately following the last session, each pair was interviewed informally and questioned about their feelings towards the activity. Many reported feeling self-conscious about reading aloud with a partner. Reading silently, however, meant that a pair did not always read exactly the same segment of text or, if they did, not at the same speed. They also reported that having to wait while one's partner finished reading a portion of text or talking about what he or she had understood resulted in a breakdown in progress through the text and in 'losing the idea'. Moreover, a segment of text might suggest one area of thought to one student but a different idea to his or her partner. Or it might not need further clarification. In these instances, students reported feeling unsure about whether they had correctly comprehended the text, and they were also reluctant to elaborate on an idea with someone else.

A further difficulty which emerged from the interviews was that the students had different purposes for reading; or more precisely, a different focus. Some concentrated more on understanding individual words (which as we have already commented, tends to be typical behaviour of low-level

L2 readers), while others focused more on trying to understand the ideas contained in the text.

It was also clear that the different readers deployed their knowledge and powers of reasoning to varying degrees; those who were less engaged in the activity (or less confident) allowed their partner to dominate and tended to passively concur with their ideas.

Although some pairs worked better together than others, it was clear that the students held negative views about reading in this way. In their view, elaborating or clarifying ideas in the text with a partner in such a direct way seemed more of a hindrance than a help to comprehension. It was therefore decided to discontinue the training of this group. Nevertheless, work with the remaining two experimental groups and the control group was completed, and we move on to describe this part of the study.

9.7 Training procedure for the Note-taking and Asking Questions conditions

9.7.1 General procedure

During the six-week training period (one session per week), students were given a total of ten training texts which varied in length and complexity, with the shortest and simplest given first and the most complex given last. (See Tables 9.1a and 9.1b, above). The first 4 texts and the final text were presented on hard copy, while texts 5-9 were accessed electronically.

In both the Note-taking Group (NTG) and the Asking Questions Group (AQG), students worked in groups of two or sometimes three. Training took the form of either making notes (in the case of the NTG) or asking questions (in the case of the AQG) about each text. Examples of students' work was then elicited or highlighted directly by the researcher – who had monitored the students as they carried out the activity – and discussed as a class. The researcher's own notes or questions (written on an overhead transparency) were then modelled by projecting them onto a screen. Their degree of effectiveness was also discussed by the class as a whole.

Training, therefore, took the form of practising taking notes or asking questions, evaluating the effectiveness of these and having them evaluated by others, having notes or questions modelled, and discussing the effectiveness of these. Thus, members of these two experimental groups not only practised the skill which they had been assigned, but actively participated in the evaluation of notes or questions as well as observing how others carried out the tasks. In this sense we might expect some vicarious learning[81] to have taken place although this is not an issue we shall explore here further.

Also, by working in small groups, the students were required to take into account what their partner(s) understood from the texts, relate that to their own comprehension and agree on a joint product (notes or questions).

9.7.2 Specific procedures - Note-taking condition

<u>Week 1</u>

[81] The term 'vicarious learning' has been used by some researchers to refer to learning through observation and modelling, or social learning (e.g., Bandura, 1971). By simply observing some activity carried out (by a teacher, for instance, who thus provides a model) the student learns how to perform that activity even without overt practice. Thus, in the classroom it seems reasonable to expect students to benefit as observers and not only as participants (cf. Lee, Dineen & McKendree, 1998: 17).

Step 1. The underlying goal of note-taking was explained to the students as being to identify the main ideas relevant to a particular purpose for reading, and to structure this information in such a way as to make it memorable and/or to facilitate its retrieval.

Step 2. Students were given the first of the ten practice texts (Mini DVCamcorder, see Appendix E2), asked to read paragraph one and note down the advantages and disadvantages of mini DV camcorders. Given that the text says only that the advantages of these cameras are “obvious”, the activity provides an opportunity of pointing out the importance of incorporating one’s own background knowledge into the notes; that is, relating the information in the text to what one already knows about the topic. The advantages were, therefore, elicited from the students and written on the blackboard. The alternatives offered were discussed and agreement reached as to which were the most appropriate.

Step 3. Students were asked to read the remaining text and add any relevant information to their notes. Again, this was elicited from the students, their suggestions were discussed and the most appropriate added to the notes on the blackboard. The model notes for this activity are shown in Figure 9.10 below.

The information required from this text (advantages and disadvantages) is very limited, thus the activity serves as a straightforward example of how picking out relevant information can reduce a text to a few easily-handled phrases.

Advantages and disadvantages of mini DV camcorders	
Advantages	
· Lighter	
· Easier to carry	
Disadvantages	
· Harder to use	- smaller LCD viewing screen - control buttons smaller and closer
· Lower optical-zoom magnification	
· Use digital image stabilization	

Fig. 9.10. Model notes for Training Text 1.

Step 4. Before giving out the second text, the importance of reading with a concrete purpose was stressed to the students (for the reasons outlined in pages above and in our discussion of split focus in Section 6.5.1). It was pointed out that the focus of the second practice text was contained in the title ‘Travel and the environment’, and students were asked to make notes on the advantages of rail travel for (i) the environment, and (ii) for passengers. Students were monitored by the researcher as they carried out this activity.

Step 5. Subsequently, the researcher’s notes (see Figure 9.11) for this text were shown using an overhead projector (OHP). It was pointed out that notes do not need to follow a text, rather the information can be organised into themes or topics. Thus, in the researcher’s notes for the second practice text, the information had been organised into themes; environmental advantages and passenger advantages. It was also stressed that notes do not necessarily need to consist of complete or grammatically well-formed sentences, but could be short phrases encapsulating an idea or concept and designed to trigger further details from memory if required.

<u>Travel and the environment</u>

Advantages of rail transport

Efficient

Rail more environmentally friendly than road or air travel
- less air pollution
- uses less land than roads

Rail reduces congestion on roads - highways (intercity)
- streets (urban)

Passengers - save time & money
- 450-800 kms competitive travel times with air
- stations in city centres → reduced travel/waiting time
- cars last longer
- less stress

Figure 9.11. Model notes for Text 2.

Step 6. Students were told that the examples of notes so far, followed a linear format, but that there were other formats. Two other examples of notes for Text 2 were shown, one in the form of a 'diagrammatic skeleton' (see Figure 9.12) and the other as a 'mind map' (see Figure 9.13). It was stressed that the information contained in each set of notes was exactly the same, but that it was set out in a different form.

<u>Travel and the environment</u>

Advantages of rail transport

Efficient

Rail more environmentally friendly than road or air travel
- less air pollution
- uses less land than roads

Rail reduces congestion on roads
- highways (intercity)
- streets (urban)

Passengers
- save time & money
- 450-800 kms competitive travel times with air
- stations in city centres → reduced travel/waiting time
- cars last longer
- less stress

Figure 9.12. Model notes in an alternative format for Text 2.

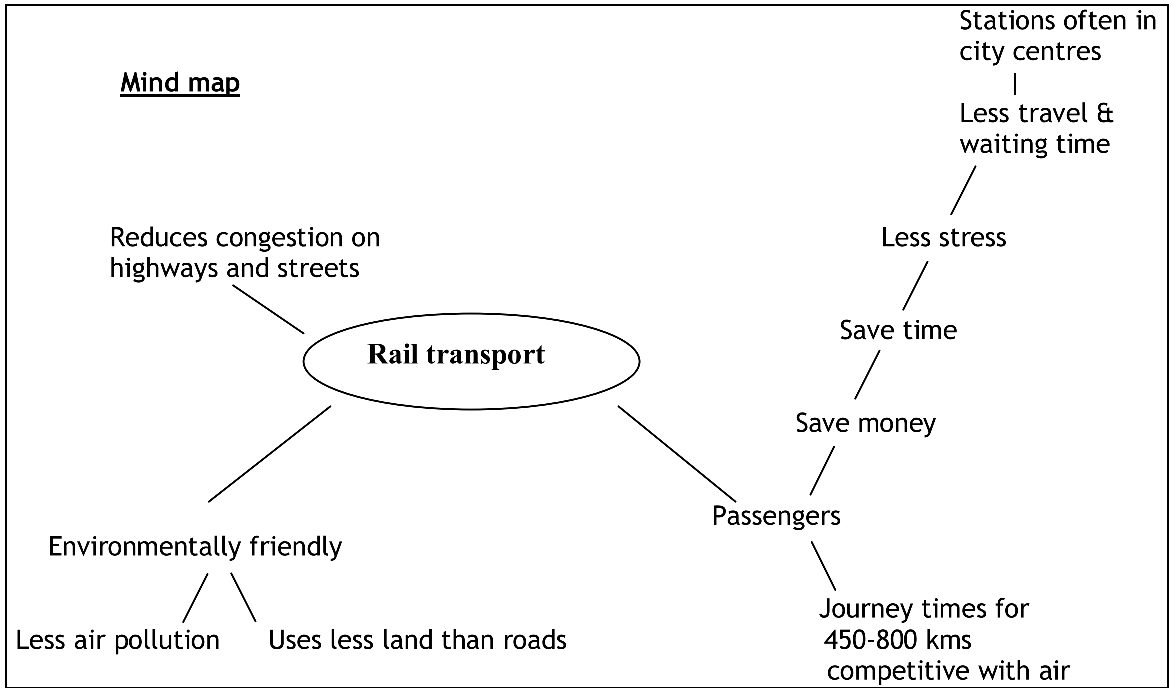

Figure 9.13. Notes in a second alternative format for Text 2.

Week 2

Step 7. Students were reminded of the points made so far, and an additional advantage of note-taking was pointed out; that of helping to avoid plagiarism.

Step 8. The procedure for Practice Text 3 (Plastics) was as follows: students were given the text and asked to make notes in not more than 42 words – the number used by the researcher. The purpose of this was to encourage students to pick out only the most important ideas and write them down in an abbreviated form. During our monitoring of the participants' note-taking in the previous class, it was observed that several students had 'lifted' whole sentences such as 'Another disadvantage of the pocket-size models is that they usually have smaller optical-zoom magnification', or 'Commuters have realized that they can save both time and money when they use rail'. By allowing only a limited number of words, it was hoped the students would focus on the main ideas and find ways to express them in a reduced, yet understandable, form. Again, the researcher monitored the students as they made their notes, offering suggestions and clarifications.

Step 9. The researcher's model notes (see Figure 9.14) were shown using an OHP. It was pointed out that these notes represented only one possibility. Alternatives were elicited and discussed.

Plastics

Versatile

Can be manufactured to meet very specific functional needs

Plastic packaging →	protects food from contamination is lighter is unbreakable goods are easier to carry
Plastic improves →	resistance to corrosion efficiency durability quietness resistance to bumps and scratches running costs

Figure 9.14. Model notes on Text 3.

Step 10. The procedure for Training Text 4 (Batteries) was similar to that for the previous texts. Once students had made their own notes, the model notes (see Figure 9.15) were shown. The symbols and abbreviations as well as any alternatives and differences between the students' notes and the researcher's notes were discussed.

Batteries

Batteries - generate electrical current through chemical reactions

'Flat' battery = dead battery

Primary cells	Secondary cells
not rechargeable	rechargeable

latest developments use lithium → lightest of all metals
greatest electrochemical potential
provides the most energy

Lithium primary batteries used in: photography
currently best for scientific and military applications

But: lithium metal NOT USED for rechargeable batteries → unsafe

Rechargeable batteries use lithium ions found in e.g. lithium-cobalt dioxide.

Lithium-ion batteries now the most common battery in high tech applications
e.g. cellular phones
laptop computers

Re size, battery development is not as advanced as silicon.

Figure 9.15. Model notes on Text 4.

Week 3

Step 11. There were several differences between the fifth text used and the previous four. Firstly, it was considerably longer (854 words as opposed to the previous maximum of 351 for the Batteries text). Secondly, it was presented electronically and accessed by the students directly from the Internet. Thirdly, students were allowed to make 'electronic notes'; that is, they could open a file on the computer and make notes directly from the source text. The danger in doing so, is that it is easy to simply 'copy and paste' portions from the original without thinking about the content, a behaviour which would go against the whole purpose of constructive processing. Students were warned against doing this. Fourthly, students were told that if they wished to do so, they could make notes in Spanish, although in the event no one did (perhaps because the text is relatively straighforward). An example of notes made by two of the students working together is given below in Figure 9.16. Although the English contains some mistakes (and was later corrected with the students concerned), these notes are interesting for the first use made of abbreviations and for the fact that they do focus only on the main points.

INDOOR AIR POLLUTION

What is Indoor Air Pollution?

| gases
toxic < or → can harm your health
| particles

Factors contribute to the high risk from indoor air pollution?

1. **Indoor pollutants → more dangerous → people inhale them easily**
2. **Most air that humans breath → indoor air**

   Indoor air > pollution <u>THAN</u> → outdoor air

Health Effects

- **Eye and throat irritation**

- **Respiratory disease**
- **Cancer**
- **Immediate death**

Prevention

- **“tighter" construction in newer homes.**
- **Adequate ventilation.**
- **Select Building Materials that don’t emit pollutants.**
- **Non-using products or engaging in activities that may generate pollutants.**
- **Restricting cigarette smoking to outdoor areas.**

Figure 9.16. An example of student notes (before correcting) from Training Text 5.

Week 4

Step 12. The Training texts in Session 4 (Numbers 6-8) introduce the students to the sort of text they may expect to deal with in future academic work, and are both linguistically and informationally more dense than all the previous texts. They also present a complex topic, that of corrosion, and for this reason the first text is in Spanish. It was thought it would serve to provide a more accessible grounding in the basic idea underrlying galvanic protection.

The three texts used in this Session were also presented to the students electronically. The students were instructed to make their notes on the first text (No. 6) and then add information from texts 7 and 8.

Weeks 5 and 6

These followed the procedure established in the previous sessions. Students read the texts and made notes which were then evaluated and commented on in a class discussion. The only difference between the sessions was that Training text 9 was accessed by the students electronically, while Text 10 was presented on hardcopy.

9.7.3 Specific procedures - Asking Questions condition

Week 1

Step 1. The purpose of asking questions was explained to the students as being to check comprehension, to elaborate on ideas in the text and to relate information in the text with backgroud knowledge.

Step 2. Students were put into pairs or groups of three and given the first of the four practice texts (Mini DVCamcorder). They were asked to read paragraph one and write down three questions they would ask about this paragraph if they were a teacher. Students were told they could only write questions for which they knew the answer, but that the answer did not have to be explicit in the text. The questions were then elicited and written on the blackboard. Any linguistic errors were corrected as a class. The researcher added the question ‘What are the advantages of pocket-size camcorders?’ which are not specified in the text. The answers were discussed as a class, as well as where the answer could be found; i.e., from the text, from general knowledge, or by reasoning.

Step 3. The procedure in Step 2 was repeated for the remainder of the text. Some example questions for the whole text are shown in Figure 9.17.

Can pocket-size and full-size camcorders use 60-minute tapes?
What are the advantages of a pocket-size camcorder?
What are the disadvantages of a pocket-size camcorder?
Why is a pocket-size camcorder harder to edit?
How many kinds of zoom are there?
Do optical or digital zooms give better image quality?
Why do optical zooms give better image quality?
What is the function of image stabilization?
What is the disadvantage of using digital image stabilization?
Why do most digital cameras use digital image stabilization?

Figure 9.17. Questions on Training Text 1.

Step 4. Remaining in their groups, students were given the second text, and asked to read it. It is not always possible to ask a question about every sentence in expository writing, therefore, students were asked to write between 2-3 questions for each paragraph. Again it was stressed that the answer did not have to be explicit in the text, but that the group must know the answer. The researcher monitored the groups as they carried out this task, attending to the effectiveness of the questions or to specific linguistic points.

Step 5. The researcher's own questions (see Figure 9.18) were projected on to a screen, and the answers (shown in italics in Figure 9.18) discussed as a class.

Travel and the environment

Q. 1. Why is rail transport more environmentally friendly than road or air travel?

less air pollution
railways use less land than roads

Q. 2. How can using railways reduce travel times in some cases?

stations in city centres
no waiting

Q. 3. What are the benefits of using rail transport for commuters and passengers?

save time and money
less stress
cars last longer
travel times are competitive with air (450-800kms)

Figure 9.18. Three model questions on Training Text 2, with the expected answers.

Week 2

Step 6. Students were reminded that the purpose of asking questions when reading a text was to go beyond the superficial information in order to relate the information in the text with what one already knew about the subject and to create a deeper understanding of the text topic.

Step 7. The procedure for the third text (Plastics) was the same as for the previous text. After monitoring the students' questions, the researcher projected his own onto a screen (see Figure 9.19). Their effectiveness as a means of highlighting the important information in the text was discussed.

Plastics

3 model questions for Text 3 (Plastics), with the expected answers

Q. 1. How does the consumer benefit from plastic packaging?

- *food is protected from contamination*
- *bottles, packets, etc, are lighter and unbreakable*

Q. 2. How has plastic helped to improve the quality of the products it is used to make?

- *more resistant to corrosion*
- *more resistant to scratches*
- *more efficient*
- *consume less energy*

Q. 3. How has plastic helped to improve the quality of life?

- *appliances are more efficient and quieter*
- *more hygienic*
- *easier to store and carry*

Figure 9.19. Three model questions on Training Text 3, with the expected answers.

A particularly interesting issue that arose while doing this activity was the question of how expectations as to what constitutes an acceptable answer might influence comprehension. For example, a number of students wrote the question: *Why are plastics so widely used?*, giving as the answer a sentence taken directly from the text: *They make life easier and better*. This illustrates, in fact, that 'Why' questions do not always lead to greater understanding. One group had continued with this idea writing a follow up question: *Can you give an example of how plastics make life easier and better?* The answer they gave was: *You can lift an economy-size bottle of* *fruit juice*. All of this is perfectly correct. Indeed, it suggests that the students have understood the text. Nevertheless, when asked to explain the answer using other words, the group was unable to do so and stated that they did not really understand what was meant. The point highlights the fact that, in question asking and answering, students must be trained to not simply repeat what is in the text or what they do not understand, but to go beyond what is in the text and to generalise from specific examples.

Step 8. Students were put into pairs or groups of three and given Training Text 4 (Batteries). As before, their task was to read the text and write down 3-5 questions per paragraph. Students were encouraged to write questions which required answers which were not explicitly mentioned in the text, although they were warned that they must know the answer to any question they wrote. The questions were then elicited and written on the blackboard. Any linguistic errors were corrected as a class, and the effectiveness of each question as a means of learning about the topic were discussed.

Weeks 3 – 6

The remaining weeks in which training was carried out followed a similar pattern to that used in Week 2, although, as we have mentioned, the texts were longer and both conceptually and linguistically more demanding. Students worked in groups of two or three, reading and asking questions of a text. Their activities were monitored by the researcher, who highlighted to the rest of the class effective questions; that is, those questions which produced understanding, contrasting these with those questions that merely required superficial reading of the text. The differences between the questions, as well as alternative answers, were discussed as a class.

9.8 Control condition

Students in the Control condition read the same ten training texts as those in the Experimental conditions, and they were presented in the same order, in the same weeks (see Table 9.1), and in the same formats. However, the sessions devoted to reading comprehension with this group were of the 'traditional' type; that is, the lesson centred on a text followed by between 5 and 10 questions which focused mainly on superficial details, and were designed to *test* whether the student had understood the text, or at least, those parts of it to which the questions referred, rather than produce understanding or teach ways of contributing actively to making sense of the text (Nuttall, 1992; Urquhart & Weir, 1998).

9.9 Presentation of the post-training tasks

9.9.1 The target texts and comprehension questions

One week after training had been completed, each group was presented with hardcopy versions of the Target Texts together with the questions pertaining to that text. Details of the texts are shown in Table E3, Appendix E, while the texts in full are included as Appendix E4. In order to ensure that the students from all the conditions were equally motivated to engage in the tasks, they were presented as the final part of an exam. Students were instructed to read the texts and provide written answers to the questions. Answers could be in English or in Spanish. The students were informed that some answers consisted of more than one piece of information and told that the more complete the answer; that is, the more relevant information it contained, the more marks it would receive. The students who had been participants in the experimental conditions were encouraged to read as they had been taught in the training sessions. They were not allowed, however, to take notes or to write questions. Since the amount of time spent on a task is a general predictor of learning success (Renkl, 1997) this would have allowed the experimental groups more time to process the information in the texts and given them an unfair advantage over the students in the control condition. No time limit was set for the task but students were told they could read the texts as many times as they wished.

9.9.2 The free recall task at Weeks 10 and 14

The free recall task was a repetition of the task used to assess background knowledge of the Target Text topics and is described in sub-section 9.5.2 above (see also Figure 9.2). The purpose behind the free recall task was simply to ascertain what students could remember about the text topics. If the students in one of the conditions could remember more than the others, it would suggest that the information during reading had been encoded in a way more amenable to recall, for example by paying attention to selected incoming material, organising the material into a coherent structure, and relating incoming information with prior knowledge (cf. Wittrock's (1989) theory of generative learning).

9.9.3 The cued recall task at Week 15

These consisted of the same questions given at Week 7. This time, however, students did not have the texts available. The purpose behind this activity was to manipulate the accessibility of information from a text which had been stored but which could not be spontaneously recalled. It was thought that the questions might act as retrieval cues, evoking information that had been encoded into semantic memory that could not otherwise be remembered. The assumption is that those students who have generated a deeper or richer situation model of the text will be able to recall or remember more.

9.10 Analysis of the answers

9.10.1 What was analysed

The purpose of this experiment was to examine the effects of giving groups of students training in constructive activities which were operationalised as self-explaining, note-taking and asking questions. In order to assess the effectiveness of the training, and ascertain whether or not the initial hypotheses – that training in self-regulated, constructive reading activities would enhance comprehension and long-term learning (see sub-section 1.2.3) – were correct or not, it was necessary to determine how well each group had performed on the post-training tasks and compare the results of the three groups.

It was felt unlikely that students at this level would include all the possible responses (see the performance criteria described in sub-section 9.4.3), especially for the more complex questions, and that many answers would include both relevant and irrelevant items of information. Moreover, we were not interested in linguistic correctness, but in whether the students could identify relevant information in a text or in several sections of a text, and whether the way in which the text was read would influence how the information was later recalled. Additionally, the free recall tasks at Weeks 10 and 14 would not require answers to questions, but would require the inclusion of items or units of information. Thus, the students' answers have not been analysed in terms of whether they were linguistically well-formed or not, or whether they included *all* the relevant information, but rather in terms of the number of relevant and irrelevant units of information that have been identified by each subject and included in his or her answer.

9.10.2 Classification of the answers

Five categories of answer were established:

A) completely correct – the answer included all of the relevant information and no incorrect or irrelevant information.

B) partially correct 1 – the answer included some, though not all, of the relevant units of information and no incorrect or irrelevant information.

C) partially correct 2 – the answer included either all or some of the relevant information but also some incorrect or irrelevant information.

D) incorrect – the answer included only incorrect or irrelevant items.

E) no answer – no answer was attempted or the subject indicated that he or she was unable to answer; for example, by writing "I don't know".

9.10.3 Symbols used in the tables

In the tables below, the '✓' row shows the total number of relevant items mentioned for each question, while the '~' row shows the total number of irrelevant or incorrect items mentioned for each question in those cases where the answer also includes correct information (in other words, category C of the classification above). The '×' row' shows the total number of completely incorrect answers – those with no correct items mentioned (category D). The 'Ø' row indicates a blank answer; i.e., that an answer has not been attempted. Summarising:

✓ = correct item of information

~ = irrelevant or incorrect item – where the subject has also included correct items

× = completely incorrect answer (i.e. with no correct items at all)

Ø = blank answer: no answer offered, space left blank or subject has written 'I don't know'.

The students' responses to each question were analysed according to the scheme described above. Each relevant or irrelevant piece of information included counted as one point. A completely incorrect answer (regardless of how many items of information it contained) also counted as one point, as did a blank answer. The number of points 'scored' by each member of a group were then added together to give a total group score for each category of answer.

9.11 Results and discussion

9.11.1 Results for the post-training comprehension task at Week 7

Text 1

The first salient feature of the results is that the NTG gave both quantitatively and qualitatively better answers than either the AQG or the CG. In other words, the NTG included more information and this information was more relevant than either of the other two conditions. This can be seen in Table 9.8, which shows the groups' scores for Target Text 1. The '✓' row indicates the total number of correct units or items of information given to each question (i.e., the total from each group's twenty-six members). Thus, to Question 1, the NTG included a total of 56 completely correct items, with just 1 item which was incorrect. This item was, however, included in an answer which included correct responses and is therefore placed in the '~' row. Question 2, on the other hand, produced 55 correct items of information with 1 completely incorrect response. Two students offered no response to Question 8 and one did not answer Question 11. The 'Total' column shows the total number of correct or relevant units of information included in their answers to all eleven questions by the members of the NTG (in this case, 558). There were 12 partially correct responses, and 2 answers which were completely incorrect; that is they included no relevant information at all. Answers were left blank on 3 occasions.

Text 1 Week 7		*Questions*											
Group		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*Total*
Note-taking Group (NTG)	✓	56	55	60	80	39	26	65	38	57	42	40	*558*
	~	1		8		2						1	*12*
	×		1			1							*2*
	Ø								2			1	*3*
Asking Questions Group (AQG)	✓	49	41	49	63	31	26	43	25	45	34	28	*434*
	~			19									*19*
	×	1	1	1		2			4				*9*
	Ø								6			2	*8*
Control Group (CG)	✓	39	37	52	51	14	26	38	23	28	23	17	*348*
	~	1	1	21	4					1			*28*
	×	5	1	4	1	13				3	2	2	*31*
	Ø					1		1	9		1	8	*20*

Table 9.8. Text 1, Week 7: Total number of relevant and irrelevant items given for each question, plus incorrect answers and blank answers, by group.

Table 9.8 also shows that the AQG (with a total of 434 correct items of information) gave more complete and more relevant answers than the CG (with 348). Put another way, the CG included 210 fewer items of correct information than the NTG. They gave more incorrect responses and left more questions unanswered than either of the experimental groups. The NTG's performance was superior to both other conditions. This can be seen particularly in Questions 2, 4, 5, 7, 9 and 11.

In addition, the answers to Question 8 (*Aluminium was first used for aircraft in the 1920s. What material(s) were used before aluminium?*) and to Question 11 (*Some composite materials absorb moisture. Why is this a problem?*), were not in the text. In order to answer these questions, students needed to draw on general world knowledge and/or apply common sense. Nevertheless, only 2 members of the NTG left their answer to Question 8 blank, compared to 6 from the AQG and 9 from the CG, while only 1 member of the NTG did not respond to Question 11 compared to 2 of the AQG and 8 of the CG. This suggests that the NTG were more disposed to attempt a reasoned answer than the other conditions. This is especially so for the Control condition; approximately one third of the CG made no attempt to answer either of these questions.

The NTG group, also seem to display greater learning of the content of the training texts. Question 5, for example, (*How can composite materials be manipulated in order to obtain specific properties?*) makes reference to paragraph 8 of Training Text 9, which states:

> Over recent decades many new composites have been developed, some with very valuable properties. By carefully choosing the reinforcement, the matrix, and the manufacturing process that brings them together, engineers can tailor the properties to meet specific requirements. They can, for example, make the composite sheet very strong in one direction by aligning the fibres that way, but weaker in another direction where strength is not so important. They can also select

> properties such as resistance to heat, chemicals, and weathering by choosing an appropriate matrix material.
>
> *Putting it together – composite materials*,
> Training text 9, paragraph 8.

Although some members of the AQG did mention one or other of these relevant items, the NTG students included more. The difference between the experimental groups and the control group (who identified just 14 correct items) is considerable. Moreover, half the CG answered this question (incorrectly) by copying word for word either the second or the third sentence of Paragraph 1 of the Target text. These read:

> Composites are materials that are combinations of two or more organic or inorganic components. One material serves as a "matrix", which is the material that holds everything together, while the other material serves as a "reinforcement", in the form of fibers embedded in the matrix.
>
> From: Target Text 1, para. 1

Members of the NTG also included an earlier item from Training Text 9 in their answers to Question 3 (*What are some of the problems with manufacturing composites?*). More of them remembered an item from that text; namely that the raw materials from which composites are made can be expensive. The inclusion of this piece of information partly accounts for the higher number of items given for this question.

One other feature of the results arising from Question 3 concerns the amount of incorrect information included in otherwise correct responses; that is, the '~' column. It can be seen that 8 of the NTG; 19 of the AQG; and 21 of the CG included irrelevant information. As we commented earlier, (in sub-section 9.4.3 *Performance criteria*), most of the relevant information necessary to answer this question can be found in paragraph 3 of Target Text 1. However, paragraph 5 contained some information which referred to the performance and maintenance of composite materials and not to their manufacture. This did not, therefore, count as a correct answer to the question. The inclusion of this incorrect information from paragraph 5 accounts for the bulk of the 'incorrect/irrelevant' items mentioned for Question 3 by the students from all conditions. Admittedly, the difference between manufacture and maintenance can be easily lost, especially across intervening text, but the question was not set as an intentional trap. What is interesting is that far more of the NTG appear to have understood, or picked up on, the difference.

Text 2

The results for Target Text 2 shown in Table 9.9 are similar to those for Text 1 and confirm that the NTG attempted to find answers to all the questions, identified more relevant information (compare especially Questions 2, 4, 5 and 7), and included less irrelevant information.

For example, Question 6 of Text 2 was: *What kind of power system will interplanetary spacecraft use in the future?* The correct response can be found in the second paragraph: *nuclear fission reactors*, yet five students in the Control condition, and only the Control condition, simply copied verbatim the following lines from the opening paragraph of the text: *A power supply for an interplanetary spacecraft must provide a large percentage of its rated power over a lifetime measured in years or decades*. It appears that students in the Control condition tended to pick up on the first piece of information that looked relevant, instead of reading for understanding. The answer given by the other students (from all conditions) who got this question wrong was *ion propulsion engines*, a not entirely unreasonable response, although the engine is not the power system.

In their answers to Questions 2, 4, 5 and 7, all of which required some degree of understanding of the situation described in the text and for which a fully correct answer involved several units of information, it can be seen that the NTG have given more considered and complete answers, although the AQG also performed well on Questions 2 and 5[82].

Text 2 Week 7		*Questions*									
Group		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*Total*
NTG	✓	26	50	25	31	79	24	23	44	20	*322*
	~										*1*
	×			1	3		2	3		6	*15*
	Ø										*0*
AQG	✓	26	42	25	18	73	24	14	37	20	*279*
	~				3	1		1			*5*
	×				10		2	11	2	5	*30*
	Ø			1				1	1	1	*4*
CG	✓	26	21	21	13	44	20	6	36	18	*205*
	~	7	2			3	3	2		1	*13*
	×		5	4	14	3	6	19	1	7	*59*
	Ø		1	1		3		1	2	1	*9*

Table 9.9. Text 2, Week 7: Total number of relevant and irrelevant items given for each question, plus incorrect answers and blank answers, by group.

<u>Copying answers from the texts</u>

Table 9.10 shows the number of times subjects' answers were copied from the text (either word for word in English or through a direct translation). It

[82] Just to put things into perspective, Tables E6a and E6b in Appendix E show the number of relevant items possible for each question according to the performance criteria which was established by the two 'expert' native readers.

can be seen that the NTG rarely copied from the texts (on just 4 occasions, in fact), while both the AQG and the CG resorted to this technique relatively often. This suggests that the training the NTG had received to put ideas and concepts contained in the text into their own words and to understand the text had had some effect. It is also interesting to note that the AQG copied verbatim from the text slightly more than the CG. This can perhaps be accounted for by the fact that during training, the AQG were concerned more with formulating questions – which they could answer – than with understanding the text. The strategy which both the AQG and the CG seem to have adopted was that of 'search-and-match' (Johnston, 1984), whereby they looked back at the text (which was present throughout the question answering) and selected what seemed to be an appropriate response on the basis of lexical similarity, rather than try to comprehend the situation described in the text or apply reasoning.

Group	*Text 1*	*Text 2*	*Text 1 + Text 2*
NTG	3	1	*4*
AQG	19	21	*40*
CG	17	19	*36*

Table 9.10. Week 7. Number of times subjects either copied or translated directly from the texts (by group).

To give an example of this, Question 4 asks: *How is the heat produced by Cassini's RTG used?* The answer to this question can be found in two places in the text: in paragraph 10 and in paragraph 12.

... RTGs as currently designed for space missions contain several kilograms of an isotopic mixture of the radioactive element plutonium in the form of an oxide, pressed into a ceramic pellet ... The pellets

> are arranged in a converter housing where they function as a heat source to generate the electricity provided by the RTG. The natural radioactive decay of the plutonium produces heat (RTGs do not use fission or fusion), some of which is converted into electricity by an array of thermocouples made of silicon-germanium junctions.
>
> From: Target Text 2, para.10
>
> Since they remain thermally hot, RTGs present advantages and disadvantages. The Cassini spacecraft employs much of its RTGs' radiant heat inside its thermal blanketing, to warm the spacecraft and propellant tanks.
>
> From: Target Text 2, para.12

Firstly, we may note that more of the NTG identified *both* pieces of relevant information, indicating that they were connecting ideas across different sections of text. Secondly, although 3 members of the NTG wrote incorrect answers, 10 from the AQG and 14 from the CG limited their responses to one of the following sentences; the first copied from paragraph 10, the second from paragraph 12:

(Waste) heat is radiated into space from an array of metal fins.

The Cassini spacecraft employs much of its RTGs' radiant heat inside its thermal blanketing.

Similarly, Question 7 of Text 2 asks: *Solar cells are cemented onto a substrate. Why is it important that both the cement and the substrate can conduct heat?* The answer is fairly clear in paragraph 6:

> The resulting assemblies are called solar panels, PV panels, or solar arrays. The cement and the substrate must be thermally conductive, because in flight the cells absorb infrared energy and can reach high temperatures, though they are more efficient when kept to lower temperatures.
>
> From: Target Text 2, para. 6

In other words, it is a question of maintaining efficiency by conducting heat away from the solar panels and reducing the temperature. However, 3 students from the NTG, 11 from the AQG and 19 from the CG failed to mention the need to conduct heat or reduce temperature. Many simply cited the following lines from Paragraph 6 of the Target text: "... because in flight the cells absorb infrared energy".

Blank answers

As can be seen from Table 9.11, The NTG left fewer questions unanswered than either the AQG or the CG.

Number of unanswered questions (Ø) per group, Week 7.													
Group		*Questions*											*Total*
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	
NTG	**Text 1**								2			1	*3*
	Text 2												*0*
AQG	**Text 1**								6			2	*8*
	Text 2			1				1	1	1			*4*
CG	**Text 1**					1		1	9		1	8	*20*
	Text 2		1	1		3		1	2	1			*9*

Table 9.11. Number of unanswered questions (Ø) per group, Week 7.

Questions 2, 7, 8 and 11 of Text 1 and Question 7 of Text 2 were 'knowledge inference questions (see sub-section 9.4.2 above). Questions 8 and 11 in particular were designed so that the answers were not contained either explicitly or implicitly in the text. To answer these questions, students needed to activate their general world knowledge and/or apply common sense or logic. Table 9.11 shows that it was precisely these questions which students found most difficult to answer, although nearly all the students in the NTG attempted to answer even these. It would appear from this that the students in the note-taking condition were more disposed to apply general knowledge, common sense or logic than those students in the asking questions condition or those who had received no training in constructive activities.

9.11.2 Results for the free recall task at Week 10

To evaluate the participants' performance on the free recall task, the students' answers were analysed independently by the researcher and a colleague, who each compiled lists of the correct and incorrect items of information mentioned by the subjects. The lists were subsequently compared and any disagreements evaluated individually. Table 9.12 shows the total number of relevant items mentioned by the subjects for Texts 1 and 2 and for both Texts together, by group. Table 9.13 shows the figures for Text 2 broken down into Part I (Photovoltaic Cells) and Part II (RTGs).

Week 10	**Text 1**		**Text 2**		**Texts 1+2**	
Group	*Total nº. of correct items mentioned*	*Mean nº. of correct items per subject*	*Total nº. of correct items mentioned*	*Mean nº. of correct items per subject*	*Total nº. of correct items mentioned*	*Mean nº. of correct items per subject*
NTG	214	8.23	165	6.34	379	14.57
AQG	157	6.04	136	5.23	293	11.27
CG	107	4.11	89	3.42	196	7.54

Table 9.12. Texts 1 and 2, Week 10: Total number of relevant items mentioned for each text by group.

Week 10	Text 2 (Part I) Photovoltaic cells		Text 2 (Part II) RTGs	
Group	*Total nº. of correct items mentioned*	*Mean nº. of correct items per subject*	*Total nº. of correct items mentioned*	*Mean nº. of correct items per subject*
NTG	86	3.31	79	3.04
AQG	72	2.77	64	2.46
CG	49	1.88	40	1.54

Table 9.13. Text 2, Week 10: Total number of relevant items mentioned for Parts I and II of Text 2, by group.

Again the results indicate that although the AQG remembered more than the CG, the NTG outperfomed both the other groups in terms of the number of relevant items of information remembered. With respect to the topic of Text 1, on average each member of the NTG gave twice as much information as those of the CG (8.23 relevant items, as opposed to 4.11) and the figures are similar for the topics of Text 2.

9.11.3 Results for the free recall task at Week 14

The procedure used to evaluate the Free Recall task at Week 14 was the same as that used at Week 10; that is, the texts were analysed independently by the researcher and a colleague and the relevant items mentioned by each subject in each condition added together to give the Group's total score. Table 9.14 shows the total number of relevant items mentioned for Texts 1 and 2 and for both Texts together, by group. Table 9.15 shows the figures for Text 2 broken down into Part I (Photovoltaic Cells) and Part II (RTGs).

What is particularly interesting about these results is that if we compare them with those at Week 10 (see Figures 9.12 and 9.13) we can see that although all conditions show evidence of having 'forgotten' during the three weeks between the earlier and the later test times (forgotten at least in the sense of including fewer pieces of correct or relevant information in their answers), the NTG have 'forgotten' proportionately less than the other two groups (see also Tables 9.18 and 9.19 below).

Week 14	**Text 1**		**Text 2**		**Texts 1+2**	
Group	*Total n°. of items mentioned*	*Mean n°. of items per subject*	*Total n°. of items mentioned*	*Mean n°. of items per subject*	*Total n°. of items mentioned*	*Mean n°. of items per subject*
NTG	155	5.96	119	4.58	274	10.54
AQG	102	3.92	78	3.00	180	6.92
CG	65	2.50	53	2.04	118	4.54

Table 9.14. Texts 1 and 2, Week 14: Total number of relevant items mentioned for each text by group.

Week 14	**Text 2 (Part I) Photovoltaic cells**		**Text 2 (Part II) RTGs**	
Group	*Total n°. of items mentioned*	*Mean n°. of items per subject*	*Total n°. of items mentioned*	*Mean n°. of items per subject*
NTG	60	2.31	59	2.27
AQG	42	1.61	36	1.38
CG	32	1.23	21	0.81

Table 9.15. Text 2, Week 14: Total number of relevant items mentioned for Parts I and II of Text 2, by group.

An important point to mention, and one which is not shown by the Tables, is that there were considerable differences between the students' answers, both in terms of the number of individual items of information included in their responses, as well as at the more macro-level of a connected and coherent representation of the text topics. Some students included very little information or showed a high degree of confusion, while others had developed a good understanding of the subject matter. These differences occurred both between and within the three conditions, although in general the members of the NTG did seem to have constructed more coherent representations. Rather than take examples at random, the four given below are from the students who scored the highest mark (27) on the initial English proficiency test administered at Week 0. The first is from a member of the CG, the second from a member of the AQG and the third and fourth from members of the NTG. The third example in particular shows evidence of a well-connected mental representation of the topics and the student has also incorporated details from her background knowledge. We have included the fourth example to illustrate the differences mentioned above. The language has not been corrected.

Example 1, from the CG

1. the composite materials are lightweight and strenght, but the composites need more maintenance that other materials for example Aluminium, and these materials are very expensive, but this, the scientifics are think that if in the future they will use the composite materials or not.

2. the photovoltaic pannels are very important in the future. these pannels get transform the solar energy in electrically energy but if pannels are exposed in bright temperatures the photvoltaic pannels losses efficacy.

Example 2, from the AQG

Composite materials are compounds that are use to produce semiconductors. This materials are made of silice wich is a high conductor of electricity and that's why is so effective.

Photovoltaics in interplanetary space missions.

- No fuel is needed.
- Panels has to be very large.
- The effectivity depends on the distance from the sun.

RTG's (I think) (Remember)
- ~~Something to be with atom fushion.~~
- Radio Termical Generators?
- Fuel needed is not to much and it can last for many time.
- Power produced is not very high but constant.

Example 3, from the NTG

<u>Composite materials</u>
Composite materials are those which are composed with two or more different simple materials. The union of different materials let humans change, give or modify the properties of these materials, it's to say, we can have materials with the properties we want (such as hrdness, strength, ductibility, maleability, toughness). The development of these kind of materials is in connection with the development of the industry because as the industry grows up, it needs more specific properties of materials for the advances. Mainly composite materials have one material called 'matrix', which is the base where the reinforcement material is.

<u>Photovoltaics in interplanetary space missions</u>
Photovoltaic cells use thesolar light to produce energy. Lots of photovoltaics cells form a panel. The bigger the panel is, the more energy it can produce. This form of obtention of energy is suitable to interplanetary devices because it's a renewable energy, it's to say, it uses the energy of Sun so it can't be finished.

The problems of photovoltaic cells are that the installaton and materials to form them are very expensive. Moreover, it's necessary large panels to produce energy, which make the the interplanetary device weigh a lot and be difficult to move. Photovoltaic cell can be used in domestic devices and interplanetary device.

RTGs

RTGs are Radiosotope thermal generators. With these generators we can obtain energy using heat. We can obtein more energy with these devices than with photovoltaic panels, so they are more suitable for interplanetary devices. The instalation is expensive.

Example 4, from the NTG

Composite materials are more stable and stronger
Aluminium alloys are lighter. One material gives to the other one same qualities that it hasn't

It's manufacture and maintenance are more expensive and it is more difficult to repair

It is very difficult to install solar panles in the spacecrafts, they need to be very large but it steals [*sic*] movility.
To avoid these problems exists RTGs (radioisotope thermal generators) another system to obtain energy

9.11.4 Results for the cued recall task at Week 15

Tables 9.16 and 9.17 show the results of the comprehension questions task given at Week 15 for Text 1 and Text 2 respectively. The results bear out previous indications that the members of the NTG included more relevant information, gave fewer incorrect answers and attempted more questions than either the other two groups, and that the AQG performed better than the CG. When looking at the figures, one should bear in mind the possibility of a practice effect caused by carrying out the recall task at Week 10 and at Week 14, which may have increased the subsequent probability of retrieving the relevant information.

Week 15 Text 1		*Questions*											*Total nº. of items*	*Mean nº. of items per subject*
Group		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*		
NTG	✓	39	38	26	39	34	15	43	33	29	28	34	*358*	*13.77*
	~			5		6							*11*	
	×						7						*7*	
	Ø		2				4		5	1	2		*14*	
AQG	✓	29	32	15	20	18	11	27	16	18	17	22	*225*	*8.65*
	~			14	3	6							*23*	
	×			7	2	3	9						*21*	
	Ø	3	3	4	4	5	5	1	10	8	9	4	*56*	
CG	✓	22	20	14	13	10	10	23	15	12	13	18	*170*	*6.54*
	~			1	5	2							*3*	
	×		1	3		4	9						*17*	
	Ø	7	7	9	13	11	7	3	11	14	13	8	*103*	

Table 9.16. Text 1, Week 15: Total number of relevant and irrelevant items mentioned for each question plus questions not answered, by group.

Week 15 Text 2		*Questions*									*Total nº. of items*	*Mean nº. of items per subject*
Group		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*		
Note-taking	✓	22	29	5	17	32	15	17	22	19	*178*	*6.85*
	~			2	2						*4*	
	×			15	2	1	5	2		5	*30*	
	Ø	2	3	6	9	3	6	7	4	2	*42*	
Asking Qs	✓	23	22	3	12	19	15	10	22	11	*137*	*5.27*
	~										*0*	
	×			14			2	3		9	*28*	
	Ø	3	5	9	12	10	9	13	4	6	*71*	
Control	✓	22	15	0	6	8	13	2	13	7	*86*	*3.30*
	~										*0*	
	×			18		1	4	3	0	8	*34*	
	Ø	6	11	8	20	17	9	22	13	11	*117*	

Table 9.17. Text 2, Week 15: Total number of relevant and irrelevant items mentioned for each question plus questions not answered, by group.

It is also interesting to note that the same questions seem to have given rise to poorer answers across conditions. The AQG and CG coincide in having a relatively high number of completely incorrect or blank answers to Questions 3, 4, 5, 8, 9 and 10 of Text 1 and to Questions 4, 5 and 7 of Text 2. In addition, the responses given to Question 6 of Text 1 and Question 3 and 6 (and perhaps 9) of Text 2, are poor across all the conditions. It is worth noting that these were questions to which the answer was to be found explicitly in the text, suggesting, perhaps, that in these cases the information was not encoded at the time of reading, but the answer merely 'matched' to the question.

9.11.5 Development of the answers

Tables 9.18 (Text 1) and 9.19 (Text 2) show how the amount of correct information included by the subjects in their answers compares over the weeks when testing took place. The 'Week 0' column refers to the number of units of information given during the test of background knowledge administered prior to the training: 13 in the case of the NTG; 15 by the AQG and 16 by the CG. The 'Week 7' column shows the total number of relevant units of information included by each condition in their answers to the comprehension questions for Text 1. The two columns in 'Week 10' show, firstly, the number of units of relevant information given by each condition in the free recall task at Week 10, and secondly, this figure expressed as a percentage of the information given at Week 7. The 'Week 14' and 'Week 15' columns include the equivalent information for Weeks 14 and 15.

We may think of the percentage figures as representing the amount of information given at Week 7 which had been 'remembered' at Weeks 10, 14 and 15. However, although the answers to the tasks at these later test times included information previously given at Week 7, they also included a very small amount of new information; that is, a student included an

Text 1	Week 0	Week 7	Week 10		Week 14		Week 15	
	Total nº. of items mentioned	*Total nº. of correct items mentioned*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*
NTG	13	558	214	38.35	155	27.77	358	64.15
AQG	15	434	157	36.17	102	23.50	225	51.84
CG	16	348	107	30.75	65	18.68	170	48.85

Table 9.18. Text 1. Items mentioned at Weeks 0 and 7, and at Weeks 10, 14 and 15 as a % of items mentioned at Week 7, by group.

Text 2	Week 0			Week 7	Week 10		Week 14		Week 15	
	Total nº. of items mentioned			*Total nº. of correct items mentioned*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*	*Total nº. of correct items mentioned*	*Nº. of items as a % of the nº. of items at Week 7*
	Part 1	*2*	*Tot.*							
NTG	12	0	12	322	165	51.24	119	36.95	178	55.28
AQG	10	1	11	279	136	48.75	78	27.96	137	49.10
CG	14	0	14	205	89	43.41	53	25.85	86	41.95

Table 9.19. Text 2. Items mentioned at Weeks 0 and 7, and at Weeks 10, 14 and 15 as a % of items mentioned at Week 7, by group.

item which he or she had previously not mentioned. In fact, this occurred only with 3 items. Thus, although *strictly s*peaking one can not talk in terms of material that has been been forgotten or remembered from one test time to another, it does enable an interesting comparison to be made.

The figures indicate that with respect to their *relative* performances at Week 7, the NTG and AQG performed similarly at Week 10; that is, each group 'remembered' a proportionately similar amount of the information it had given at Week 7, with the NTG (38.35%) slightly outperforming the AQG (36.17%), and both outperforming the CG (30.75). At Week 14 the difference is greater, with the NTG remembering 27.77%, the AQG 23.50%, and the CG 18.68%. The figures from the cued recall task at Week 15 suggest that substantially more information became accessible for recall to members of the NTG (64.15%) than to those of either the AQG (51.84%) or the CG (48.85%), and therefore that more information had been encoded at Week 7. The results for Text 2 show a similar pattern. In addition, some items of information (such as examples of composite materials mentioned in the previous texts, or how specific properties of composites can be obtained) were mentioned only by the NTG. Presumably, therefore, only students in this condition encoded the information at the time of reading.

9.12 Conclusion

The results from the main experiment seem to confirm previous research (in L1, Ainsworth & Loizou, 2003; Chi, de Leeuw, Chiu & Lavancher, 1994 among others, in L2, Block, 1992; O'Malley, Chamot, Stewner-Manzanares, & Kupper, 1985; Nunan, 1997; Nuttall, 1982; Verdugo Ramírez, 2004, among others) in that students can be trained to self-regulate their reading and that their comprehension does benefit from such training. In addition, the measures of learning carried out also suggest that by engaging in constructive reading activities such as note-taking and asking questions (as they have been operationalised here), readers may encode information in ways that make it more accessible to recall; that is, they learn more about the topic of the text and remember it for longer than students who do not read constructively.

Moreover, the results suggest that there is a relationship between reading condition and performance on (i) the comprehension transfer task at Week 7, and (ii) the long-term learning tasks at Weeks 10, 14 and 15, with the note-taking condition demonstrating higher levels of comprehension and learning than the other experimental condition or the control condition. In particular, reading and note-taking (as operationalised in this study), appears to have encouraged students to build greater links between sections of text, to connect new pieces of information with previous information, to activate background knowledge, and to integrate the ideas from these sources into a coherent knowledge structure.

With respect to the Asking Questions condition, it may be that more specific training is required. While monitoring the students in this group during training, it was clear that many of them interpreted their task as finding facts about which they could ask a question and, importantly as this was a requirement, this had to be a question to which they would know the answer. Thus, students in this group did not always read for understanding or try to build up a global idea of what the text was about. Nor did they make the inferences required when information was not immediately obvious. Rather, they looked for (usually explicit) details about which to formulate questions, processing only those sections of text about which they asked the question, but not integrating the information into their knowledge base or into a macrostructure of the text. More intensive training, with more emphasis on deep-level questions which require the integration of ideas across text might have produced different results.

To turn, then, to the research questions which prompted the study, we can answer them as follows:

9.12.1 Research Question 4

Research Question 4 was stated in the following terms:

4) Can the benefits of self-explaining texts be extended to students with an elementary/lower-intermediate level of English as a second language, reading expository texts in English?

It is apparent now that we can only give a partial answer to this question in the form in which it is stated. From the experiment reported in Chapter 7, we have seen how some students spontaneously generate self-explanations while others do not. Quite possibly those who do not could be trained individually to do so, as reported in the L1 self-explaining literature (e.g., Bielaczyc, Pirolli & Brown, 1995; Chi, de Leeuw, Chiu & Lavancher, 1994), but as this experiment was designed to measure *group* training, and the participants worked in groups of two or sometimes three, as well as together as a class, there is no data available on which to base a conclusion. What is clear is that the group training in self-explaining, where 'self-explaining is taken as 'explaining the sentences of a text to oneself as one proceeds through the text', failed.

On the other hand, if we take 'self-explaining' as engaging in one of the other constructive activities (note-taking or asking questions), we can say that students with this level of English have benefitted from the training received.

9.12.2 Research Question 5

Research Question 5 was:

5) Can readers with this level of English be instructed to self-explain L2 texts in a classroom situation as a group rather than individually, and will this group instruction improve the individual comprehension and learning of the participants?

Again, the answer to this question depends on how self-explaining is operationalised. We have taken it in this study to mean engaging with the text in one of three ways (self-explaining, note-taking or asking questions) in order to construct meaning. With respect to the first of these, and despite the limited data, the answer to Research Question 5 would appear to be a negative; students can not be instructed to self-explain as a group. From the experience described above in Section 9.6, and especially in sub-section 9.6.3, it would seem that reading a sentence and explaining what it means to oneself is an activity that is best carried out on one's own, where individual readers are at liberty to read at their own pace, to verbalise their own doubts and breakdowns in comprehension, to apply reasoning, critical analysis and inferencing ability to the text elements they wish, and to draw on their own linguistic and background knowledge in order to pursue their own elaborations.

Having said that, it would have been interesting to see whether the same students were able to work together to self-explain L1 texts. We might also have modified the experiment so that the students worked individually (as opposed to in pairs or threes) on the L2 texts in class. Unfortunately, the remaining time available during the period set aside or training precluded both these possibilities. It may also have been the case that the texts were too straightforward and did not encourage much elaboration to take place, or, as commented on above, that the instruction itself was ineffective.

However, when ‘self-explaining’ is understood as note-taking or asking questions, large group training does seem a viable and effective method of instruction, allowing learners to participate in different ways; for example as observers, as models for their peers, in the negotiation or joint construction of meaning, or in the generation and sharing of ideas and knowledge.

9.12.3 Research Question 6

Research Question 6 was:

6) Self-explaining can be operationalised in different ways. Are different forms of self-explaining; that is, different constructive activities, more, less, or equally effective in achieving the stated goals in our teaching-learning situation?

The answer to this question appears to be ‘yes’. The results reported in this research suggest that self-explaining operationalised as note-taking is more effective in enhancing comprehension and learning than self-explaining operationalised as asking questions, at least in the context in which they were developed here.

9.13 General summary

The picture that emerges from the research carried out in this study is that careful reading is a highly complex activity which involves coordinating a number of processes and operations in order to extract information from a text and construct meaningful representations. These processes are constrained by several variables deriving from features of the text, the context of reading, the task or purpose of reading and the reader. Some of these processes and operations are automatic, and hence consume very few attentional resources. Others involve the deliberate application of strategies in order for comprehension to be successful.

Various factors may hinder a reader’s ability to attend to the meaning of a text. These include, background knowledge, linguistic difficulty, lack of familiarity with text genre, low levels of interest or motivation. One variable which, it seems, is often overlooked in Higher Education, is the reader’s ability to decode and recognise words. It is assumed that having already learned to read in their L1, the student is able to decode easily and automatically in the L2 (Urquhart & Weir, 1998). The following comment taken from a report by the Thematic Network Project (TNP) Committee (2003), seems representative of this general assumption:

> The TNP Committee was concerned with Higher Education only, and therefore confined itself to the level of reading comprehension that goes beyond decoding written symbols: to the level of understanding whole texts, where the reader's reading skills in the first language appear to transfer largely to the foreign language.

One consequence of this assumption is that the skill of word recognition may be neglected, despite the fact that there are considerable differences in how easily L2 readers recognise words. The need for L2 students to be able to decode words rapidly and accurately has been stressed for some time (e.g. Beck, 1981; Haynes, 1993; Paran, 1996), and the (admittedly small-scale) studies reported in Chapter 4 of this thesis confirms that L2 word recognition by many of the participants in those studies is not an automatic process. Poor decoding is an immediate cause of comprehension problems and may result in further difficulties at deeper levels of language analysis and comprehension.

Having said that, although the ability to decode can facilitate L2 reading, it is, as Swaffar, Arens & Byrnes (1991) point out, no guarantee of understanding. Indeed, the interactive approach to reading we have adopted, views reading as a combination of lower-level identification or decoding processes and higher-level comprehension and interpretation processes. Apart from decoding, readers need to establish the reference and meaning of words and phrases, identify syntactic structures and patterns, interpret longer pieces of discourse, generate various types of inferences, and integrate different ideas and concepts with the general theme of the text and with their existing knowledge. Thus, comprehension is, in Kintsch's (1988, 1998) terms, a process of construction and integration. The cognitive processes involved operate on a variety of representations ranging from single letters to the whole text. In addition, readers must also apply a certain amount of common sense or logic and draw on background knowledge.

We have also noted the importance of monitoring comprehension and the ability to control and manage (self-regulate) one's own cognitive activities in a reflective, and purposeful fashion; for example by evaluating understanding and resolving difficulties or breakdowns through the application of an appropriate strategy. This involves knowing how and when to use which strategy, and to orchestrate its use with other strategies. On this point, a particular difficulty that low-level language learners may find is that while they may know what strategies to use in a given situation, their lack of vocabulary prevents them from establishing sufficient understanding of the content to apply the strategy, or build on what they have understood.

Similarly, the ability of the reader to draw on background knowledge and other schema-related information is also important for interpreting written materials. Doing so through the medium of a second language, however, may also limit the ability of some readers to make optimal use of what they already know.

A particular difficulty found by readers of expository texts is the unfamiliar nature of the content. In L2 reading contexts this can be exacerbated by unknown vocabulary or complex syntactic patterns. Nevertheless, as Tomlinson (1999: 4), points out:

> Low-level learners can be stimulated and helped to develop high-level skills and should not be restricted by special materials which focus on linguistic decoding and simple language practice.

One way of helping learners to develop high-level skills is through appropriate and authentic tasks which are appropriate to the text, and which allow learners to combine and integrate the use and the practice of linguistic, cognitive, and even physical, skills (Mishan, 2005). Another way would be to train readers in the sort of constructive reading activities described above. We would argue that appropriate tasks and constructive reading activities should be used in combination, thereby providing learners with opportunities to use and develop their reading skills – without forgetting that not all reading contexts require the sort of careful reading we have focused on here, and that the types of knowledge and comprehension necessary to correctly process one type of text may be different to those required to process another type of text (cf. the asymmetric view of reading competence put forward by León, 2004a; 2004b).

9.14 Implications and applications of the research

There is no doubt that being able to read technical, informational texts is a useful and important skill in both academic and professional contexts. Nevertheless, such texts can be extremely demanding in terms of their content, structure and language. Such are the difficulties, that many students are often reluctant to dedicate time, resources and effort into understanding them. Comparing the results from our note-taking group and the control group, however, suggests that training students in this form of self-regulated constructive reading activity helps them to overcome some of the problems associated with reading expository texts in their L2. Furthermore, training in constructive reading appears to strengthen students' motivation, autonomy and self-confidence in their ability to identify and extract relevant information and to build richer situation models of the states of affairs described in the texts. Despite Bernhardt's (1991: 173) reminder that there are no generic classrooms and that the effectiveness of providing instruction in comprehension strategies may vary from context to context, we believe that all students would benefit from training in self-regulated constructive reading activities.

With respect to training, Baddeley (1997: 196) makes the point that:

> In any situation where training occurs, it is essential to be aware of the danger that it may not transfer to the real-life environment, a problem that is of course central to the whole area of education.

Nevertheless, we would suggest that the benefits of constructive reading *do* transfer to real life situations. Despite the many practical difficulties, therefore, it is clearly important for education systems, and society in general, to ensure learners have adequate exposure to written materials and sufficient opportunities to develop their reading skills in both their first language and their second language.

Part IV

Chapter 10

Future research

The research described in this thesis itself gives rise to several interesting avenues of further investigation. In this final Chapter we present seven areas which we believe warrant further study, as well as our plans to use a recently acquired computer simulation programme of the Landscape Model (see Chapter 3), although without specifying a concrete research agenda.

1) In hindsight, and with respect to the study described in the immediately preceding Chapter, the comprehension and recall tasks enabled students to show items of information they had learned from the texts, but they did not capture the degree to which the participants' mental representations of the text were structured in memory; that is, the degree to which each idea unit, concept or proposition for each topic were *connected* in a consistent, meaningful way. It seems important to devise and develop some way of evaluating how knowledge is structured as a result of carrying out constructive reading activities.

2) A related issue is whether the format and type of questions (verbatim, comprehension inference, knowledge inference, etc.) as well as the presence or absence of the text while answering, and the wording of questions, particularly in a second language context, have an impact on how students perform. For example, having the text present enables the student to carry out search processes for specific details. When the text is absent, the student must rely more on memory, and as a consequence may

answer at a more general or macro-level. This is an area which is also concerned with assessment, and needs further study.

3) The main research described in this thesis was conducted in a real classroom setting, and an important issue to investigate further is whether the results are generalisable to other real life reading situations. Related to this is the question of whether students maintain the self-regulated reading skills they have developed and whether they apply them to new reading situations and tasks. In other words, how can maintenance and transfer effects be assured?

4) Educational materials are no longer restricted to the traditional printed format. The 'new' technologies have created novel and potentially powerful learning environments. Indeed, much work has already been done in the area of language learning and the use of the World Wide Web.

One feature of electronic reading materials is the use of hypermedia, which allows the reader to choose the order in which materials are read, and multimedia, which uses more than one mode of presenting information. Text may now be accompanied by auditory and/or visual (graphic) information, some of which may be animated, three-dimensional or interactive, in order to improve comprehension.

The primary research question regarding multimedia environments seems to be not whether multimedia instruction is effective, but rather under what conditions and for whom. In other words, studies need to be carried out in order to determine the effectiveness of specific features of multimedia materials for specific learning tasks, for the specific types of learners in our, and other, teaching-learning contexts, with the goal of ascertaining how each variable might contribute to L2 reading or to the learning of subject matter.

Some of these variables might include the effectiveness of auditory material, ranging from spoken, individual words to entire texts. Different kinds of graphics, including still images such as charts, tables, graphs, photographs or drawings and dynamic images such as videos or short film sequences, or interactive visual materials. In addition, individual learner differences, such as L2 proficiency level, motivation, interest or learning style may also have an effect on learning through multimedia.

Schnotz (1993: 248) argues that the construction of a mental model of a situation is qualitatively different when learning from text and when learning from images. Graphics, he says, possess "[...] inherent structural properties used for their representational functions, which is not the case with text". In other words, while the construction of a mental model from text requires the construction of propositional representations, which then have to be integrated into the mental model, in Schnotz's view, the use of images "[...] provides the possibility of a relatively direct construction of a mental model" (ibid: 248-249). Thus, whereas text comprehension requires an indirect transformation between the symbolic representation of the text and the analog mental model, the comprehension of an image requires establishing an analogy between the picture and the corresponding mental model, effectively bypassing the propositional representation of information altogether. Images, therefore, can be language independent.

This gives rise to a number of questions: to what extent does a learner use the text and to what extent the graphics? Are there any kinds of graphics which facilitate or hinder comprehension? Are there any factors which influence the use of verbal material or pictorial materials? How might adding a picture to a text influence (i) learning of the text content, (ii) learning of any target language features in the text? How can both types of representations be combined to improve comprehension of a text? Do learners have preferences for using one type of information over another? Can the use of more than one channel of information interfere with processing or with where attention is directed?

5) In Chapter 4 we discussed the fact that readers appear to automatically generate a phonological code, even when reading silently. Some researchers believe that this is the ‘inner voice’ (cf. Urquhart & Weir, 1998) and that its function is to hold words long enough in WM to enable us to process the meaning of strings of words (phrases or sentences). If this is the case, we might expect more familiar sounds to facilitate the detection of syllables and, higher up the hierarchy, known words. In contrast, unfamiliar phonemes, or unfamiliar sounding words, would either not be recognised or interpreted in terms of existing vocabulary items (cf. Baddeley & Logie, 1999). It seems important to ascertain the role, if any, of inner speech in L2 reading and word recognition.

6) Remaining with words, the task at Week 15 was used to stimulate retrieval of information by giving cues which would aid recall. This has implications for the design of examination questions. In the area of vocabulary learning, for example. In Chapter 4 we saw that students knew the meanings of words presented to them although they appeared not to be very familiar with their phonological or orthographic features. We also saw in the experiment with the Vocabulary Knowledge Scale, that when students learned the meaning of a word, what was learned was not the general meaning(s) but only a particular meaning or aspect of meaning in a specific context (cf. Barclay, Bransford, Franks, McCarrell & Nitsch, 1974, cited by Baddeley, 1997, or Figueroa (1989), who noted that words may represent the same general idea or concept but have variations and different levels of difficulty across languages). This suggests that we need to be specific about what aspect(s) of the meaning of a word we want our

students to know, and whether we will be satisfied if they are able to passively recognise the word or whether they need to be able to use the word productively. Alternative methods for testing *and teaching* lexis need to be devised, therefore, methods which reinforce clear objectives for given language items.

7) Research into L2 sentence processing, as well as the results of the small study reported in Chapter 5, suggests that L2 readers underuse structural information when processing sentences from the L2, and instead rely primarily on lexical-semantic information. Teaching materials need to be designed which would (i) increase the learners' awareness of syntactic patterns or form, and (ii) enable them to make greater use of this information in order to establish units of meaning, as well as to better identify the relationships existing between elements in a text.

Finally, and in addition to the above, we have recently obtained the computer programme of the Landscape Model from Paul van den Broek. This model captures both online comprehension processes and the offline memory representation after reading has been completed (Tzeng, van den Broek, Kendeou & Lee, 2005), and the programme allows inferential processes and memory representations of comprehension to be simulated. We plan to use the programme to model how linguistic factors may influence the availability and understanding of information from current and prior reading cycles of a text, as well as the availability of background knowledge and a possibly reduced cohort activation. While cohort activation in a first language may be fast and passive, we believe it needs to be more strategic in a second language. The Landscape Model allows these factors to be simulated and their connection strengths altered.

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Appendices

Appendix A

Proficiency schemes and guidelines

A1. The Components of Bachman & Palmer's (1996) model of language ability.

<table>
<tr><th colspan="3">Components of Bachman & Palmer's (1996)
model of language ability</th></tr>
<tr><td rowspan="4">Language use</td><td rowspan="2">Organisational knowledge</td><td>grammatical
· vocabulary
· syntax
· phonology/graphology</td></tr>
<tr><td>textual
· cohesion
· rhetorical or conversational organisation</td></tr>
<tr><td rowspan="2">Pragmatic knowledge</td><td>functional
· ideational
· manipulative
· heuristic,
· imaginative</td></tr>
<tr><td>sociolinguistic
· dialects/varieties
· registers
· natural or idiomatic expressions
· cultural references
· figures of speech</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Strategic competence</td><td>Goal setting</td><td>· deciding what one is going to do</td></tr>
<tr><td>Assessment</td><td>· taking stock of what is needed</td></tr>
<tr><td>Planning</td><td>· deciding how to use what one has</td></tr>
</table>

Table A1. The components of Bachman & Palmer's (1996) model of language ability.
Source: Bachman & Palmer (1996: 67-73).

Appendix A2. Common Reference Levels: global scale.

Common European Framework Reference Levels: global scale		
Descrip-tive label	*Level*	*Descriptors*
Basic User	A1	Can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type. Can introduce him/herself and others and can ask and answer questions about personal details such as where he/she lives, people he/she knows and things he/she has. Can interact in a simple way provided the other person talks slowly and clearly and is prepared to help.
	A2	Can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need.
Independent User	B1	Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.
	B2	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

Appendix A2 (continued). Common Reference Levels: global scale.

Common European Framework Reference Levels: global scale		
Descrip-tive label	*Level*	*Descriptors*
Proficient User	C1	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexible and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
	C2	Can understand with ease virtually everything heard or read. Can summarise information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation. Can express him/herself spontaneously, very fluently and precisely, differentiating finer shades of meaning even in more complex situations.

Table A2. Common Reference Levels: global scale (continued).
Source: Council of Europe, 2001b: 24.

Appendix A3. Common Reference Levels for the self-assessment of general reading.

CEF descriptors for the self-assessment of general reading	
Level	***Descriptors***
A1	I can understand familiar names, words and very simple sentences, for example on notices and posters or in catalogues.
A2	I can read very short, simple texts. I can find specific, predictable information in simple everyday material such as advertisements, prospectuses, menus and timetables and I can understand short simple personal letters.
B1	I can understand texts that consist mainly of high frequency everyday or job-related language. I can understand the description of events, feelings and wishes in personal letters.
B2	I can read articles and reports concerned with contemporary problems in which the writers adopt particular attitudes or viewpoints. I can understand contemporary literary prose.
C1	I can understand long and complex factual and literary texts, appreciating distinctions of style. I can understand specialised articles and longer technical instructions, even when they do not relate to my field.
C2	I can read with ease virtually all forms of the written language, including abstract, structurally or linguistically complex texts such as manuals, specialised articles and literary works.

Table A3. Common Reference Levels:
self-assessment grid for general reading.
Source: Council of Europe, 2001b: 26.

Appendix A4. The principal features of each ALTE level.

CEF level	*ALTE level*	*Salient features*
A1	Break-through	a basic ability to communicate and exchange information in a simple way. *Example: CAN ask simple questions about a menu and understand simple answers.*
A2	1	an ability to deal with simple, straightforward information and begin to express oneself in familiar contexts. *Example: CAN take part in a routine conversation on simple predictable topics.*
B1	2	an ability to express oneself in a limited way in familiar situations and to deal in a general way with non-routine information. *Example: CAN ask to open an account at a bank, provided that the procedure is straightforward.*
B2	3	the capacity to achieve most goals and express oneself on a range of topics. *Example: CAN show visitors round and give a detailed description of a place.*
C1	4	an ability to communicate with the emphasis on how well it is done, in terms of appropriacy, sensitivity and the capacity to deal with unfamiliar topics. *Example: CAN deal with hostile questioning confidently. CAN get and hold onto his/her turn to speak.*
C2	5	the capacity to deal with material which is academic or cognitively demanding, and to use language to good effect, at a level of performance which may in certain respects be more advanced than that of an average native speaker. *Example: CAN scan texts for relevant information, and grasp main topic of text, reading almost as quickly as a native speaker.*

Table A4. The salient features of each ALTE level.
Source: Council of Europe, 2001b: 248-249.

Appendix A5 (i). The ACTFL Guidelines for reading at the Novice levels.

The ACTFL Guidelines for reading at the Novice levels	
Level	*Guidelines*
Novice-Low	Able occasionally to identify isolated words and/or major phrases when strongly supported by context.
Novice-Mid	Able to recognize the symbols of an alphabetic and/or syllabic writing system and/or a limited number of characters in a system that uses characters. The reader can identify an increasing number of highly contextualized words and/or phrases including cognates and borrowed words, where appropriate. Material understood rarely exceeds a single phrase at a time, and rereading may be required.
Novice-High	Has sufficient control of the writing system to interpret written language in areas of practical need. Where vocabulary has been learned, can read for instructional and directional purposes, standardized messages, phrases, or expressions, such as some items on menus, schedules, timetables, maps, and signs. At times, but not on a consistent basis, the Novice-High level reader may be able to derive meaning from material at a slightly higher level where context and/or extralinguistic background knowledge are supportive.

Table A5. The ACTFL Guidelines for reading.

Appendix A5 (ii). The ACTFL Guidelines for reading at the Intermediate levels.

The ACTFL Guidelines for reading at the Intermediate levels	
Level	*Guidelines*
Intermediate - Low	Able to understand main ideas and/or some facts from the simplest connected texts dealing with basic personal and social needs. Such texts are linguistically noncomplex and have a clear underlying internal structure, for example, chronological sequencing. They impart basic information about which the reader has to make only minimal suppositions or to which the reader brings personal interest and/or knowledge. Examples include messages with social purposes and information for the widest possible audience, such as public announcements and short, straightforward instructions dealing with public life. Some misunderstandings will occur.
Intermediate - Mid	Able to read consistently with increased understanding simple, connected texts dealing with a variety of basic and social needs. Such texts are still linguistically noncomplex and have a clear underlying internal structure. They impart basic information about which the reader has to make minimal suppositions and to which the reader brings personal interest and/or knowledge. Examples may include short, straightforward descriptions of persons, places, and things written for a wide audience.
Intermediate - High	Able to read consistently with full understanding simple connected texts dealing with basic personal and social needs about which the reader has personal interest and/or knowledge. Can get some main ideas and information from texts at the next higher level featuring description and narration. Structural complexity may interfere with comprehension; for example, basic grammatical relations may be misinterpreted and temporal references may rely primarily on lexical items. Has some difficulty with the cohesive factors in discourse, such as matching pronouns with referents. While texts do not differ significantly from those at the Advanced level, comprehension is less consistent. May have to read material several times for understanding.

Table A5. The ACTFL Guidelines for reading

Appendix A5 (iii). The ACTFL Guidelines for reading at the Advanced levels.

The ACTFL Guidelines for reading at the Advanced levels	
Level	*Guidelines*
Advanced	Able to read somewhat longer prose of several paragraphs in length, particularly if presented with a clear underlying structure. The prose is predominantly in familiar sentence patterns. Reader gets the main ideas and facts and misses some details. Comprehension derives not only from situational and subject matter knowledge but from increasing control of the language. Texts at this level include descriptions and narrations such as simple short stories, news items, bibliographical information, social notices, personal correspondence, routinized business letters, and simple technical material written for the general reader.
Advanced - Plus	Able to follow essential points of written discourse at the Superior level in areas of special interest or knowledge. Able to understand parts of texts which are conceptually abstract and linguistically complex, and/or texts which treat unfamiliar topics and situations, as well as some texts which involve aspects of target-language culture. Able to comprehend the facts to make appropriate inferences. An emerging awareness of the aesthetic properties of language and of its literary styles permits comprehension of a wider variety of texts, including literary. Misunderstandings may occur.

Table A5. The ACTFL Guidelines for reading

Appendix A5 (iv). The ACTFL Guidelines for reading at the Superior level.

The ACTFL Guidelines for reading at the Superior level	
Level	*Guidelines*
Superior	Able to read with almost complete comprehension and at normal speed expository prose on unfamiliar subjects and a variety of literary texts. Reading ability is not dependent on subject matter knowledge, although the reader is not expected to comprehend thoroughly texts which are highly dependent on knowledge of the target culture. Reads easily for pleasure. Superior-level texts feature hypotheses, argumentation, and supported opinions, and include grammatical patterns and vocabulary ordinarily encountered in academic/professional reading. At this level, due to the control of general vocabulary and structure, the reader is almost always able to match the meanings derived from extralinguistic knowledge with meanings derived from knowledge of the language, allowing for smooth and efficient reading of diverse texts. Occasional misunderstandings may still occur; for example, the reader may experience some difficulty with unusually complex structures and low-frequency idioms. At the Superior level the reader can match strategies, top-down or bottom-up, which are most appropriate to the text. (Top-down strategies rely on real-world knowledge and prediction based on genre and organizational scheme of the text. Bottom-up strategies rely on actual linguistic knowledge.) Material at this level will include a variety of literary texts, editorials, correspondence, general reports, and technical material in professional fields. Rereading is rarely necessary, and misreading is rare.

Table A5. The ACTFL Guidelines for reading

Appendix A5 (v). The ACTFL Guidelines for reading at the Distinguished level.

The ACTFL Guidelines for reading at the Distinguished level	
Level	*Guidelines*
Distinguished	Able to read fluently and accurately most styles and forms of the language pertinent to academic and professional needs. Able to relate inferences in the text to real-world knowledge and understand almost all sociolinguistic and cultural references by processing language from within the cultural framework. Able to understand a writer's use of nuance and subtlety. Can readily follow unpredictable turns of thought and author intent in such materials as sophisticated editorials, specialized journal articles, and literary texts such as novels, plays, poems, as well as in any subject matter area directed to the general reader.

Table A5. The ACTFL Guidelines for reading
Source:
<http://www.sil.org/lingualinks/LANGUAGELEARNING/OtherResources/ACTFLProficiencyGuidelines/TheACTFLGuidelines.htm>

Appendix B
Questionnaires

The questions from the survey into reading habits outside the University. The items on the questionnaire were also explained in Spanish.

You may write your answer in English or in Spanish.

1) How many hours per week do you spend reading outside the university (any kind of reading counts; e.g., books, magazines, Internet, comics, etc.):

in Spanish? _____

in English? _____

2) If you don't read very much in English, why is this?

3) Do you think being able to read in English is important or useful for your:

academic studies	yes / no
work	yes / no
social or personal reasons	yes / no

4) Is it a skill you would like to develop, and if so, why?

Thank you for your cooperation

Appendix C

The texts used in the preliminary study reported in Chapter 7

C1. Details of the texts used in the study on comprehension strategies reported in Chapter 7.

Training text

Timing is everything

Source: *Blue Wings* (Magazine of Finnair Airlines), September-October 2002, p. 42.

Nº. of words: 80

English texts

1) *Introduction to Materials Selection*

Source: <http://www.corrosion-doctors.org/MatSelect/Frames.htm>

Date retrieved: 16 January 2003

Nº. of words: 953

2) *Rosetta Spacecraft Design*

Source: < http://www.estec.esa.nl/spdwww/rosetta/html/design.html >

Date retrieved: 16 January 2003

Nº. of words: 699

Spanish texts

3) *Nuevos ojos en el espacio para la primera luz*

Source:

<http://www.elpais.es/suple/futuro/articulo.html?d_date=20021009&

xref=20021009elpepifut_1&type=Tes&anchor=elpfutpor>
Date retrieved: 22 January 2003
Nº. of words: 1116

4) *El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta*
Source: <http://www.elpais.es/suple/futuro/>
Date retrieved: 22 January 2003
Nº. of words: 1187

Appendix C2. The instructions for the tasks

Text 1
Introduction to Materials Selection

Instructions
Read the text and make brief notes (a word or phrase) on (i) the technical considerations, (ii) the economic aspects, and (iii) any other factors which need to be taken into account when choosing materials for a specific application.

Remember to say as much as you can about what you are thinking as you read, about what you do to understand, and about what you do to complete the task.

Text 2
Rosetta Spacecraft design

Instructions
Read the text, and on the drawing label as many parts of the spacecraft as you can.

Remember to say as much as you can about what you are thinking as you read, about what you do to understand, and about what you do to complete the task.

Text 3
Nuevos ojos en el espacio para la primera luz

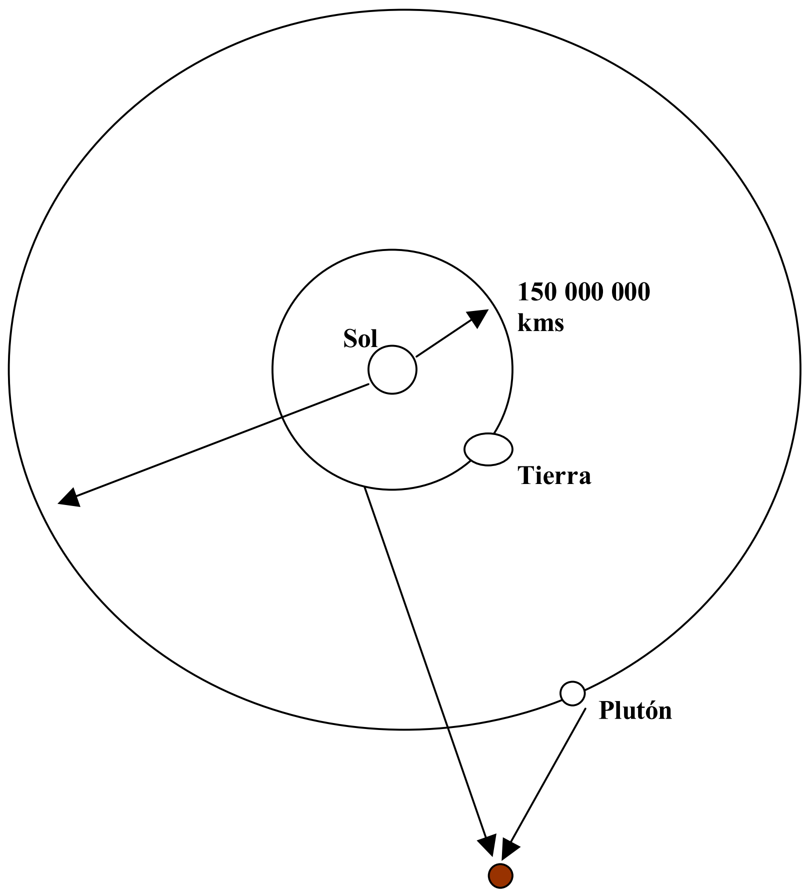
Instrucciones
Lee el texto y haz breves anotaciones sobre las características del nuevo telescopio y sus instrumentos.

Remember to say as much as you can about what you are thinking as you read, about what you do to understand, and about what you do to complete the task.

Text 4
El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta

Instrucciones
Utilizando la información contenida en el texto, completa el dibujo (que no está a escala) de la forma más detallada posible.

Remember to say as much as you can about what you are thinking as you read, about what you do to understand, and about what you do to complete the task.



Appendix C3. The complete texts

The texts were presented to the students in size 12, Times New Roman font on A4 paper and each fifth line was numbered. The change of format to a smaller page has meant that the original line numbering could not be maintained. Nevertheless, to aid identification of extracts referred to in the body of the thesis, the original line numbers in square brackets (e.g., *[25]* have been inserted in the places where they occurred.

Text 1. Introduction to Materials Selection

From a purely technical standpoint, an obvious answer to corrosion problems would be to use more resistant materials. • In many cases, this approach is an economical alternative to *[5]* other corrosion control methods. • Corrosion resistance is not the only property to be considered in making materials selection but it is of major importance in the chemical process industries. •

The choice of a material is the result of several compromises. • For example, the technical appraisal of an alloy will generally be a compromise between corrosion resistance *[10]* and some other properties such as strength and weldability. • And the final selection will be a compromise between technical competence and economic factors. In specifying a material, the task usually requires three stages:

- Listing the requirements
- Selecting and evaluating the candidate material *[15]*
- Choosing the most economic material •

The materials selection process is also influenced by the fact that the materials are either considered for the construction of a new system, or for the modification or repairs in an existing facility. • For the construction of new equipment, the selection procedure should begin as soon as possible and before the design is finalized. •

[20] The optimum design for corrosion resistance will often vary with the material used. • In a repair application, there is usually less opportunity for redesign, and the principal decision factors will be centered on delivery time and ease of fabrication in the field. • It is also

advisable to estimate the remaining life of the equipment so that the repair is not over-designed in terms of the corrosion allowance. •

Mechanical Properties of Engineering Materials

The selection criteria used by materials engineers in choosing from a group of materials includes a list of qualities that are either desirable or necessary. • Unfortunately, the optimum properties associated with each selection criteria can seldomly be all found in a single material, especially when the operating conditions become aggressive. •

Most chemical process equipment is designed and fabricated to the requirements of specific pressure vessel and piping codes. • These codes include only approved materials and establish the basis for and the setting of allowable stresses. • Thus, the mechanical properties of a material are usually the first criteria that materials engineers apply in the selection process. • This is especially important for applications at temperatures in the creep range where a minor difference in operating temperature can significantly affect the load carrying ability of the material. •

Materials Fabrication

There are many outstanding materials with highly desirable mechanical properties and corrosion resistance that are seldom used because they cannot be fabricated. • There are some materials which have excellent properties that can be fabricated as produced but, because of aging, cannot be modified or repaired after exposure to operating conditions. • Materials should therefore be selected on the basis of their maintainability as well as their original fabricability. • In general, the wrought heat resistant alloys have greater fabricability than the cast materials. • Cast alloy steels, for example, can typically tolerate significantly higher concentrations of carbon, silicon, tungsten, molybdenum, etc., which are added to enhance mechanical properties, corrosion resistance, or both. • But, these elements also can adversely affect the original, as-produced fabricability and make maintainability, particularly weldability, difficult, if not impossible. •

In materials processing, parts are manufactured from a variety of materials to meet defined product specifications. • The ever increasing concerns with performance and cost faced by companies competing in the global marketplace require that a spectrum of issues in the science of manufacturing be addressed. • Innovations and improvements in the processing of materials result from advances in the fundamental understanding of the relationships between the process, the material, and the resulting product. • Novel processing methodologies or the processing of new materials can open up opportunities for new product development, for research leading to next-generation machines and/or improvements in product performance and cost. • The advances being made in rapid prototyping, thin film and nanotechnologies, and net shape manufacturing are illustrations *[65]* of the application of fundamental research to materials processing issues. •

Availability of Materials

Materials engineers and purchasing agents become frustrated in trying to obtain materials that have a limited number of producers or a limited production volume. • Such frustration *[70]* can be particularly high when a small amount of material is needed to finish a job or replace a failed piece. • Prior to the original specification of a material, consideration should be given to its future availability for repairs or replacement in the form or forms that it will be used. • In those cases where it might not be available, alternative replacement materials should be identified. •
[75]

Materials Cost

Economics enter into every business decision. • But, the important criteria should not be the initial cost of a material, but its life-cycle cost or cost effectiveness. • It usually is much more cost effective to specify a material that will provide an extended life, particularly in *[80]* areas that are difficult to repair or in components that would cause major shut-downs in case of failure. • The following two extreme alternatives describe the consideration given to economic factors when selecting materials for specific service:

· A low initial cost system largely based on carbon steel and cast iron which will require considerable maintenance over the life of the plant. Such a system is a reasonable choice in *[85]* areas where labor costs are low and material is readily available. •

· A system based mainly on alloy materials which, if correctly designed and fabricated, will require minimum maintenance and will function reliably. Rising labor costs in most industries, together with the need for high reliability in capital intensive plant has produced a trend to this type of system. •

[90] In practice many systems are a mixture of these extreme options resulting in the high initial costs of one and the high maintenance costs of the other. •

Text 2. Rosetta Spacecraft Design

Introduction

The Rosetta mission is an interplanetary mission whose main objective is to rendez-vous *[5]* with and make in-situ measurements of comet 46 P/Wirtanen, in August 2011. • The spacecraft will also carry the Rosetta Lander (Surface Science Package) to the nucleus and deploy it onto the comet's surface. • The Lander is provided by a German-led consortium of European institutes. •

[10] Mission requirements

The ambitious scientific goals of the Rosetta create the following requirements:

- A large number of complex scientific instruments need to be accommodated on one side of the spacecraft, which must permanently face the comet during the operational phase of the mission, including at 1 km proximity to the active comet. *[15]* During the long cruise to the comet the dormant instruments must be heated to ensure their survival. •
- Complex spacecraft navigation at low altitude orbits around an irregular celestial body with weak, asymmetric, rotating gravity field, enveloped by dust and gas jets. • *[20]*
- The Rosetta Lander has to be stowed to survive the cruise and eventually to self-eject from the spacecraft. The orbiter must navigate with 10 cm, 1 mm/sec accuracy for the ejection, and then relay data from the SSP back to Earth. •

Design-driving requirements

[25] These primary mission requirements are design driving for most of the spacecraft layout and performance features, such as:

- the data rate needs to be as high as possible; given the limitations of the extremely long distance from Earth, the data must be highly compressed •
- high pointing accuracy (few arcsec), in particular for the remote-sensing *[30]* instruments •
- thermal layout - the spacecraft needs to endure both extremes of temperature, from that of deep space to that within 1 km of the active comet. •
- must be able to track the asteroid autonomously during the flybys (too fast and too far away for direct ground control) • *[35]*
- better than mm/sec relative velocity accuracy for manoeuvring in the vicinity of the comet •
- maximum 'wet' (spacecraft and fuel) mass is 2900 kg, with a propellant portion of more than 50%. This mass limit is governed by the launch capability of Ariane-5. •

- nominal spacecraft lifetime is 11 years in heliocentric trajectory •
- *[40]* the achievement of this lifetime is helped by the long hibernation periods during cruise, where most of the electrical systems are not operational. This hibernation increases their lifetime by a factor of 10 but requires onboard autonomy to guarantee continued operation in all circumstances •
- subsystem reliability maximised by a comprehensive *[45]* redundancy, including 'hot' redundancy (backup units actually on standby) for functions which are essential for a continuous, uninterrupted operation during critical mission phases. •

Mechanical Design Overview

[50] The Rosetta design is based on a box-type central structure, 2.8 m x 2.1 m x 2.0 m, on which all subsystems and payload equipments are mounted. • Two solar panels, each of 32 square metres, extend outwards, giving a total span of about 32 m tip to tip. The envisaged mechanical layout of the spacecraft, is illustrated in Figures 1 and 2. •

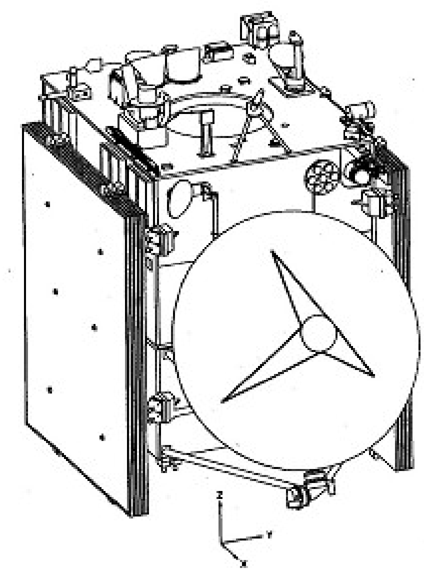


Fig. 1: Rosetta front view

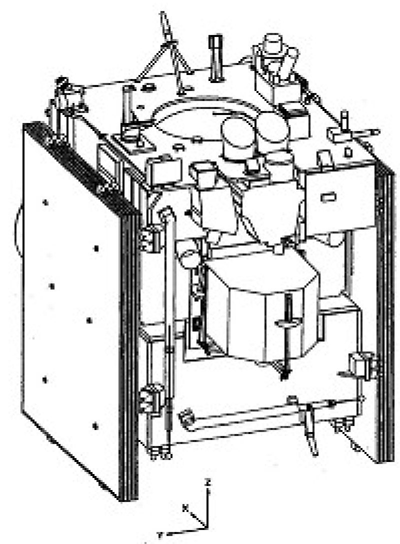


Fig. 2: Rosetta rear view

[60] The "top" of the spacecraft accommodates the payload instruments, and the "base" of the spacecraft the subsystems. • The spacecraft can be physically separated into two main modules:

- a Payload Support Module (PSM)
- a Bus Support Module (BSM). •

[65] The Lander is attached to the face opposite the two-axes steerable high-gain antenna. • The two solar wings extend from the "side" faces. • The instrument panel points almost always towards the comet, while the antennas and solar arrays point towards the Sun and Earth (at such great distances the Earth is relatively speaking in the same direction). • The spacecraft attitude concept is such that the side and back panels are shaded throughout *[70]* all nominal mission phases, offering a good location for radiators and louvres. • This will normally be facing away from the comet, minimising the effects of cometary dust. •

The spacecraft is built around a vertical thrust tube, whose diameter corresponds to the 1194 mm Ariane-5 interface. • This tube contains two large, equally sized, propellant tanks, the upper one containing fuel, and the lower one containing the (heavier) oxidiser. A *[75]* total amount of at least 1578 kg propellant will be accommodated. •

Text 3. Nuevos ojos en el espacio para la primera luz

Empieza el largo camino de la construcción del sucesor del telescopio 'Hubble' para su lanzamiento en 2010. •

El nuevo observatorio llevará el nombre de James Webb, el director de la NASA en la época del programa Apolo, que llevó el hombre a la Luna.• Aunque sólo será la mitad de grande que el Hubble, que pesa más de 10 toneladas, tendrá un espejo primario para captar la luz de 6 metros de diámetro, mucho mayor que el reflector de 2,43 metros del actual telescopio.• Con un área de captación de luz seis veces más grande que la del Hubble y un conjunto de instrumentos más sensibles, el nuevo telescopio debería ser capaz de detectar objetos con la centésima parte del brillo que el Hubble puede ver en la luz visible y a la cuadracentésima parte en el segmento infrarrojo del espectro lumínico. • Siguiendo recomendaciones de astrónomos que sugirieron un concepto nuevo y osado, la NASA ha anunciado que el observatorio a construir miraría al pasado del tiempo y del espacio para captar algo de la primera luz producida en el universo. • A diferencia del Hubble, este telescopio se enviará a una órbita alejada de la Tierra y debe ser capaz de detectar y analizar la débil y cálida luz producida cuando las primeras estrellas y galaxias se formaron varios cientos de millones de años después del Big Bang, el comienzo teórico del universo, ocurrido hace unos 14.000 millones de años, según los científicos. • El laboratorio también se usará para estudiar la formación de los planetas y buscar la materia oscura oculta que, según se cree, constituye la mayor parte de la materia existente en el universo. •

Infrarrojo

El nuevo telescopio no será sólo una versión aumentada del Hubble, un telescopio tradicional que básicamente ve el segmento de luz visible del espectro electromagnético, el que el ojo humano percibe. • El observatorio se optimizará para ver en infrarrojo, más adecuado para ver la luz de objetos que se alejan rápidamente del observador, que se adentra en el segmento rojo y térmico del espectro. •

El astrónomo Alan Dressler explica que los científicos querían algo más que simplemente un telescopio espacial de mayores dimensiones. • 'El telescopio espacial Hubble subió la apuesta inicial', dice Dressler. 'El deseo era dar un enorme salto, ir hacia algo osado que realmente supusiera un gran avance. • Por tanto, la meta se convirtió en poder ver la primera luz de las estrellas y el surgimiento de las galaxias. Ése es el nacimiento del moderno universo en el que vivimos hoy'. •

Aunque el nuevo telescopio está optimizado para ver en infrarrojo, los astrónomos y la NASA estuvieron de acuerdo en que el laboratorio debía tener la capacidad de producir fotografías en luz visible tan buenas al menos como las del *[40]* Hubble, a fin de asegurarse el apoyo público. • 'La NASA ha intentado durante años volver a captar la imaginación colectiva acerca del espacio, y ante la sorpresa de todos, la gente quedó cautivada por las imágenes del Hubble', afirma Dressler. • 'Éramos conscientes de esta percepción pública cuando hicimos nuestras recomendaciones'. •

Marcia Rieke, de la Universidad de Arizona, la principal investigadora del *[45]* instrumento primario del observatorio, una cámara para el infrarrojo cercano, afirma que las fotos del nuevo telescopio tomadas en luz visible deberían ser mejores que las del Hubble. • 'El telescopio funcionará mejor en infrarrojo, pero puede extenderse a la luz visible y hacerlo magníficamente', dice. •

La empresa TRW y sus socios, entre ellos Ball Aerospace y Eastman Kodak, *[50]* deben construir, probar y encargarse del funcionamiento del nuevo observatorio durante un año por un contrato de 843 millones de euros, que no incluye los costes de *[55]* lanzamiento. • El coste final del observatorio, pensado para durar al menos cinco años y quizá 10, podría estar en torno a los 1.277 millones de euros. •

Una de las razones por las que el funcionamiento del nuevo telescopio será más barato que el Hubble es que no se ha diseñado para ser reparado o mantenido una vez lanzado. • Por ello, los ingenieros están poniendo el énfasis en un elevado nivel de *[60]* fiabilidad y en la capacidad de recuperación de todos sus sistemas críticos, dice John C. Mather. •

Para aislar el telescopio de las interferencias infrarrojas de la Tierra y el Sol, el observatorio será lanzado en un cohete desechable en un viaje de tres meses de duración que lo llevará a una zona situada a 1.512.783 kilómetros de la Tierra llamada L2 (punto *[65]* de Lagrange 2). •

En un punto como ése, la gravedad de la Tierra y del Sol se compensan y una nave espacial puede mantener una posición estable con sólo unos pocos encendidos de su motor. • El punto L2 está situado en el lado de la Tierra opuesto al Sol, con el planeta siempre posicionado entre el punto L2 y el Sol. •

[70] El vehículo espacial, cuyos tres instrumentos principales consisten en cámaras de longitud de onda múltiple y dispositivos espectroscópicos que descomponen la luz para analizarla, también dispondrá de un filtro solar de múltiples capas del tamaño de una pista de tenis para aislarlos de la luz y el calor producidos por el Sol y la Tierra, que podría interferir en sus

observaciones. • El filtro y la posición remota permiten que el *[75]* observatorio se enfríe hasta una temperatura por debajo de -192 grados centígrados, haciendo posible que otros sistemas de refrigeración a bordo enfríen aún más los detectores para hacer las lecturas en infrarrojo en las mejores condiciones. •

Espejo segmentado
[80] A fin de que el espejo de 6 metros de diámetro quepa en el extremo de un cohete, se construirá como un conjunto de segmentos hexagonales que se plegarán en tres paneles en el momento del lanzamiento y se desplegarán en su forma circular una vez en el espacio. •

[85] Estos paneles flexibles tendrán en sus partes posteriores múltiples accionadores controlados por ordenador que pueden modificar la forma de los espejos para garantizar que la luz reflejada se concentre perfectamente en un colector. •

Para recortar costes y reducir el riesgo de problemas técnicos, la NASA ha estado apoyando investigaciones sobre espejos ligeros, detectores de estrellas y otras *[90]* tecnologías relevantes.• Mather dice que los retrasos en el desarrollo de la tecnología de espejos han incrementado el presupuesto y aplazado el momento del lanzamiento de 2008 a 2010. • 'El espejo es el mayor problema', afirma. 'Lo vimos desde el principio, así que no es ninguna sorpresa'. • En el plazo de un año, la agencia debe tomar la decisión crítica de qué material emplear para el espejo del nuevo telescopio. • Los *[95]* candidatos son un espejo metálico hecho de berilio o bien uno fabricado con alguna clase de cristal. •

Text 4. El hallazgo de un gran objeto más allá de Plutón replantea la idea de planeta

El pasado 4 de junio, usando un pequeño telescopio del veterano observatorio de Monte Palomar, y tras siete meses de búsqueda, dos astrónomos estadounidenses descubrieron *[5]* el objeto denominado Quaoar. • Siete meses son un tiempo muy corto comparado con los quince años que tardó Clyde Tombaugh en localizar a Plutón: las técnicas de análisis digital de imágenes están ya revolucionando el campo de la detección de cuerpos menores en los arrabales del Sistema solar. •

En promedio, Quaoar se encuentra 1.200 millones de kilómetros más allá de *[10]* Plutón, una distancia difícil de imaginar. • La luz del Sol tarda cinco horas en alcanzar este mundo en penumbra, una gran esfera rocosa cubierta de hielo; sin embargo, este último miembro de la familia solar es uno de los avanzados de una tribu de objetos compuesta por quizá 100.000 miembros, de los que hasta ahora se han descubierto tan sólo unos 600. • A mediados del siglo XX, el astrónomo Gerald Kuiper propuso la *[15]* existencia de un enjambre de cuerpos situados más allá de Plutón, pero más cerca que los cometas, una especie de cinturón de asteroides, pero más lejano y también más poblado: su predicción no se hizo realidad hasta 1992, cuando se descubrió el primer objeto perteneciente al enjambre, llamado Cinturón de Kuiper. •

Si Quaoar ha merecido titulares en la prensa, lo debe a su tamaño: su diámetro, *[20]* 1.250 km, es aproximadamente un tercio del de la Luna. • Se ha subrayado que se trata del mayor cuerpo descubierto en el sistema solar desde Plutón, en 1930. • Es también la primera vez que las dimensiones de un cuerpo tan lejano se verifican telescópicamente, por medio del Hubble y también por el Observatorio de Pico Veleta, en Granada. • La comprobación se ha basado en el calor solar que Quaoar refleja, y que depende de la *[25]* distancia, la temperatura y el tamaño. • Hay que subrayar la notable hazaña científica que representa medir la temperatura de un cuerpo situado a más de 6.000 millones de kilómetros de la Tierra. •

¿Qué se les ha perdido a los astrónomos planetarios en el Cinturón de Kuiper? • Cuando se descubrió Neptuno, algunos científicos, entre ellos Percival Lowell, el gran *[30]* defensor de la idea de que los canales marcianos eran en realidad obras de ingeniería planetaria, calculó que este octavo planeta no bastaba para explicar las anomalías orbitales de Urano. • Propuso entonces la existencia de otro gran planeta, el planeta X, que ha sido una especie de serpiente de verano del sistema solar hasta que se demostró, mucho tiempo después de la muerte de Lowell, ocurrida en 1916, que sus cálculos eran *[35]* erróneos, por lo que no cabía esperar ningún gran planeta exterior a Neptuno. •

Entretanto, Tombaugh, desde el observatorio privado que fundó Lowell, había descubierto Plutón (cuyas dos primeras letras son las iniciales de Lowell), un extraño planeta que nunca encontró acomodo en los dos grandes clanes del sistema: demasiado pequeño en comparación con los gigantes de gas, demasiado ligero para planeta rocoso, *[40]* a lo que más se parecía era a los satélites de los planetas gigantes. • La hipótesis clásica sobre Plutón era que se trataba de un satélite escapado del abrazo gravitatorio de Neptuno, una idea abonada por su exótica órbita, que cruza la de este planeta. •

Ahora, con el descubrimiento de centenares de objetos en el Cinturón de Kuiper, esta idea tiene una competidora: Plutón podría ser un satélite evadido, pero *[45]* también un intruso de la tribu de Kuiper al que alguna carambola astronómica ha llevado a merodear por zonas más cercanas al Sol: el dominio de los planetas. • Pero, ¿no es Plutón mismo un planeta? • En los años noventa, esta pregunta pareció lo bastante importante como para que la Unión Astronómica Internacional (IAU, siglas en inglés) revisase su definición. • El dictamen, emitido en 1999, determina que un planeta *[50]* es "un objeto en órbita alrededor de una estrella, que sea más pesado que Plutón y más ligero que la estrella más pequeña". •

Se trata, evidentemente, de acabar con la polémica salvaguardando la condición *[55]* planetaria de Plutón, pero descalificando a todos los cuerpos menores que él, descubiertos o por descubrir. • Desde luego, esta resolución salomónica choca con las definiciones clásicas de planetas. • Por ejemplo, la de la Real Academia Española, según la cual un planeta es un cuerpo celeste que gira alrededor de una estrella y que se hace visible por la luz que refleja. • O la de la Real Academia de Ciencias, que propone *[60]* que se trata de cuerpos celestes que describen órbitas alrededor del Sol o de otra estrella, a cuyo sistema pertenecen. • Aceptando cualquiera de estas definiciones, Quaoar sería un planeta de pleno derecho; el problema (semántico, que no científico) es que también cumplen estas definiciones no sólo los otros 100.000 objetos del Cinturón de Kuiper, sino también los miles de asteroides del cinturón, catalogados (2.095 en 1980) o por *[65]* catalogar. •

Vemos, por lo tanto, que la definición restrictiva de la IAU tan sólo resuelve el problema de que no sepamos exactamente cuántos cuerpos giran alrededor del Sol y que merezcan llamarse planetas; pero también que carece por completo de base científica. • Por el contrario, destila heliocentrismo, ya que en ella se convierte a la masa de Plutón *[70]* en una medida universal para clasificar objetos astronómicos no estelares. • Esta decisión podrá quizá resistir la exploración del Cinturón de Kuiper, cuyos objetos necesariamente serán o mayores o menores que Plutón: sólo en el primer caso la familia planetaria admitirá un nuevo miembro. • En lo que casi todos están de acuerdo es en que si Plutón fuese descubierto hoy, nadie pensaría en clasificarlo como un planeta. •

[75] Las predicciones actuales son optimistas, ya que tan sólo se ha revisado de forma sistemática una vigésima parte del Cinturón: casi todos los científicos planetarios apuestan por el hallazgo de varios cuerpos mayores que Plutón. Alguno de ellos fuerza la apuesta, prediciendo que en el curso de esta búsqueda se encontrará algún cuerpo tan grande como la Tierra. •

[80] Un objeto del tamaño de nuestro planeta situado en un lugar del sistema solar que apenas ha sido modificado desde su origen (algunos lo han definido como un yacimiento arqueológico de la historia del sistema) sería realmente un objeto digno de estudio. •

Paralelamente a los logros científicos, la pequeña batalla semántica por lograr la *[85]* categoría planetaria proseguirá, a medida que los astrónomos y sus ordenadores sigan escudriñando placas fotográficas cada vez más lejos del Sol. • Sin embargo, lo que es seguro es que, sean cuales sean las categorías que establezcamos, se verán desbordadas cuando los datos sobre los nuevos sistemas planetarios comiencen a llegar de manera fluida. •

[90] En una actualización reciente se contabilizaban 87 sistemas planetarios (con 101 planetas) en torno a otras estrellas. • Puesto que cualquier incursión en un terreno científicamente desconocido desencadena siempre una cascada de sorpresas, no es arriesgado predecir que los planetas extrasolares nos obligarán a modificar cualquier regla.• Porque la naturaleza siempre será más variada, y sobre todo, enormemente más *[95]* interesante, que esas muletas que empleamos para caminar a través de ella y que llamamos clasificaciones. •

Appendix D

The transcriptions of the think-aloud protocols

Subject #1

#1 Introduction to Materials Selection 1/4

I understand the first point

Para entender el segundo punto, como no entiendo qué significa ‘approach’, no .. no consigo .. saber lo que quiere decir, aun .. aun .. he leído la frase anterior, pero sigo sin entenderlo.
Supongo que quiere decir que hay una alternativa económica para .. para resolver los .. los problemas de .. de corrosión, en la resistencia de los materiales, pero he tenido que leer varias veces la frase, y aún así no estoy segura.

Ahora si que.. he entendido la siguiente frase, y entiendo más el significado de la anterior, y he entendido todas las palabras.

Entiendo el significado de la frase, aunque no entiendo lo que es ‘several .. several compromises’. Supongo que quiere decir que .. que se elige un material como resultado de .. de varias pruebas, o algo así. El problema es que no entiendo, pero entiendo más o menos el significado.

Entiendo el significado porque también está bien .. esquematizado, pone: ‘the task usually requires three stages’ y luego a parte ya me da los tres ‘stages’, que no sé lo que es, pero supongo que serán tres .. tres puntos por lo cual el material, por lo cual eh .. eligen el material, o sea, el procedimiento que siguen. Supongo que ‘stage’ será .. procedimiento o algo así. Entonces, al estar bien planteado, bien esquematizado, pues lo entiendo mejor.

Lo entiendo .. entiendo bien la frase.

Lo entiendo todo, pero tengo que .. separar la frase para .. para entender cada idea .. cada idea que da, o sea, primero construye el equipamiento, luego seleccionar el procedimiento y empezar lo antes posible, antes de que el diseño esté terminado. Entonces, tengo que leerlo poco a poco para

#1 Introduction to Materials Selection 2/4

saber cada idea, primero construirlo, luego seleccionarlo y empezar lo antes posible.

Lo entiendo todo.

También entiendo lo que quiere decir.

No entiendo mucho la frase, pero por las frases anteriores, y por todo el texto más o menos si que entiendo lo que quiere decir.

He entendido el significado. Aunque no entiendo alguna palabra como .. 'seldomly' .. supongo que sí que significa .. no lo sé. Que puede ser en ambos casos o algo así .. pues creo que sí que entiendo la idea, pero me lo tengo que traducir al español para entenderlo mejor.

Entiendo que los procesos químicos están diseñados y fabricados porque requieren algo, pero no entiendo que .. no sé lo que significa, algo de la presión.

Entiendo la idea .. sí, sí, entiendo la idea que expresa.

Lo he entendido bien .. pero .. gracias a traducírmelo al castellano, porque me resulta más fácil.

No he entendido la frase porque no entiendo muchas palabras.

Entiendo la frase, pero .. no el significado, porque .. porque dice que hay materiales que tienen propiedades mecánicas .. creo que dice que son altamente buenas, o algo así, pero luego dice, y luego dice que se usan pero no se pueden ser fabricadas, entonces no entiendo, si lo he entendido bien el significado no entiendo por qué, si se usan, no pueden ser fabricadas.

Si que lo he entendido, pero .. sigo con aclararme con la frase anterior.

Entiendo bien el significado.

Entiendo que hay algo que .. que se puede fabricar mejor que otros materiales, pero .. no entiendo lo que .. porque no entiendo lo que quiere decir .. 'wrought heat resistant alloys'.

Si que he entendido la frase gracias al final, porque dice que .. a ver .. que pueden tolerar, y dice varios compuestos, bueno, carbón, silicona, y que gracias a añadir eso a algunos materiales, eso puede afectar a las

#1 Introduction to Materials Selection 3/4

propiedades mecánicas, a la resistencia a la corrosión, o a ambos, y he entendido más o menos lo que quería decir eso porque .. al porque dice 'mechanical properties, corrosion resitance, or both', supongo que significará eso, no sé.

He entendido que los materiales de antes, pueden hacer que .. la fabricación de .. o sea, los elementos de antes pueden hacer que la fabricación de .. de los materiales puede ser difícil o imposible, pero .. no dice, lo que no entiendo es .. el porqué pueden hacer lo imposible, porque no entiendo las palabras que .. que aquí ponen.

No he entendido el significado de la frase, pero .. sé que tiene que ver con el incremento de.. de .. de lo que ganan las compañías, porque compiten en el mercado global.

He entendido bien todo el significado de .. las innovaciones que necesitan .. que necesitan un buen entendimiento entre las relaciones del proceso .. los materiales y los resultados del producto.

También he entendido esta frase.

Esta frase la he entendido gracias al principio y al final 'the advances being made in rapid' y luego acaba 'are illustrations of the application of fundamental research to materials processing issues' lo he entendido porque dice que los avances han sido rápidos y gracias a la búsqueda de mat .. de procesos de materiales o algo así. Luego lo .. esos .. todo eso por lo que la búsqueda es fundamental o algo así, no lo entiendo, pero más o menos la idea, sí. O sea, ha sido gracias al .. gracias al principio y al final de la frase, creo yo.

Lo he entendido todo bien, esta frase.

También he entendido esta bien, porque tiene mucho .. tiene, se nota que va unida a la anterior, o sea, bueno son todas, pero .. no sé, a la primera vez de leerlo ya lo he entendido, me ha resultado bastante fácil.

No he entendido el significado de la frase, y no entiendo qué tiene que ver con lo anterior.

Tampoco entiendo qué tiene que ver con lo que estaba hablando en un principio, supongo que.. quieren materiales diferentes cuando .. cuando se cree que .. que puede fallar algo, pero no.. no sé, no lo entiendo.

#1 Introduction to Materials Selection 4/4

'Economics enter into every business decision', está claro lo que quiere decir.

También he entendido la siguiente frase, hombre, el .. desde la última coma hasta el final no.. no .. no está muy claro, pero gracias a todas las frases si que lo entiendo bien.

Creo que sé de qué va la idea, pero no logro entenderla. Sé que habla de que.. que cuesta especificar lo que puede durar un material .. y luego dice que es difícil repara componentes que pueden fallar, pero no .. no logro .. unir la idea que creo que hay en el principio con lo de lo que hay después, no entiendo bien lo que me quiere decir, si es que es difícil arreglar algo que pueda fallar .. o que como es .. o como cuesta más económicamente, pues le intenta .. intenta gastarse eso en otras cosas, no? .. no lo logro .. entender.

Creo que he entendido aquí que .. que va a darnos dos .. razones por las cuales se seleccionan unos materiales u otros, bueno, desde el aspecto económico, claro, y que, bueno, el primero que dice es .. es que puede que inicialmente cueste menos, pero que .. pero que luego, en algunas áreas, o sea, que .. funciona mejor gracias a haberse gastado menos antes, pero no lo .. no lo entiendo muy bien, no lo sé, no lo sé.
Y luego el otro aspecto es que .. que .. puede ser un sistema que.. basado en materiales, que si están bien diseñados y fabricados, o sea, luego, a la hora de mantenerlos es más fácil, y luego eso ahorra. Si, supongo que quiere decir, eso, que al estar bien .. fabricados desde un principio, pues.. no sé, no lo .. supongo que será eso, que son más económicos.

Y ahora dice que lo ideal es .. ni una idea ni la otra, o sea, ni que estén .. o sea, que lo ideal es, que inicialmente sean lo más económicos posibles los materiales, y luego que estén bien diseñados y fabricados, y luego te da como .. la mezcla de estos dos sistemas dará más fruto luego, al final.

#1 Rosetta Spacecraft Design 1/3

Entiendo, lo que pasa es que hay una palabra que no entiendo, que es 'rendez-vous', que yo pensaba que era una cita, o algo así, pero no debe de ser, entonces, eso no lo entiendo, pero sí que entiendo la frase.

Si que lo entiendo, cuando pone que .. bueno, el Roseta Lander, entre paréntesis pone 'surface science package' que, bueno, no sé lo que será .. pero sí que lo entiendo.

Porque no entiendo lo que .. que si tiene unos resortes o algo que ..

En Mission requirements entiendo que, bueno en el primer punto habla de que, en la nave, en la lanzadera tienen que haber diferentes cualidades con .. tiene que tener los suficientes instrumentos para que sea lo mejor posible al cometa, y que bueno, los que vayan dentro puedan sobrevivir, por eso dice que deben .. deben calentar el .. la lanzadera para supervivencia. A lo mejor significa la supervivencia de la lanzadera, no de los que van dentro, porque igual no van ahí dentro.

Ahora dice las características de .. de .. las condiciones atmosféricas que va a haber, por ejemplo .. que van a haber cuerpos celestiales por ahí .. asimétrico .. y habrá mucho polvo.

Aunque no entiendo lo que significa.. 'stowed', 'the Roseta Lander has to be stowed to survive' si que entiendo el significado, bueno, no entiendo lo que quiere decir que .. tiene que navegar 10 cm, 1 mm por segundo y .. y eso, no?.

Ahora va a explicar lo que se requiere para .. para diseñarlo bien para .. navegarlo, para conducirlo. Y el primer punto habla de que tienen que haber muchos datos para, porque como está muy lejos de la tierra, tiene que haber muchos datos para ir comparando en cada momento cómo funciona.

Lo siguiente que pone no entiendo nada, porque no entiendo las palabras.

También necesita medir la temperatura hasta que esté cerca de .. de 1 km .. y esto sí que lo entiendo, está fácil.

Se supone que tiene que aterrizar él sólo en el .. asteroide, lo más rápido posible, que supongo que por eso antes ponía lo de 1 mm/segundo, porque tiene que ir a esa velocidad o algo, y también dice que tiene que estar lo más alejado posible de, del control principal?

#1 Rosetta Spacecraft Design 2/3

Bueno, ahora habla de la velocidad, pero es que no entiendo las últimas palabras, porque 'manouvering in the vicinity of the comet', entonces no sé, supongo que será que.. que eso es mejor que la velocidad sea de mm por segundo.

Ahora habla de las características físicas, que tiene que pesar como mucho 2900 kg, la lanzadera y el .. y la gasolina, y que está dirigido por el Ariane 5. Lo que no sé, es por qué al principio pone máximum 'wet' entre comillas, no sé lo que significa.

Se supone que el tiempo de vida que le dan a la lanzadera es de 11 años, y pone en la trayectoria heliocéntrica, que supongo que tendrá que ver algo pues, con el helio que hay en el espacio o algo, pero no lo sé cierto.

En este punto no entiendo mucho las palabras que utiliza, pero, pero sí que entiendo que tiene un período de hibernación que hace que, bueno, que tiene un sistema no operacional, bueno eléctrico, no operacional, y que todo esto ayudará a que el tiempo de vida que tenga aumente, aunque se ve que requiere .. una garantía o algo así.

No entiendo mucho lo que quiere decir el principio de la frase, pero, hombre, lo que es la base de la frase entiendo que necesita .. hay unas funciones que son esenciales para que la .. para que puedan funcionar en caso de que haya un momento crítico y necesite .. no sé, hacer cosas que normalmente no haría porque, no sé, porque es un momento crítico.

Mechanical Design Overview

En el primer punto habla de .. de que tiene una estructura central, y sus características 2.8mx2.1x2 m, y dice que ahí es donde está, o sea, se .. dónde funciona todo, donde los equipos están montado y donde funciona todo, la base de datos .. y todo eso, y se entiende bastante bien.

Ahora dice que hay 2 paneles y que son de 32 m cada uno de lado a lado, y bueno, hay dos dibujos donde se ve desde dos planos diferentes, sería, que sería el perfil y el alzado y .. ya está. Bueno a parte, en la hoja .. en esta hoja se ve más claro los paneles, la estructura central ..

Y ahora dice que, o sea, arriba del todo está como la base del funcionamiento, creo, de los subsistemas, pero no lo tengo muy claro.

Y ahora dice que puede separarse la lanzadera en dos módulos, en el 'payload support module' y en el 'bus support module', bueno eso no sé lo que significa, pero me hago una idea de lo que se puede suponer.

#1 Rosetta Spacecraft Design 3/3

No sé mucho lo que quiere decir porque no entiendo .. entiendo pocas palabras, 'the lander is attached to the face opposite the two-axes' que no sé tampoco lo que es, ' steerable high-gain antenna', supongo que será, querrá decir que, que está unido por algún sitio a la antena, y que hay dos, dos .. alas solares que están en las caras laterales.

Ahora dice que los paneles están 'towards' creo que es de cara, de cara al cometa, o no, no que están de culo al cometa y .. y que las antenas están , o sea, de espaldas también al sol y a la tierra, y siempre hablando de distancias, o sea, hablando en la dirección, en la misma dirección que la tierra.

Tampoco entiendo mucho lo que quiere decir por lo de .. 'offering a good location' supongo que será que .. que lo de, algo en la lanzadera que hace que los radares y todo eso localicen enseguida dónde están, y que de datos y cosas de esas.

Y dice que normalmente esto, al irse más lejos del cometa, esto hará que se minimicen los efectos del polvo, pero no sé qué relación tiene con la frase de antes, porque no sé qué tiene que ver el polvo, bueno, el polvo del cometa, que deja, el rastro que deja, no sé qué tiene que ver con que se pueda localizar el, la lanzadera, igual es que lo de antes no lo he entendido bien, y no era así, o no lo sé.

Ahora dice que la lanzadera está construida, o sea, lo que es la estructura central tiene dentro una especie de tubo, que corresponde .. ah, que es de la Arianne 5 , y nada, y dice que la lanzadera está construida alrededor de este tubo que se ve que es la base de .. bueno lo más importante para que funcione.

Dicen que este tubo tiene dos tanques que son del mismo tamaño, y que por arriba se pone el fuel, la.. la gasolina, bueno, el combustible, y que .. y que se puede oxidar, o no lo sé eso lo que quiere decir. ' and the lower one containing the oxidiser', ah, que el que está más bajo contiene lo que hace que .. el óxido o algo, el óxido, no lo entiendo muy bien. Y bueno, al final dice que hay .. 1578 de propellant, no sé lo que es, bueno, no sé mucho lo que quiere decir esta última frase.

#1 Nuevos Ojos en el Espacio para la Primera Luz 1/5

Lo entiendo todo al leerlo la primera vez.

En la primera lectura no le doy importancia al nombre de .. del director de la NASA, pero luego ya sabes que es el director de la nasa, y que llego a la luna, bueno, que llevó al hombre a la luna, entonces ya le doy más importancia al nombre.

Le doy más importancia a lo que dice que .. a las características del nuevo telescopio que a las del Hubble, cuando lo compara con el nuevo telescopio. Por ejemplo dice que será la mitad de grande que el Hubble, y entre comas pone que pesa más de 10 toneladas, pero eso no le doy importancia, porque no es una característica del nuevo telescopio, que es lo que nos importa.

Entiendo bien la frase, pero al ser frases largas, al ser una frase larga, y tan solo con una coma, pues tengo que releerla varias veces para .. para entenderlo bien lo que me dice.

He tenido que releer a partir de la coma porque me parecía raro que .. que el .. que el nuevo telescopio, mire al pasado del tiempo del espacio para captar algo de la primera luz producida en el universo, que es algo que no creía que fuera posible tan pronto, entonces lo he tenido que releer para asegurarme de que era el significado que yo había entendido.

Necesito releer detenidamente esta frase, porque es muy largo, y hay muchos datos en sólo 4 líneas y hace alusiones al Big Bang, lo explica brevemente lo que es, y para entenderlo todo, lo tengo que releer, porque te da eso, te da varias informaciones.

Al releer la frase esta, evito las expresiones innecesarias, como 'según se cree' para.. leer la frase de una forma más corta, y acabar antes, y entenderla rápidamente.

He tenido que releer varias veces lo que hay entre comas, que es 'un telescopio tradicional que básicamente ve el segmento de luz visible del espectro electromagnético' porque no entendía que unión tenía eso con lo que viene a continuación, que es lo que el ojo humano percibe. Y ahora si que lo entiendo que es que .. este telescopio, que ve .. o sea, que alcanza la luz visible del espectro electromagnético, esa también la percibe el ojo. Bueno y está otra vez comparando el nuevo telescopio con el Hubble.

Una vez leo esta frase el.. la aclaración que nos da de lo que es el infrarrojo la doy por desapercibida y leo directamente lo que quiere decir

#1 Nuevos Ojos en el Espacio para la Primera Luz 2/5

la frase, y luego ya pues, reparo un poco en qué es el infrarrojo, pero eso no .. es imprescindible para el texto, pienso yo.

Se entiende perfectamente esta frase, lo que pasa es que no .. no le doy gran importancia al nombre de .. del astrónomo, porque para mi es más importante lo que creen en general los astrónomos, los científicos.

Se entiende perfectamente el deseo que tenía Alan Dressler .

Se entiende perfectamente también la idea que sigue dando el científico este, el astrónomo.

En esta frase le doy más importancia a lo que es la base de la frase, que es lo que está entre las comas, que es la idea que tienen los astrónomos, lo que quieren que haga el nuevo telescopio que sea igual de bueno que el Hubble, hacer fotografías en luz visible. Y luego ya añade que es para que el público les apoye, que eso yo lo veo secundario.

Me llama la atención que diga que, que se sorprenda de que la gente se vuelva a interesar, o sea, que se interese por el espacio gracias a las imágenes del Hubble. Y también me llama la atención que lo supiera. A parte, ahora le doy más importancia a Alan Dressler, porque estoy viendo que es, es un protagonista en este texto porque ya, porque está .. porque hay varias que son cosas que dice él.

Es un poco liosa esta frase porque explica mucho lo que está diciendo, porque dice, Marcia Rieke, y enseguida nos aclara que es de la universidad de Arizona, y aclara también que es la principal investigadora del instrumento primario del observatorio, y ahora aclara lo que es el instrumento primario del observatorio, que es una cámara para el infrarrojo cercano. Y luego ya dice que .. eludiendo .. o sea, evitando todo lo de antes, dice que Marcia Reike afirma que las fotos tomadas en luz visible deberían ser mejores que las del Hubble, y tienes que ir, cada vez que lees una cosa que está entre comitas, saber que se refiere a lo de antes, que Marcia Reike .. o sea, de la universidad de Arizona, que es Marcia Reike, así todo el rato, y lo he tenido que leer dos veces porque lía, pero se entiende.

Y ahora esta última frase la dice Marcia Reike, que dice que vale, que funcionará bien el infrarrojo, pero que tiene que .. que en luz visible también tiene que hacerlo bien, porque si se supone que es un .. es un.. un telescopio más nuevo que el Hubble, se supone que tiene que hacerlo todo igual, o sea, las cosas igual y mejor, o sea, no puede ir atrás.

#1 Nuevos Ojos en el Espacio para la Primera Luz 3/5

Queda claro que la empresa TRW se tiene que encargar del funcionamiento del nuevo observatorio, lo que pasa es que no .. que me digan que .. entre los socios de esa empresa están Ball Aerospace, y Estman Kodak, a mi .. o sea, no es un dato que sea muy importante, pero al ser Eastman Kodak, pues .. por el apellido digo yo que sí que es importante, lo que me lleva a deducir que son personas muy importantes.

Queda muy claro lo que puede llegar a costar el observatorio y.. aclara que puede .. que tiene que durar de 5 a 10 años y .. nada, está claro.

Es una frase simple que deja claro que .. que el telescopio no está diseñado para .. para cuando lo lancen repararlo o algo, está claro.

Aquí dice que .. al no estar diseñado el nuevo telescopio para repararlo alguna vez cuando se lanza, he tenido que releer la frase anterior para encontrarle el sentido, o sea, al estar diseñado de esta manera, quiere decir que los ingenieros están muy seguros de que.. de que sus sistemas, pues van a .. pues son fiables, y esto lo dice un científico, John C. Mather.

Está claro lo que quiere decir, pero .. y está muy bien que especifique que L2 es el punto Lagrange 2, que no sabía lo que era, y sigo sin saberlo.

Ahora nos explica un poquito el punto de Lagrange 2 lo que es, y bueno, lo puedo entender mejor porque justamente se ha de situar ahí el nuevo telescopio, y ahora en este punto, sigue aclarándolo. Nos dice dónde está precisamente el punto Lagrange2, o sea, donde va a situarse precisamente el telescopio.

Tras leer esta frase evito eh .. centrarme en cuales son los instrumentos principales y .. me centro en que .. en que dispondrá de un filtro para .. para que no interfiera en .. en su funcionamiento la luz y el calor que producen el Sol y la Tierra, y una vez ya tengo esto bien asimilado, me centro en que los instrumentos principales son cámaras de longitud de onda múltiple, y dispositivos espectroscópicos que descomponen la luz para analizarla, aunque no sé muy bien que es eso, pero .. más o menos por el contexto se entiende.

Los filtros de los que nos habla antes, dice que permiten enfriar la temperatura mucho, y que hace posible que el infrarrojo haga unas lecturas más.. en mejores condiciones, y .. se entiende perfectamente lo que .. esto mismo, lo que quiere decir.

Al principio nos habla de que habrá un espejo primario que captará la luz, de 6m de diámetro, y ahora nos explica un poco como es .. cómo

#1 Nuevos Ojos en el Espacio para la Primera Luz 4/5

funcionará este espejo, y dice que estará .. cabrá en un extremo del cohete, y serán segmentos hexagonales y al llegar al espacio pues se abrirán teniendo una forma circular, y bueno, ya está, es fácil de entender.

También se entiende bien que .. que se controlan desde la Tierra estos espejos, y que se puede variar su, su forma, para que la luz se refleje de la mejor manera posible.

Se entiende perfectamente que la NASA ha estado apoyando las investigaciones sobre espejos ligeros para que así les costara menos el .. el nuevo telescopio, y es normal que haya apoyado este tipo de proyectos, para recortar costes.

Se entiende perfectamente, sólo que a la primera lectura así por encima se.. se confunde un poco porque dice: ‘ Mather dice que los retrasos en el desarrollo’, y es un poco lioso, los retrasos en el desarrollo, pero nada, la segunda vez que lo lees se entiende perfectamente.

También se entiende bien lo que dice Mather de que ya se lo imaginaban, que sería un problema lo de los espejos, y veo más sencillo cuando estaba hablando uno, porque es como si te hablara así, a ti mismo, sabes? Y .. no sé, lo veo un poco más sencillo que si.. pone: ‘el espejo es el mayor problema, lo vimos desde el principio, así que no es ninguna sorpresa’, que si lo pusiera como está poniendo todo el texto, explicándolo supongo que sería un poco más complicado, pero nada que no se pueda entender.

Se entiende fácilmente que .. que hay una .. que es una decisión importante elegir el .. el espejo que se va a utilizar, tanto por el precio como por la calidad del espejo, porque se supone que es un proyecto importante, y si se supone que .. que está hecho para que

luego no se repare ni nada, pues .. si se ha hecho para que no se repare ni nada, pues se supone que tienen que elegir los mejores materiales para que no haya problemas y falle el telescopio.

Y ya por último te dice que hay 2 tipos de espejo que .. que se pueden, que van a poderse utilizar, que son, o un espejo metálico hecho de berilio, o uno fabricado con una clase de cristal, eso simplemente para que lo sepamos, pero .. no .. yo lo que no sé por qué uno será mejor que el otro, pero bueno, es fácil de entenderlo.

#1 Nuevos Ojos en el Espacio para la Primera Luz 5/5

Me ha resultado un texto bastante fácil de entender, y que .. y con muchas explicaciones, o sea, te dice una cosa y luego te explica un poco más detalladamente sus características, o .. lo que sea.

#1 El hallazgo de un gran objeto más allá de Plutón ... 1/4

Se entiende bien, aunque no sabía que había un observatorio llamado Monte Palomar, y todavía no sé qué es el objeto Quaoar, pero se entiende bien.

También se entiende bien, y bueno, no sabía que fue Clyde Tombaugh quien localizó Plutón, pero ya supongo que el Quaoar ese es un planeta o algo así.

Se entiende fácilmente y realmente como aquí dice 1200 millones de kilómetros es una distancia difícil de imaginar, porque si está a eso de Plutón y la tierra, a saber

Aquí da datos de Quaoar, que ya se sabe que es una esfera rocosa cubierta de hielo, y también se sabe, que bueno, que por donde está hay muchos más objetos, y que se han descubierto hasta ahora 600 de 100000 que dice que hay, y que este es uno destacable porque es grande, se ve que es más grande que los demás.

Aquí explica que el astrónomo Gerald Kupier pues ya había descubierto que había una especie de objetos o algo más allá de Plutón en el Siglo XX, y hasta 1992 no se descubrió que esto era cierto, y bueno, se entiende fácilmente, aunque esto no lo sabía.

Sigue dando datos del Quaoar, da su diámetro 1250 km y dice que es como un tercio de la luna, lo compara un poco.

Y bueno, y luego dice que .. que .. es uno de los mayores cuerpos descubierto después de Plutón, y antes ha dicho que .. que había salido en titulares de prensa, por lo que esto, lo del Quaoar ya es un hecho ya famoso y conocido.

Aquí se quiere dejar constancia de que es un gran descubrimiento porque es la primera vez que se descubre un cuerpo que está tan lejos y que se pueden averiguar sus dimensiones, o sea, que se pueden averiguar sus dimensiones porque está muy lejos, y se ve que es un gran descubrimiento eso, un gran avance.

Y además aclara cómo han descubierto sus dimensiones, que depende, no, que se basa en el calor solar que refleja.

Y esto es como una nota pues que dice que es muy difícil averiguar la temperatura de un cuerpo que está a 6000 millones.

#1 El hallazgo de un gran objeto más allá de Plutón ... 2/4

En este párrafo se supone que nos va a explicar por qué están los astrónomos tan interesados en el cinturón de Kupier, porque hace una pregunta aludiendo eso.

Ahora explica que cuando se descubrió Neptuno hubo un científico que .. que decía que.. que las anomalías orbitales de Urano, bueno pues eso, que dice que no era suficiente, o sea no era suficiente información, que .. o sea, el descubrimiento de Neptuno como para explicar las órbitas de Urano, y había un científico que se llamaba Percival Lowell que fue quien dijo esto.

Ahora nos dice que .. se creía que había otro planeta que le llamaron X, y bueno, esto era lo que creía Lowell, vale, pero que después de morir él, se descubrió que no había un planeta exterior a Neptuno.

Ahora nos dijo que Tombaugh descubrió Plutón, desde un observatorio, y que no sabía si era un planeta muy ligero para ser rocoso, y muy pesado para ser de gas.

Y bueno, y se creyó pues que Plutón era un satélite de Neptuno, pero como la órbita de Plutón se cruzaba con la de Neptuno, se ve que desecharon esa idea.

Y ahora, al descubrir lo del cinturón de Kupier, pues se creen que podría ser Plutón un satélite de.. del cinturón de Kupier .. y .. o .. o un, o sea, y que se hubiera puesto más cerca del sol donde los planetas, y por eso lo confundieron con un planeta, pero no se sabe.

Y ahora viene una pregunta, y nos dicen, ¿pero no es Plutón mismo un planeta? Y supongo que ahora contestará.

Bueno dice que en los años se se .. hizo hizo esta pregunta la unión astronómica internacional.

Bueno, entonces dice que la unión astronómica internacional para ver si era un planeta, pues que .. revisaron su definición, y dice que un planeta es un objeto en órbita alrededor de una estrella que tiene que ser más pesado que plutón, pero menos que la estrella, no espera, pero más ligero que la estrella más pequeña.

Entonces aquí lo que quieren decir es que .. dejar claro que Plutón es un planeta, y decir que los cuerpos menores que él, pues no lo son.

#1 El hallazgo de un gran objeto más allá de Plutón ... 3/4

Y dice que esta definición, pues está un poco en contra de la definición de planeta de siempre, que bueno, supongo que cuanto más avance la tecnología y todo, pues .. más precisas son las definiciones, más cosas se descubren, más preguntas hay y .. por eso digo yo que cambiarán las definiciones, por ejemplo esta de planeta, si no, no habría tanto dilema con lo de Plutón.

Y ahora dice por ejemplo esto que la Real Academia Española dice que un Planeta es un cuerpo celeste que gira alrededor de una estrella y que se hace visible por la luz que refleja, y esto no es la misma definición que la que ha dado antes, del dictamen emitido por la unión astronómica internacional, entonces es diferente.

Y luego dice que la real academia de ciencias da otra definición de planeta, entonces, pues, si hay 3 definiciones, ¿cuál es la cierta?

Bueno, y ahora dice que cualquiera de estas definiciones que son distintas pues harían que todos los objetos del cinturón de Kupier fueran planetas, igual que Quaoar, o sea, dice que Quaoar sería un planeta pero que hay un problema, que todos los objetos descubiertos en el cinturón de Kupier también lo serían. Y luego dice que hay miles de asteroides, unos descubiertos y otros todavía no que también cumplen esa definición.

Entonces, o se precisa más, o hay a saber cuántos planetas. Todavía, o sea, descubiertos pero no hechos públicos supongo, no sé.

Ahora critica, creo yo un poco, la definición que da la unión astronómica internacional, porque dice que esa definición no tiene base científica, y que no resuelve, o sea, resuelve el problema de que no sepamos cuántos cuerpos giran alrededor del sol, y que sean planetas.

Bueno y a parte que dice que esa definición de la unión astronómica internacional hace que Plutón sea una medida universal para clasificar objetos astronómicos no estelares.

Hombre, aquí dice que en el cinturón de Kupier pues, los objetos que haya, serán mayores o menores que Plutón, porque iguales no van a ser.

Ahora anota que si Plutón no hubiera sido descubierto hoy en día no se creería que es un planeta, se creería que es otro objeto, y supongo que dudarían.

Bueno, y ahora dice en el siguiente párrafo que tan solo se ha estudiado una vigésima parte del cinturón de Kupier, y nada, y que dicen los

#1 El hallazgo de un gran objeto más allá de Plutón ... 4/4

científicos que seguro que hay cuerpos mayores que Plutón y que son como la Tierra de granes, y esto .. hombre, puede ser, porque si han estudiado sólo una vigésima parte aún queda mucho por descubrir, si es que lo descubren.

Y ahora dice que, que si hubiera un planeta más grande que la Tierra que no se hubiera movido, no se hubiera modificado desde su origen, sería un objeto digno de estudio. Yo no sé si aquí lo dice esto de verdad o se está burlando un poco de los científicos, porque no lo han encontrado.

Bueno, y ahora dice que seguirán los estudios porque hoy en día los ordenadores son más buenos y todo y que seguirán los estudios para lograr definir exactamente qué es un planeta.

Y aquí dice que en el momento en que se sepan .. o sea, muchos de estos datos de otros.. de otros planetas o de otros asteroides o lo que sea, pues habrá problemas todavía en definir qué es un planeta, y qué no es.

Y dice que por ahora, pues hay 101 planetas en 87 sistemas planetarios, y eso es lo que he encontrado hasta ahora, y ahora dice que .. que se modificaran las reglas de decir 'esto es un planeta y esto no' porque , porque estamos en un terreno desconocido, y es normal que cuando se descubran nuevos planetas extrasolares, habrá que modificar definiciones y más cosas.

Y ahora nos dice, para acabar, que la naturaleza es muy variada, y que no .. es muy simple el concepto de clasificación que hemos hecho, bueno, que se hizo en su día, y que eso, que la naturaleza nos va a sorprender siempre, y siempre será más complicada que las simples clasificaciones que podamos hacer, siempre se descubrirán cosas nuevas.

Subject #2 Introduction to Materials Selection 1/9

A ver .. eh .. 'standpoint' yo creo que significa, pues como estamos hablando de cosas técnicas, desde el punto de vista técnico, debe de ser punto de vista. Eh .. la solución a los problemas de corrosión sería usar materiales más resistentes mmm

La segunda es fácil, 'this approach' esta elección, porque como estamos hablando de soluciones, no, pues yo no sé lo que significa mucho, pero como están hablando de soluciones, esta selección, el elegir esto es una manera alternativa .. es económicamente mejor que otros controles de corrosión, métodos de control.

La tercera es fácil también porque dice, la resistencia a la corrosión 'is not the only' lo hace para recalcar, la única propiedad que hay que tener en cuenta cuando se hace una selección de materiales, 'but it is of major', major como es grande, o sea una importante , que tiene una mayor importancia en el proceso químico 'chemical' químico .. en las industrias.

Entonces ahora aquí en lo de las notas, ya hay que considerar que se tiene que considerar .. económicamente, igual económicamente se puede solucionar el problema, y también que .. y también la importancia de .. no sé.

'This choice of a material is the result of several compromises'. Aquí 'compromises' .. pues yo pienso que compromisos se refiere a cuando tienen que elegir un material para una función, no?, pues tienen que comprobar varias cosas, y ahora el texto irá viendo cuales son las diferentes casos en los que .. en los que se probará .. no sé, pensará en un material para cada caso y luego se verá cual es el mejor , no?

Por ejemplo .. a ver .. ' the technical appraisal', 'appraisal no sé lo que es, alloy sé que es una aleación 'the technical appraisal', no sé, creo que puede ser la función técnica que puede tener una 'alloy' puede ser un compromiso, o sea, puede ser una faceta a elegir entre la resistencia a la corrosión, y otras como la fuerza y la maleabilidad. Las características técnicas, yo creo que es 'appraisal technical', si .. yo creo que es eso.

'And the final selection will be a compromise between technical competence and economic factors'. Si .. debe ser .. compromise debe ser comprobación, por lo que como hemos dicho antes y sale aquí ya tres veces, es una .. como una .. una .. se mira, es como sopesar qué interesa primero .. primero lo revisa con las características de cada material y después ya son las características .. las 'technical competences' y va a servir para .. para si lo podemos llevar a cabo este material con nuestros procesos técnicos que tenemos, porque igual, vale, conviene utilizar ese

#2 Introduction to Materials Selection 2/9

pero .. pero no se puede, no podemos malearlo o lo que sea. Y luego como siempre los factores económicos .. luego es que a la hora de usar un material específico se divide en tres partes:

'listing the requirements', 'requirements' es .. lo que nos hace falta, tomarán datos de .. lo que requerimos, lo que queremos obtener.

'selecting and evaluating the candidate material', pues eso es facil, la única así un poco candidato, pero .. candidato podría ser a la presidencia, pero como lo que se barajan son .. posibles materiales, pues es, los que están a elegir.

Y finalmente, 'choosing the most economic material' es fácil también, el más económico.

'either' es que tanto puede ser para una cosa como para la otra, pueden ser considerados para la construcción de cosas de sistemas de .. sistemas aquí se refiere .. un nuevo .. lo que sea, entramado, y .. o una modificación o .. para reparar 'an existing facility', yo lo que hago aquí para saber lo que es facility, aunque si lo traducimos al castellano es facilidad, pero facilidad no tiene mucho que ver, pero si facilidad lo relacionas con que normalmente los aparatos técnicos es para mejorar .. para hacer más fácil la vida, entonces te viene a la cabeza facilidad, pues , cualquier dispositivo, para modificar, estamos hablando de modificar algo que está hecho.

Después, 'For the construction' para la construcción de un nuevo equipo .. el proceso de selección, porque procedure me suena a process entonces, el procedimiento de selección empezará lo antes posible, y antes de que el diseño esté finalizado, y claro, es lógico, porque no vas a ponerte a hacer una cosa si no sabes lo resistente que va a ser .. van a influir muchas cosas.

'Optimum' debe ser una palabra latina, porque es muy parecida, el diseño óptimo para la resistencia de todo a la corrosión 'vary', pues .. vary me suena a variar, puede variar con el material usado.

'In a repair application' Cuando se está reparando una aplicación, es una parte de un .. de un .. de algo técnico de .. de un dispositivo, de un aparato, de una maquinaria, redesign, re- el afijo .. el prefijo re- es volver a hacer algo, y design es diseñar, pues para volver a diseñar, y los factores principales de decisión, esto es igual, se centran 'on delivery time' aquí hay dos palabras, 'delivery' and 'ease' como están hablando de tiempo yo ahora, para saber lo que significa esto lo que hago es, sé que estamos

#2 Introduction to Materials Selection 3/9

hablando de elección de materiales, sé que estamos hablando del campo técnico donde las cosas, el tiempo y el dinero son prácticamente lo más importante, salvar un obstáculo de la forma mejor, entonces, si no puedes elegir el material, sólo te queda el tiempo, y debe ser .. 'delivery' yo creo que podría ser ahorrar, o sea, que se centra en la menor pérdida de tiempo, and 'ease' yo lo que hago es .. 'ease' me recuerda a 'easy', puede ser otra terminación, entonces, lo que cueste menos, yo diría, lo que cueste menos tiempo, y sea más fácil su fabricación en ese campo, en ese terreno, donde esté situada la maquinaria, porque claro, no es lo mismo que esté en un techo, que esté abajo, entonces depende los materiales que tengas que utilizar.

It is also advisable .. *advisable* debe ser .. *advise* es yo me sé la palabra *advise* que es avisar, como anuncio, entonces, con la terminación -*able*, pues, que también es importante estimar, calcular, lo que le falta de .. *remaining* es lo que le queda de tiempo, no sé .. del .. claro porque, yo por ejemplo, sin leerlo ya sé más o menos por donde va, porque sé que me va a hablar, sin leerlo eh, de que .. no te va a salir, o sea, igual, la reparación te sale más cara que lo que vas .. que comprar uno nuevo, entonces supongo que será eso, que también es importante calcular lo que le queda de vida al equipo para que .. no pues no era eso .. he quedado mal .. para que la reparación .. *over-designed* .. aquí no sé .. pues que igual luego interesa que hay que tener en cuenta la reparación que se hace y lo que le queda de vida, teniendo en cuenta lo que le falta de .. *allowance* es .. permitividad, creo que es permitir, entonces .. que igual lo que le queda de .. para permitir al corrosión es muy pequeño, entonces igual haría falta hacer un .. comprar uno nuevo y no sale rentable arreglarlo si luego sólo va a resistir dos años más, entiendes?, pues eso, *corrosion allowance* pues *allow* es .. permitir, entonces en este caso permite la corrosión, que consigue paliar los efectos o sea, la corrosión en este material.

Ahora entonces me voy a hacer el ejercicio, que dice ..

(i) technical considerations.
Para la corrosión, la solución sería coger materiales más resistentes.
Hay que tener en cuenta las .. 'technical appraisals', 'resistance' .. 'availability' ..
Y hay que tener en cuenta lo de .. vale.
Pues eso, yo lo que hago es un esquema, voy paso por paso, texto por texto

#2 Introduction to Materials Selection 4/9

El criterio, criteria es la palabra latina, nosotros usamos criterio. El criterio de selección usado .. esta frase creo que está bastante clara, donde podría haber problemas es .. ‘qualities’ es cualidad, y ‘either’ es entre dos cosas, se pone entre dos cosas, ‘desirable’ son cosas deseables, ‘desire’ es deseo .. porque lo sé de canciones y cosas de esas, o sea, entre las cosas que se desean y las que son realmente necesarias.

‘Unfortunately’ .. ‘seldomly’, vamos a ver lo que es ‘seldomly’. Yo entiendo el contexto, vale?, lamentable mente las .. las propiedades mejores .. ‘seldom’ .. es que esa palabra la sabía .. ‘seldomly’ supongo que tendrá que ver con .. ‘be all found in a single material’ que difícilmente, ‘seldomly’ es difícilmente, si, porque dice can .. , no pone cannot, sino can, así que tiene que ser algo positivo, no?, eligiendo la estructura sintáctica .. entonces tiene que ser algo positivo .. can seldomly .. difícilmente encontrados todos en un material, supongo que será eso. Y especialmente cuando las condiciones en la operación, para operar, las condiciones para operar ‘operating’ become aggressive.

‘Most chemical process’ Vale, no hay problema hasta que llegamos a ‘pressure vessel’, ‘pressure’ es .. tiene que ser presión, y ‘vessel’, no tengo ni idea. ‘Piping’ sé que son tuberías .. ‘codes’ .. entonces yo lo que hago es leer otra vez la frase. Procesos químicos .. bueno, yo aquí no entiendo lo que son exactamente, lo que pasa es que yo en este texto continuaría, porque yo ya tengo claro que estamos hablando de que los procesos químicos muchas veces se ven influenciados con su diseño por unos requerimientos, por unas cosas que se van a dar en algunos casos, como pueden ser específicos presiones y .. y formas para tener que poner las tuberías, y entonces dependiendo de cómo esté la zona y supongo que será las condiciones del lugar, vale?.
‘These codes’, ‘codes’ debe ser lo que estás .. lo que te . .el ámbito donde te puedes mover, te reduce el espacio, una forma de reducir el espacio de elección porque como está hablando después de que incluye .. serían como reglas, yo creo, porque incluye sólo materiales aprobados y establecidos para la base de la creación, entonces es .. ‘codes’ para mi será como reglas o manual, códigos .. yo creo que será como códigos. ‘Basis’ es base .. y ‘stresses’ no tengo ni idea. ‘Stress’ creo que en este caso no tiene nada que ver con stress de estar estresado, no sé, igual está hablando en este caso de que se provoca estrés, pero no creo. Continuaremos.

Aquí leemos si .. parece que es fácil .. las propiedades mecánicas de un material son el primer criterio lo que los ingenieros de materiales aplican. ‘apply’ es aplicar, pedir algo, en este caso utilizan, en el proceso de selección. Y esto ya no me acuerdo yo por qué frase estamos más o menos, la 35, para luego hacer el ejercicio.

#2 Introduction to Materials Selection 5/9

'This is especially' es especialmente importante para .. 'applications' ya habíamos dicho antes para dispositivos, para maquinarias .. en general, que trabajan a temperaturas 'in the creep range', 'creep range' .. debe ser simplemente por el contexto y por .. imaginación, como está hablando de temperatura extremas .. no?, sería como un extremas .. para .. que están en temperaturas extremas, yo diría extremas, 'creep range', como sería en el borde, en el abismo o algo así, donde una diferencia pequeña, como lees después una pequeña diferencia, pues estás muy .. sabes? .. 'in operation temperature' .. en la temperatura de operación puede afectar significablemente 'the load carrying ability of the material' .. 'load', pues 'load', a mí me vienen a la cabeza los juegos, 'save', and 'load', cargar, la forma de cargar?, no sé. La resistencia, no sé, yo creo que 'load' en este caso puede ser como estaban, o sea, load es como salvar, como cargar, como volver a lo que estaba antes, entonces puede ser que el material no puede volver a como era antes, no sé. Esta claro, que .. lo que tiene que quedar claro es que a unas temperaturas extremas, el proceso de temperatura puede afectar a las cualidades del material, y puede no volver a tenerlas, puede pasarse, puede ser esto.

Materials Fabrication

'There are', 'outstanding' .. hay materiales que no pueden ser utilizados aunque les gustaría porque pueden ser difícilmente fabricados, 'seldom' parece que sí que es correcto lo que habíamos dicho antes de difícilmente .. 'outstanding' puede ser estar fuera de uso, no sé.

'There are several materials' aquí habla de otros materiales que sí que son, que tienen propiedades excelentes y pueden ser fabricados y producidos, pero lo que les pasa es que, 'because of aging', 'aging', claro debe ser por su edad, porque 'age' se le pone la partícula y cambia la palabra, pero con su, cuando se van haciendo más .. con el paso de los años, no pueden ser modificados o reparados, después de estar en unas condiciones, entonces, puede ser que no sean .. buena solución.

'Materials' .. 'maintainability' es la forma de mantenerlo en base .. en base a la .. y la fabricación original, la facilidad de fabricación o algo así.

'The wrought heat', 'wrought' no sé , puede que .. __ porque 'wrought heat' son un tipo de .. 'heat es calor', un tipo de aleación que son 'wrought heat' o sea que son hechas en .. igual en mucho calor .. tienen mejor fabricación que los 'cast materials' que son , 'cast', en este caso podemos pensar en un primer momento, tiene que ver con casto, y entonces igual .. si yo pienso que los cast materials deben ser los materiales sin mezclar con otros, los materiales puros, como si dijéramos.

#2 Introduction to Materials Selection 6/9

'Cast alloy steels' 'tolerate', que pueden tolerar 'significablemente' grandes concentraciones de carbón, 'tungsten', esto son tipos de cosas que no hace falta saber, que son añadidos .. para mejorar el material, o para mejorar sus propiedades mecánicas y su resistencia a la corrosión, son .. son cosas químicas que los mejoran. Pero estos elementos pueden también .. pueden afectar 'adversely', es importantemente, contrariamente a lo que esperaban .. 'weldability' ya me queda prácticamente claro que es maleabilidad, porque, no tengo ninguna idea, pero por el contexto .. puede ser particularmente difícil, casi imposible, la mantenibilidad y la

A ver, esta frase es muy chunga, a ver .. 'The ever in', a ver, las formas de elección están creciendo en cuanto a .. 'performance' la forma de hacerlo y el coste .. __ por compañías en la competitividad del mercado global, todo este tipo de cosas requiere 'spectrum' espectro, una serie de cosas, 'issues' temas. Bueno esta frase es difícil, no sé, es una frase extraña, no?, entonces tu la lees primero y te quedas un poco como parado, pero luego, eh, lo que haces es, la lees y dices, que hay .. los nuevos tipos, la .. la competitividad que hay y todo esto hace que sean .. hay una serie de .. un espectro de cosas que .. 'be addressed' debe ser tener en cuenta .. apuntar, apuntar a la dirección.

Innovaciones y 'improvements' mejoras, en el proceso de los materiales, resultados de los .. del avance y el .. esta es fácil, no tiene ninguna

'Novel processing', 'novel' no sé, en este caso 'novel' es nuevos, no?, productos novel, en nuevos procesos y con metodologías .. 'open up' abrir, sacar, presentar nuevas oportunidades para que el nuevo producto se .. 'develop' es desarrollar, se desarrolle, 'leading to', 'leading' un 'lead' es lo del periódico, entonces 'leading' es encabezando, teniendo muy en cuenta, encabezando las nuevas generaciones, las maquinarias de nueva generación y/o las mejoras .. la forma de hacerlo, 'performance' y el coste.

'Prototyping' son prototipos, me suena, 'thin' .. 'thin film' pues no sé, aquí thin me suena a delgado, pero .. no sé, 'thin film and nanotechnologies', 'nano' pues están hablando de cosas pequeñas, porque thin film, son pequeñas .. pero no sé qué relación tiene que ver aquí, 'nanotechnologies' son tecnologías a escala muy pequeña, 'and net', 'net' a mi me suena a red, tanto por internet como por el tennis, sé que es una red, ahora leemos el conjunto .. los avances que se han podido hacer gracias a los rápidos formas de hacer prototipos, y la capacidad de trabajar

#2 Introduction to Materials Selection 7/9

a escalas muy pequeñas y la gran .. y .. y la globalización que se ha hecho en las formas son .. 'are illustrations', aquí en este caso 'illustrations' ilustran eso, dan a ver, son ejemplos, como si dijésemos, todo esto es como para remarcar la aplicación fundamental del proceso de la elección de materiales.

Availability of Materials

Ingenieros en materiales .. 'purchasing', 'purchasing' no sé lo que es .. 'purchase', son otro tipo de performance, 'purchase' puede que sea.. no sé, no sé. 'Become frustrated', en las dos primeras frases de esto no encuentro problemas, en la primera .. 'such frustration can be particularly high when a small amount of material is needed' una pequeña cantidad, pequeñas cantidades se necesitan para acabar un trabajo, o reemplazar una pieza fallida.

'Prior', 'prior to' prioritariamente a .. 'prior' es principalmente, 'prior to' en relación a .. la especificación original del material .. __ para su viabilidad en el futuro para las reparaciones o los cambios en 'in the form or forms', esto también hay que contarlo luego en el ejercicio, se considerará, a parte de sus aplicaciones en general, la viabilidad, la posibilidad de emplazar los materiales en las piezas fallidas, en el caso que no se pueda, que no sea available, possible, 'should be identified' serán marcados, no sé exactamente si se refiere a que en los casos en que no se puedan cambiar estos materiales no se tendrán en cuenta porque no .. no conviene, o en los casos en que no se pueda, pondrán .. marcarán otros que si que puedan servir.

Materials Cost

'Economics enter into every', claro, esto ya lo habíamos comentado antes, la economía siempre .. vamos, es lo que mueve el mundo hoy en día.

'But, the important criteria', el ciclo de la vida del coste, claro, hay que tener en cuenta .. 'or cost effectiveness', efectivo, todos sabemos lo que es efectivo, entonces es, si va a ser, si el coste que vamos a utilizar va a ser efectivo, si todo el dinero que vamos a meter nos va a dar un provecho.

Claro , y aquí te dice que muchas veces es más efectivo utilizar un material que a primera vista te resulta costoso, pero que .. 'provide' va a tener, te va a dar .. una extended, 'extended' es una extensión, y extensión es una larga vida, particularmente, en áreas o lugares donde va

#2 Introduction to Materials Selection 8/9

a ser difícil su reparación 'or in components', 'shut-down', o en componentes o en partes de la maquinaria donde va a ser un gran problema, 'shut-down' va a ser como 'break-down', que se fastidie, que se rompa, que va a llevarte más dificultades en caso de que se estropee una parte, o sea , que es mejor el que esa parte esté bien protegida, y que no se estropee nunca, porque si se estropea, nos va a traer muchos dolores de cabeza.

'The following' las siguientes 'two extreme' extremas de...'eine Probleme', ahora te viene los dos 'a low initial' .. aquí hablan de un tipo de sistema donde se utiliza el carbón y el hierro, 'which require' que requiere considerable .. proceso de manutención, para la vida de la planta, planta en este caso es fábrica, ___ que sobre este punto de vista, 'such a system' .. es razonable, 'choice' elección .. donde la labor, labor es como en castellano, los costes de producción son bajos .. 'and material is readily available' 'ready' es .. preparado, entonces es que sean fácilmente

A system .. pues basado en la principal, *alloy materials*, vale, aleaciones que están correctamente diseñados y fabricados tendrán una muy, una *minimum*, una muy pequeña manutención, que se tiene que mantener muy poco, *and will function reliably*, *rely* es confiar, entonces será .. puedes confiar en ella, que será muy buena.
'Rising' .. es, 'rising labor costs' subir los costes 'in most industries' .. 'trend' es una tendencia, entonces, que la necesidad de .. en las capitales .. 'rising labor costs in most industries', 'rising' es como se pueden subir, como han subido los costes de producción en muchas industrias, los costes de materiales primarios, en muchos casos es mejor gastarse mucho dinero al principio y luego que te dure, que no estar continuamente teniendo que proveer de cosas .. y ya está.

'In practice many systems' .. 'mixture', mezcla, de estas dos opciones, resultado de los grandes costes .. bueno pues ya está, y ahora vamos a hacer los ejercicios.

1. Technical considerations.

En technical considerations vamos a poner, yo recuerdo el texto y .. lo que ya hemos dicho antes, facilidad de .. para la reparación, el lugar donde se encuentra el dispositivo, eh .. qué más .. la corrosión sobre todo .. the mechanical .. the .. también lo que habíamos dicho antes la capacidad para tolerar .. los elementos .. que mejoran la resistencia .. yo estoy

#2 Introduction to Materials Selection 9/9

haciendo un repaso, así, un skimm .. la .. availability y luego ya son costes.

Segundo, 2. The economic aspects

Es importante, pues ahora, tenemos un apartado donde están los costes, _ pero primero hacemos un pequeño repasito .. mm .. se hace un criterio, se .. eligen unos materiales y .. considerando .. eh .. las cualidades .. de éstos y sus costes, se eligen los materiales, mm .. cuenta más la efectividad del coste, que no bajo coste inicial.
Dos tipos de sistemas,
primero: bajo coste y manutención barata, pero mucha;
segundo: alto coste inicial, poca manutención, porque es cara.

Y tercera, 3. Any other factors which need to be taken into account when choosing materials for a specific application

The area where the material is going to be placed, as temperature, pressure, ahora vamos aquí, eh .. pressure vessel, mm .. qué más .. _ eso, las condiciones, o sea, more conditions, economical .. eh .. y creo que ya está, no?, Y ya está, bueno, con esto ya he acabado, espero haberlo hecho lo mejor posible, aunque creo que no lo he hecho exactamente bien, porque .. bueno, ya está, FIN.

#2 Rosetta Spacecraft Design 1/7

Bueno .. *The Rosetta* .. ok, pues a ver, el principio .. *Rosetta* es el nombre del de la nave que van a mandar para allá, interplanetaria misión interplanetaria, cuyo *principal objetivo es to rendez-vous*, eso es francés .. *and make in-situ, in-situ* es en el momento .. *measurements of comet* .. *rendez-vous* en este caso será yo creo, puede ser, no tengo ni idea, por el contexto, eh.. encontrarse, al ser 'with' es con algo, entonces puede ser , el objetivo es encontrarse, o sea, llegar y.. y hacer medidas sobre el cometa tal que viene .. medir la velocidad que lleva, su tamaño y todo esto, y todo eso será en el 2011. La nave, que también llevará el Rosetta Lander, 'lander' es .. *surface science package* eso .. bueno, claro, después, después de leer esto yo.. creo que rendez-vous sí debe ser encontrarse, porque .. los landers son que aterrizan, landing es aterrizaje, to land es aterrizar en tierra, entonces esto es un .. 'surface science package debe ser .. un dispositivo para hacer un estudio sobre la superficie del mismo cometa, igual que en .. no lo sé 'to the nucleus' eh .. entonces esto quiere decir que la nave llevará también al.. al esto de aterrizaje Rosetta, que se situará sobre la superficie, y lo llevará al.. núcleo .. y 'deploy', 'deploy' no sé lo que es, que será dejar. Lo llevará hasta la superficie del cometa.

'The Lander is provided' el lander..el lander en este caso llaman a la nave que aterrizó en la tierra, en la superficie, ha sido provisto, o sea, lo han llevado a cabo un consorcio de alemanes .. de la .. del instituto europeo, o sea, que lo han hecho los alemanes, pero.. eh.. en conjunto con la .. con los institutos europeos de .. de .. astronautas, vale.

Misión requierements
'The ambitious' las ambiciosas y científicas .. 'goals' creo que es misión, o sea, los planes que llevan .. del Rosetta, eh .. o sea .. tienen los siguientes requerimientos, necesitan .. lo que necesita el roseta para hacer todo lo que se espera de él, quiere decir, un grande número, un número grande de y complejo .. de .. un número grande de .. [leyendo] .. bueno, pues que llevarán un gran número de instrumentos cien .. muy complejos y .. instrumentos científicos muy complejos y .. complejos que deben ser..que deben ser situados en un .. en un lado del spacecraft que tendrá que estar permanentemente de cara al cometa, o sea, para poder tomar cosas del cometa, para poder tomar datos del cometa tiene que estar siempre esa parte de cara, y creo que esto luego habrá que señalarlo aquí en el mapita este, que es la tarea que tengo que hacer, que ya sé donde está, pero lo haré al final, el ejercicio y .. y a ver, cómo estaba, y entonces .. debe ser permanentemente de cara mientras que la .. durante la fase operacional, o sea, que no .. la misión, o sea, que no están hablando de .. de ir hasta el cometa y todo eso, entonces, una vez que están en el cometa entra en juego esa parte, entonces, durante ese momento siempre tiene que estar

#2 Rosetta Spacecraft Design 2/7

de cara, mientras vaya de viaje no importa, incluyendo hasta 1 km de proximidad .. del activo cometa, o sea, que estando a 1 km, ya tiene que estar de cara.
Durante el largo crucero hasta el cometa, durante el largo viaje hasta el cometa, [leyendo] vale, que durante el largo camino hasta llegar al cometa, los instrumentos .. eh .. deben ser calentados, bueno, no sé por qué, pero bueno, supongo que será que al calentarlos estarán mejor protegidos, o lo que sea, o porque el espacio es muy frio, no sé, para asegurar su supervivencia, o sea, para asegurar que cuando lleguen hasta.. no vaya a ser que monten toda la misión, y cuando lleguen a la altura del cometa, lo que tiene que.. hacer las medidas va a estar estropeado, entonces tienen que asegurarse que lleguen en el perfecto estado.

Sigamos (leyendo) eso es un requerimiento. Un complejo sistema de navegación para la nave que puede dar .. ir a bajas altit .. a bajas .. latitudes de órbita, o sea, a bajas órbitas, du .. alre .. que puedan trabajar .. o sea, que es complicado el dispositivo, o sea, el sistema de navegación, como comprenderéis, ahí no va ninguna persona, entonces eso tiene que estar todo programado, entonces, el programa es bastante complejo, ya que tiene que estar alrededor, o sea, en órbitas bajas alrededor de un cuerpo celeste eh.. irregular, débil, asimétrico... y un.. y una cant.. y un...(leyendo) y un campo de gravedad tan.. que cambia, que no es constante, eh...
(leyendo)... proporcionado por un 'dust' puede ser que sea basura?, .. no sé si es basura, y 'gas jets', 'jets' es propulsores, que yo sepa, entonces unos propulsores a gas, que lo lleven a cabo este movimiento.

Continuemos 'the Rosetta lander', 'stowed' no sé exactamente lo que es .. no sé exactamente el significado de esto, pero bueno, lo .. el caso es que.. el roseta, que .. la nave esta que va a hacer la misión .. debe estar, puede ser atado o fuertemente enganchado .. a la nave .. bueno, pues el roseta lander va a ir metido en un cohete espacial, que es el spacecraft, que lo va a llevar hasta allí, y una vez a la altura a la que se encuentre cerca del .. mm .. del cometa en sí, se soltará y entonces, ya empezará su rumbo hacia allí, entonces lo que quiere decir aquí es .. que tiene que estar 'stowed to survive the cruise', que es fuerte, o que debe estar unido .. o lo que sea, para sobrevivir al viaje, y de repente, en el momento dado, 'selfeject' es soltarse libremente él mismo .. soltarse del .. de la nave, y entonces ya empezar, debe ser así, creo que estará enganchado a la nave, eh

'The orbiter' es el orbital, o .. en este caso se refiere al roseta lander, debe navegar con 10 cm .. de accuracy, 'accuracy' no estoy seguro .. me parece que era resistencia o .. o algo así como una resistencia de 10cm,

#2 Rosetta Spacecraft Design 3/7

1mm/sec pero no sé , como no sea, o sea, una forma de medirlo para el .. para el despegue, pues es eso, o los propulsores
'and then relay data ..' y enton .. no, y después devolver datos .. (releyendo) , SSP, SSP es el Surface Science Package .. and then relay data .. (releyendo), debe de ser que .. o una de dos, o .. una vez que acabe la misión devolver los .. la información que ha cogido el SSP al .. a la Tierra, o bien, __ un programilla que lo mande para casa, no estoy seguro.

Veamos

Design-driving requirements
These primary ..

Esta misión primaria requiere un diseño de viaje .. para los típicos diseños de .. o sea que .. bueno, pues que .. después 'the data rate' eso quiere decir los requerimientos del viaje espacial, del diseño de lo que lleva el viaje espacial (releyendo hasta el final).. es que el 'data' este no sé lo que significa .. 'data' igual puede ser que sea, no estoy seguro, combustible, no sé porque el combustible medio debe ser lo mayor posible dadas las limitaciones y la .. las limitaciones que nos da la larga distancia que se encuentra de la tierra, por ello el combustible debe ser fuertemente com.. compreso .. o sea, compresionado

'high pointing accuracy' que debe ser muy .. según yo .. muy fuerte o muy .. resistente, y en particular para .. los remotos, y en particular sobre todo los .. ah, vale, que deben estar muy .. deben ser muy resistentes, los instrumentos que llevan la superficie alli, que van a tomar los datos, 'sensing instrumentos' son los que van a sentir, como si dijéramos, los que van a captar la radiación del cometa.

'thermal layout' que tiene que tener un dispositivo .. térmico, ya que .. importante, ya que el .. la nave tiene que estar .. tiene que resistir eh .. dos extremas temperaturas, tanto la del .. la del .. profundo espacio, como si dijéramos, la de .. el espacio está frío, que yo sepa, la atmósfera

está fria, hace mucho frío y luego, a un km del cometa, como comprenderéis, el cometa va con velocidad .. y un cometa no es más que, que, por la .. la fricción con la velocidad con .. con .. el aire con lo que hay en el espacio, pues se va descomponiendo, y eso es lo que hay, entonces, a un km de distancia del cometa debe hacer mucho calor, por lo tanto, lo que quiere decir es que hay que estar muy bien preparado.

'Must be able' .. debe ser capaz de llevar .. 'track' .. el asteroide eh .. el asteroide se referirá al Wirtanen este, al cometa Wirtanen, eh .. au .. de

#2 Rosetta Spacecraft Design 4/7

forma propia durante los flybys .. que no sé lo que es .. aquí pone ‘too fast and too far’ demasiado rápido y demasiado lejos .. debe ser que están .. son demasiado rápidos y están demasiado .. lejanos para dirigirlos desde la tierra, (leyendo) por tanto debe ser autónomo para seguir al asteroide, debe ser esto.

‘better than’ una .. evita .. la nave espacial evita una mejora .. de la velocidad relativa y .. para maniobrar ‘in the vicinity of the comet’, ‘vicinity’ debe ser cercanías, porque vecino, entonces debería del latín, vicinity, eh .. las proximidades al cometa.

maximum wet .. pues no. Debe ser que *data* no es .. no es fuel, el .. debe estar entre el máximo posible de fuel, ya que .. y tiene una porción de más de 50% de combustible. Esta masa está limitada porque lo que le va a llevar, lo que le va a despegar de la tierra, es la Ariane-5 no tiene capacidad para más .. eh..

nominal spacecraft .. la vida del .. de la nave que se va a enviar es de .. de once años, en una trayctoria heliocéntrica, o sea, dando vueltas al sol.

‘the achievement’ .. esto quiere decir que se consigue estar.. que se consigue estar.. larga vida, o sea, estar esta duración.. del cometa, está .. es ayudada por largos, largos periodos de hibernación, durante el crucero de viaje hasta llegar al cometa, donde muchos de los dispositivos eléctricos no están operacionales, están apagados. Esta hibernación crece hasta que crezca su vida su.. su vida aproximada calculada un factor de un diez por ciento .. of 10, de un diez por ciento debe ser, pero requiere que el.. un piloto automático como si dijéramos para garantizar la continuidad de la operación en todas las circunstancias.

‘subsystem’ un subsystem .. un subsistema .. de los primarios, fiabilidad máxima, reliability maximised .. de .. un subsistema de confianza, o sea que .. bueno, el máximo que se pueda tener .. ‘by a comprehensive redundancy’ no sé .. (leyendo) .. Por que, a ver, o sea, un subsistema que sea siempre fiel, o sea que nunca .. o sea, la fiabilidad máxima, sobre todo en los ‘hot’ redundancy, o sea, ‘hot’ redundancy es en los momentos en los que más se necesita, lo más importante de la misión, para funciones que son esenciales para la continuidad en la interrupción de la operación durante los momentos críticos .. vale.

Mechanical Design Overview
Aquí tenemos el diseño del Rosetta .. el diseño del Rosetta está basado (leyendo) vale, bueno.

#2 Rosetta Spacecraft Design 5/7

Está claro que en este texto yo ya sé que prácticamente voy a obtener toda la información para que me den el dibujo, pero lo harán al final, pero ya me iré quedando dónde están las cosas.

El diseño de Roseta está basado en un tipo de ca .. o sea, en una caja .. que es de tipo caja, cubo, central, que hace de estructura, de medidas 2'8m, por 2,1 m de ancho, por 2m de alto, donde .. en todos los subsistemas (leyendo) y .. y equipos de funciones son montados en él. Dos paneles solares, los dos de .. 'square metres' .. 'square metres' metros cuadrados, de 32 metros cuadrados, que extendidos por fuera, dando un total de expansión de más o menos, 32 m de ala a ala, 'tip to tip' debe ser de extremo a extremo. (leyendo) Avistada como es .. la visión mecánica de la .. de lo que lleva, de la nave, está ilustrado en las figuras. Ok.

'The top', the top, la parte de arriba del spacecraft lleva 'accomodates' .. es donde se encuentra los 'payload' los .. igual los payload son los más caros, o los más importantes y la.. y la base de los spacecraft subsystems y la base de los sistemas más importantes de la nave, yo creo que es importante que vayan ahí ya que .. si esa es la parte que va a estar más protegida, mejor equipada para todo, ya que esa parte es esencial para la misión, seguramente lleven ahí los controladores del resto de la nave, para que en ningún momento .. para que por lo menos vayan en el mejor sitio posible, el que menos riesgo haya que se rompan.

El spacecraft puede ser físicamente separado en dos módulos principales, será. 'a payload support module (PSM), and a bus support module. Pues el PSM será la parte de arriba, donde están situados todos los instrumentos importantes, y un bus .. debe ser.. un módulo de soporte, debe ser como un autobús, donde puede, donde viaje, no sé, ahora veremos.

'The lander is attached' .. dice, a ver, la nave .. está 'attached' debe ser.. que tiene, que lleva incorporada, en la cara opuesta a las dos 'two-axes' .. axe es hacha, así que serán alas, yo creo, a las dos alas, o al .. paneneles solares, por una estirable, por una antena, vamos, que tiene en la parte opuesta a las eso, una antena.

'The two solar wings' las dos .. alas solares, hemos dicho antes paneles solares, extendidas por los lados .. por las caras las caras laterales,
'The instrument' .. los paneles .. los .. los puntos del panel, casi siempre. Towards to the comet, ah .. esto debe ser que .. casi siempre, los paneles estarán replegados al cometa, (leyendo), mientras las antenas y los solar arrays, y los rayos solares señalan (leyendo)

#2 Rosetta Spacecraft Design 6/7

No sé, debe ser que la antena y los solar arrays están siempre señalando hacia el sol y la tierra, y tan .. tanto a largas distancias estas, o sea, que para mantenerse relacionado hablando en la misma dirección a la tierra, no sé, no lo entiendo muy bien.

'The spacecraft attitude' .. El concepto de 'attitude' no sé lo que es .. de la nave .. es tal que el.. la cara y la cara opuesta de los paneles solares (leyendo) .. los paneles, que juegan un papel importante en todas las .. las fases importantes de la misión, ofrecen un buen .. una buena localización para los radiadores y los louvres, que debe ser algo también en francés y que yo debería de saber, pues museo .. no es que no está .. este párrafo .. no lo entiendo pero nada. La nave, el concepto de la nave, es tanto, es tal que en la cara y en la parte de atrás de los paneles son .. están dispuestos todos los .. todas las partes importantes de la nave, dando una buena localización para los radiadores y los louvres. Esto .. hará normali .. estarán normalmente de cara .. 'facing away' alejados .. alejados del cometa, minimizando así los efectos que puedan provocar la basura planetaria, la basura espacial.

The spacecraft será construido alrededor de un .. de un tubo .. vertical, cuyo diámetro corresponde al de 1194 mm de la .. de la .. del Ariane-5, que es lo que les va a mandar allá.

Este tubo contiene dos largos .. iden .. este tubo contiene dos largos y del mismo tamaño de tubos del pro .. de tanques de propelano, que es un carbono .. un tipo de combustible de carbón, de carbono, 'the upper one' .. propelano debe ser material, de tanques de .. material. El de más arriba conteniendo al fuel, el combustible, y el de más abajo conteniendo el pesado
oxidante. Es verdad, que las naves van con .. unos combustibles __, un oxidante y un no sé qué.

Una .. una total de más o menos, alrededor de al menos 1578 kg de propelano serán acomodados, estarán allímetidos.
Y ahora, una vez acabado este texto, vamos a poner los nombrecitos.
Empecemos por arriba (leyendo)

A esto le podemos llamar complex scientific instruments (releyendo el texto buscando información .. scanning)
Bueno, pasamos a la parte que ya hemos dicho del diseño mecánico .. (releyendo) .. claro que se abre .. aquí ponemos .. cuando está cerrado .. boxtype central .. pero lo que pasa aquí es que están separados, sabes?

#2 Rosetta Spacecraft Design 7/7

Two solar panels, aquí

(Scanning)

Payload instruments (Payload support module y bus support module)
Antenna
The two solar wings, eso ya lo tenemos
(Scanning) .. los radiadores .. el spacecraft .. vertical thrust tube .. two large equaly sized propellant tanks .. containing fuel .. y este .. oxidiser y .. y ya está no?, más o menos (revisando rápidamente ..) y ya está.

#2 Nuevos Ojos en el Espacio para la Primera Luz 1/7

[leyendo] Bueno, pues el sucesor del telescopio Hubble supongo que será como el telescopio Hubble es un .. será otro bastante mejor en el 2002 .. que se manda al .. satélites de estos.

James Webb es el director de la NASA _ que fue el director que estaba cuando fue la época del programa Apolo que lo llevó a la luna, o sea, que era director en aquellos tiempos, en los tiempos en los que se llevó el hombre a la Luna. [leyendo] o sea, que pesará 5 toneladas, [leyendo]. A ver, tendrá un espejo primario, un espejo que capta la luz, porque los telescopios lo que hacen es captar la luz, y pasa por una serie de cristales hasta que , para ir aumentándolos. Entonces el espejo primario supongo que será el primero, el de entrada, eh... tiene 6 metros, sin embargo el del Hubble tenía 2,43m, no? _ [leyendo]

OK. Siendo como es que el área de captación de la luz es 6 veces más grande, capta más luz que el Hubble y los .. y está formado por instrumentos más sensibles y mejores, el nuevo telescopio de James Webb, debería, se supone, cuando esté allí, será capaz de ver objetos.... con mucho menos brillo y mayor nitidez que el Hubble y .. se podrá ver mejor la luz, y el brillo que provoca y la cuadracentésima parte .. [leyendo], pues una cuarta parte entre cien, supongo que será, eh .. parten el segmento infrarrojo, o sea, la luz está dividida en la luz UV, tal cual, luz que se ve, luz que no se qué, entonces, cuando la longitud de onda se encuentra en tal, la que llamamos luz infrarroja, podrá ver 4 veces partido por 100 mejor que el Hubble.

[leyendo] osado es como desafiante, nuevo, que no .. que .. provoca, aunque en este caso no tiene nada que provocar, osado es que es diferente, que no se corresponde con lo habitual.

[leyendo] La NASA ha anunciado que el observatorio, o sea James Webb, que se va a construir miraría el pasado, o sease, como la luz se propaga con el tiempo, lo que nosotros estamos ahora viendo en el espacio no es lo que está pasando ahora, sino que ha pasado hace tiempo, hace un cierto tiempo, independientemente de lo lejos que esté, cuanto más lejos está es que hace más tiempo que ha pasado, entonces cuando se refieren a mirar al pasado significa que van a apuntar muy lejos, y van a mirar, y entonces verán cosas que están pasando ahora y que han pasado cuando ya las analicen, ¿lo entendemos todos? Ok. Eh.... para captar la primera luz producida en el universo, entonces quieren buscar esta luz muy muy, muy atrás, porque aún pueden, se supone, que esa luz que se formó, y nosotros todo lo que vemos ahora va con retraso, la primera de todas las luces que se formó, si esto es enfoca, se supone que si es tan sensible igual se podría

#2 Nuevos Ojos en el Espacio para la Primera Luz 2/7

detectar, eso es lo que pretende .. la primera luz, aunque después mil.. mil años después nos llegue.

[leyendo] una orbita, la orbita es, pues, si los cohetes se mandan con una cierta velocidad y un .. una velocidad mayor que la velocidad de escape de la tierra y no se qué no se cuantos, el caso es que el planeta queda en órbita, el planeta se queda, o sea, con un motorcito que lo mantiene a una distancia x de la tierra. Eh.. más lejana, y [leyendo 'debe ser capaz ..']entonces eso es lo que hemos explicado, que tiene que analizar la luz que se produjo cuando se formaron las primeras estrellas y galaxias, se quiere detectarlas después del big bang. El big bang es lo que todos conocemos, que la materia estaba unida en un punto y se supone que explotó toda junta y se fue formando el universo poco a poco y se fue separando y separando y aparecieron las estrellas de los pequeños trozos que se formaron.

[leyendo' el comienzo teórico'] materia oscura, supongo que será el vacío, donde no hay nada, no lo sé. [releyendo] pero no solo son las estrellas, sino las estrellas y el marco en el que están situadas, qué predomina, no las estrellas que tienen un gran volumen, sino el volumen que engloba a todas ellas, o sea que van a estudiar esta parte oscura.

Infrarrojo
[leyendo] o sea, que no solo será mejor que el Hubble .. el Hubble ve como nosotros vemos, no ve partes infrarrojas, ve la parte de luz visible. El observatorio será utilizado para ver el infrarrojo, lo que he comentado antes, más adecuado para ver la luz de objetos, 'más adecuado' .. porque los rayos infrarrojos captan diferencias en .. los infrarrojos captan diferencias entre.. entre calor, marcando de un color más oscuro, o sea, cuanto más… calor eso es más rojo, y cuanto menos es más amarillo, yo creo, o algo así, o verde.

'El astrónomo .. pues eso. 'El telescopio espacial' .. eso quiere decir que en un principio se estaba pensando en hacer un proyecto para utilizar un .. un nuevo telescopio, y alguien dijo no, y por qué no hacemos esto?, más.. algo más diferente y más eso?. 'El deseo' .. y aquí han sacado la palabra, por cierto, que yo había utilizado en el principio.Por tanto .. pues lo que ya he explicado. Todo esto es más o menos lo que ya he explicado antes, mirar en el fondo para llegar a ver las primeras luces, cuándo se formaron con este micros… con este.. telescopio, y ver el crecimiento de las galaxias y ver como fue evolucionando todo, así tendremos una clara visión de todo. De cómo se separaron, se fueron separando y separando como se formaron las galaxias, las estrellas, las estrellas rojas, etc, etc.

#2 Nuevos Ojos en el Espacio para la Primera Luz 3/7

‘Aunque el nuevo telescopio .. claro, porque esto quiere decir que si el telescopio ve en infrarrojos, ve el calor y el tal, si tu se lo enseñas a alguien en el periódico, no comprende nada, entonces lo que quieren es que, lo que querían .. lo tenían que convertir de infrarrojo a luz, a hacer las fotografías a luz visible, de modo que .. para que a la hora de .. pues hemos descubierto tal que podamos la gente de a pié que no entendemos cómo descifrar el código, cómo entender cuando ves un infrarrojo, pues lo viésemos en.. en partículas, en fotografía normal.

‘La NASA .. lo que dice aquí es que la NASA intenta captar la imaginación colectiva acerca del espacio, o sea, yo creo que esto quiere decir que quiere, lo que hemos dicho, ver al principio cuando el espacio estaba todo unido en un punto, la imaginación colectiva todo junto del espacio, y el Hubble consiguió ver algo, bastante, entonces se han propuesto hacer algo ‘super’ .. que sea capaz de ver el principio.

‘Éramos conscientes .. o sea, lo que quiere decir esto es que eso provocó, las fotografías provocaron la sorpresa de todo el mundo, no sólo de los científicos, sino que toda la gente se quedó paralizada, por eso lo que ahora lo que… lo pretenden hacer con el nuevo.

‘Marcia Rieke’ Marcia Rieke trabaja en la universidad de Arizona y es la que investiga eh .. simplemente en el cristal primario del observatorio, está en lo principal del observatorio, lo que va a mover todo, el resto es la envoltura, lo más importante. Y ella afirma que las fotos que se tomen con el nuevo en luz visible serán mejores incluso que las del Hubble.

‘El telescopio’ pues el telescopio está diseñado para trabajar en el infrarrojo, muy bien, y será donde mejor trabaje, pero sin embargo, puede hacerlo igualmente en luz visible sin per .. sin perder la calidad, lo que pasa es que esta calidad no será tan buena como con el infrarrojo, aunque aún así será magnífica.

‘La empresa TRW’ pues esto es que las tres empresas Aerospace Eatman y Kodak, Eastman Kodak, etc, etc., van a construir, probar y encargar lo que es el instrumento del observatorio, lo que hace las fotos y todo eso, en un año por tanto precio, y esto no incluye lo de mandarlo al espacio, que eso es .. eso ya lo pagará la NASA.

‘El coste final del observatorio’ o sea, el coste final de lo que valdrá tanto el observatorio, como mandarlo, como hacerlo, todo, para una duración de 5 años en el espacio, incluso 10 siendo ambiciosos, podría estar entorno a los 1277 euros, que sooon… si no calculo mal, unos 2 billones de pesetas, o sea, una gran cantidad.

#2 Nuevos Ojos en el Espacio para la Primera Luz 4/7

'Una de las razones' o sea, que se manda, y ya se recoge cuando, o se deja caer en el océano cuando se acabe, pero está diseñado para .. que no piensa ser reparado, o sea que ya está todo de una.

'Por ello los ingenieros' por eso, lo que se mande allí tiene que ser de las mejores condiciones, y sea de lo mejor que haya de cada cosa, para que no haya, haga falta tener que cambiar alguna parte y que todo dure hasta unos años, la calidad de las fotos y todo dure por lo menos unos .. de 5 .. de 5 a 10 años.

'Para aislar' la Tierra y el Sol también emiten interferencias, también emiten infrarrojos, porque también están calientes, entonces lo que se pretende _ para poder ver más allá, o sea, que no se capten estas, o se capten mucho menos para que las que capten de más lejos que serán mucho más pequeñas en intensidad, no se vean afectadas por las de la tierra, no se superpongan, por eso se piensa lanzar el telescopio a una, a un..a distancia X de la tierra, en este caso a 1512783 km de la tierra, que es un punto que se ve que por relaciones matemáticas de Lagrange, o por langragianos o como sea lo han hallado, y piensan que es el punto en el que menos, en el que mejor se va a ver la luz lejana.

'En un punto como este' eso pasa con, eso pasa con la mayoría de los puntos, que la .. que la fuerza centrípeta es igual a la centrífuga entonces da vueltas.

'El punto L2' el punto L2 está situado en el lado de la Tierra opuesto al sol, o sea, que el sol está aquí, el sol está a la derecha, y la Tierra está en el centro, está situado .. en la parte izquierda de la Tierra, con el planeta siempre situado entre el punto L2 y el sol, correcto, o sea, que siempre está la Tierra de por medio, entre el Sol y la .. L2 siempre está la Tierra de por medio.

'El vehículo espacial' longitud de onda, lógico, porque estamos hablando de luz visible, 'dispositivos electroscópicos' porque lo que hacen es enfocar, enfocan la luz para analizarla' .. también dispondrá .. eh .. lo que hablábamos antes, a parte de que sea el mejor punto para estar, y tiene que estar no influido por la Tierra y el Sol, por eso es esta última capa o filtro solar múltiple que tiene muchas capas, para aislarlo, para que estas no lleguen a él, sin embargo supongo que un puntito saldrá .. que puede interferir en sus observaciones. Es lo que he comentado antes, exactamente.

'El filtro y su posición' claro, está totalmente aislado .. su temperatura baja porque no recibe el calor del sol, 'haciendo posible' claro, esto se

#2 Nuevos Ojos en el Espacio para la Primera Luz 5/7

entiende, te explicaré. Si tu lo que quieres es captar información de lo más lej .. de muy lejano, eh .. tiene que estar lo más frio posible, o sea, tus infrarrojos tienen que ser lo más negativos posibles para que al mínimo infrarrojo que se detecte, o sea que los infrarrojos, el más pequeño corresponda…, no sé si me entiendes. Si tu tienes un infrarrojo x, el .. un x mayor que .. si el, si el .. los otros puntos, tu no vas a poder ver nunca por debajo de x, porque tu te estas viendo a ti mismo, por eso tienes que hacer lo posible para que puedas verlos todos, ¿sabes?, pues ya está.

Espejo segmentado
'A fin' para que quepa en el extremo de un cohete, se construirá como un conjunto de segmentos hexagonales, si los segmentos hexagonales se plegarán en 3 paneles, claro, si tu te das cuenta, segmentos hexagonales, que se pliegan en 3, 1 y 2, 1, 2 y 3, se pliegan todos y te queda algo más pequeñito que ya se podrá encajar. 'Se plegarán los paneles' eh

'Estos paneles flexibles' los paneles podrán.. tienen capacidad de movimiento ordenados desde un ordenador central de la esto, para que estos se corrijan o se cambien de manera que .. que toda la luz vaya concentrada en un punto o colector que .. o que .. es como un .. como un microscopio practicamente para este caso el telescopio que _ que la luz vaya en un punto para verlo más nítidamente.

'Para recortar costes' pues para que salga bien, y que no haya problemas, y que además sea más barato, que sea mas barato .. cuando se dice que sea más barato es que no tengas que hacer ningún cambio después que te saldría mucho más caro, se ha apoyado estudios para que todo sea lo mejor .. lo mejor .. se ha investigado lo mejor posible.

'Mather dice que' eh, la tecnología de espejos que había hasta el momento era muy pequeña, entonces, han tenido que potenciarlo un montón y eso ha retrasado. Ellos confiaban en que se podía hacer más rápido, pero no .. no lo han conseguido. Se supone que para el 2010 la tecnología entonces será tremenda, y entonces será capaz.

'El espejo es' el espejo es lo que más va a costar que tenga esa calidad.

'En el plazo de' un año para elegir cual es el mejor material que se utilize como espejo .. que reflejen hay muchos, pero tiene que ser el mejor para que sea capaz de durar 5 años en el espacio, tiene que ser capaz de durar 5 años en el espacio, eh concentrar la .. la .. la luz en un colector lo mejor posible, lo más exactamente posible, y, y .. y otros, otra serie de datos, lo que decíamos en el otro, que tienen que .. los ingenieros de materiales tienen que ver .. los ingenieros de materiales tienen que ver cula es en

#2 Nuevos Ojos en el Espacio para la Primera Luz 6/7

realidad el mejor para esa serie de condiciones en el espacio, y que se adapte mejor a las características que tu quieres de tu proyecto.

'Los candidatos son', espejo metálico hecho de berilio, de la tabla periódica, o bien uno fabricado con alguna clase de cristal, y se acabó.

Instrucciones
El nuevo telescopio que se llama James Webb, pues tiene .. se lanzará primero que todo en el 2010, eh .. pesa .. peso .. más o menos, 5 toneladas menor peso, menor peso que Hubble.

Mayor .. espejo primario, unos 6 metros de diámetro.
¿qué más?, mayor área de captación que es una cetésima parte del brillo .. mayor área de captación, menor brillo, y puede ver en los infrarrojos, en el segmento infrarrojo del espectro de luz

¿Qué más? Ahora pasamos al siguiente tal .. bueno, esto ya no es importante porque eso ya se va con los científicos.

El infrarrojo
En el infrarrojo vemos que .. ve el infrarrojo, donde mejor ve; pero también pede fotografiar en .. en luz visible, y aquí apuntamos, para potenciar, bueno, para potenciar no, para .. opinión pública. Eh .. ¿qué mas? .. [leyendo] fotos mejores que el Hubble y calidad tanto en infrarrojo (la mejor) como en luz visible, creo que eso lo he repetido.

Eh… presupuesto para .. para el observatorio eh .. 1277 millones de euros, eh .. No reparaciones. Duración .. duración esperada .. de 5 a 10 años, eh .. situado en el punto L2, eh…un punto lejano, no. Situación de la órbita, situación en la órbita lejana, a una distancia L2 donde .. donde mejora la calidad de la imagen, no se ve influenciado por eh… por los infrarrojos de Tierra y Sol, eh .. qué mas?, casi. Tiene la pared esta, ¿cómo se llamaba? Filtro solar, filtro solar de muchas capas, para refrigerar y hacer bajar la temperatura, así como .. estos .. mecanismos, no? Mecanismos de refrigeración que posibilitarán una temperatura de trabajo de -192 grados centígrados, y .. también tiene que me habia dejado .. cámara .. de longitud de onda .. múltiple.

Y luego espejo .. espejo pieza fundamental .. espejo es la pieza fundamental, se envía en 3 partes hexagonales eran? Si. Se unen en el espacio y se pueden rectificar para mejorar la luz en el conductor.

Continúa abajo.

#2 Nuevos Ojos en el Espacio para la Primera Luz 7/7

Eh, bueno, el dibujito este que me he hecho aquí es para .. ayudar a la comprensión de uno de los hexágonos y esto .. y materiales que se barajan para la formación del espejo son .. el .. el metálico .. espejo metálico de berilio, uno, y luego espejo con alguna clase de cristal. Muy bien. [relee lo que ha escrito]
Bueno, pues se acabó, bueno pues hasta luego.

#2 El hallazgo de un gran objeto más allá de Plutón ... 1/8

Aquí dice que hace ya, en verano, usando un pequeño telescopio de Monte Palomar, que será el lugar donde está el telescopio, y tras 7 meses de búsqueda que parecen muchos, los astrónomos descubrieron el objeto llamado Quaoar, que debe ser un planeta, porque.. bueno, un planeta no, un objeto como dice aquí .. [leyendo] Aquí lo que está diciendo es que, aunque parezca mucho 7 meses, son pocos realmente para poder confirmar o afirmar que hay un objeto y detectarlo ya que cuando fue Plutón, cuando reconocieron a Plutón como planeta, tardaron 15 años en seguir toda su eso.

[leyendo] eso es lógico porque las técnicas de hoy en día son mucho mejores que las de hace tiempo, entonces detectar con nuestros telescopios que hay hoy en día es impresionante, se hace fácilmente.

[leyendo] el promedio quiere decir más o menos, como si dijésemos, para hacer una comparación, se encuentra Quaoar, que es el planeta este se encuentra mucho más allá de Plutón, a 1200 millones de km, que son muchos, pero no parecen muchos aquí, o sea que está mas lejos que Plutón, que sería un nuevo planeta más allá de plutón, que es el último planeta del sistema solar.

[leyendo] 'La luz del sol tarda cinco horas en alcanzar este mundo de penumbra' lo que quiere decir eso, a lo que se refiere es que la velocidad de la luz, o sea, la luz a Plutón todo le ocurre 5 horas más tarde de lo que realmente ocurre.

Una gran estrella rocosa cubierta de hielo, lógicamente, porque al estar tan lejos del sol, hay hielo, o sea, hace mucho frío y hay hielo .. [leyendo] a ver esto, esto último .. [leyendo] .. supongo que querrá decir que, a parte de los planetas que ya tenemos, los planetas que son planetas, hay un montón de objetos, claro están en el mismo sistema solar, pero más alejados .. y este es de los que más cerca está, supongo, o de los más importantes, porque igual hay una piedra por ahí, y también se cuenta, pero este

[leyendo] Vale, aquí lo que dice es que, a mediados del Siglo XX, o sea, mil tal tal tal, el astrónomo Gerald Kuipier dijo que existía, o sea, predijo, por sus cálculos supongo, que había un enjambre, cuando dice enjambre es de abejas, pero es en sentido figurado, se refiere a un mogollón de cuerpos situados todos juntos, o más o menos.. cuando se dice juntos en cosas del espacio, separados pero bastante cerca .. Plutón es el último planeta, por eso se coge como referencia, pero más cerca de los cometas, porque los cometas estarán en órbitas mucho más lejanas, entonces entre medias, Kuiper decía que había unos .. un enjambre de planetas

#2 El hallazgo de un gran objeto más allá de Plutón ... 2/8

Eh .. una especie de cinturón de asteroides, pero más lejano y también más poblado, o sea, un conjunto de pedruscos que van por ahí bambando.

[leyendo] en __ se ve que predijo, cuando se descubrió el primer objeto perteneciente al enjambre, llamado cinturón de Kuiper.

[leyendo] Aquí a lo que se refiere es que .. eh si es tan importante es porque es muy grande, vamos, hay que hacer una comparación con la Luna tal, o sea, que no es una cosa pequeñita, es bastante seria, es un tercio de la luna, o sea, si la luna es grande .. lo que pasa es que nosotros estamos lejos, pero será bastante grande.

[leyendo] .. o sea, que por orden de tamaño va después de Plutón, o sea, que casi debería ser un planeta.

[leyendo] Vale, esto a lo que se refiere .. es que normalmente cuando una cosa está lejana, hacen un cálculo, supongo que harán un cálculo estimado y dirán tal, tal tal, y ya al tener tanta precisión con los telescopios y .. y bueno, y que es un descubrimiento importante, se han hecho tantos estudios en tantos observatorios, entonces las conclusiones han podido ser verificadas exactamente, telescópicamente, con el telescopio, por medio del Hubble, que es un telescopio, creo que está en el cielo, o sea que es un.. cómo se dice, Hostia no me sale! .. los que están en órbitas alrededor de la tierra y .. satélites eso, es un satélite que tenemos ahí puesto para hacer fotos en el espacio, también con el observatorio de Pico Veleta en Granada, la comprobación... supongo que en Sierra Nevada, porque Pico Veleta .. bueno.

[leyendo] Bueno, esto es la técnica que han utilizado para determinar el diámetro y el tamaño del planeta, ya que supongo que medirán el calor que reflejan, y entonces calcularán que si un cuerpo tal, pues este cuerpo estando a tanta distancia de la tierra, entonces tal, y lo calculan así.

[leyendo] aquí lo que recalca es que es una labor muy difícil y complicada pero que a pesar de ello ha sido lograda, porque se han tomado las medidas de temperatura no a metros, sino a 6.000 millones de km, bueno.

[leyendo] a ver, esto lo voy a volver a leer .. a ver, por qué tiene tanto interés para ellos, para los astrónomos este cinturón de Kuiper, este enjambre de planetas? Pues será porque habrá algo importante si los astrónomos lo consideran así..

Cuando se descubrió Neptuno... está hablando de que en, cuando ocurrió aquello, van a recordar cosas que han pasado, algunos científicos como tal

#2 El hallazgo de un gran objeto más allá de Plutón ... 3/8

tal tal, [leyendo] no sé, esto aquí debe referirse a cuando se creó, o sea, estaba todo muy pensado, cuando se refiere a obras de ingeniería planetaria, supongo que es eso, se refiere a que son .. cosas que realmente están muy calculadas, aunque realmente las han hecho con el tiempo, pero que no son obras de ingeniería fabricadas a mano, lógicamente. Calculó que el octavo planeta no bastaba para explicar las anomalías orbitales de Urano?
Ah bueno, si supongo que las anomalías, ya ya , ya lo entiendo , cuando un planeta recorre su órbita, hay anomalías, pero por qué? Porque hay otro cuerpo, que por la ley de la gravedad universal, pues supongo que dos cuerpos que estén cerca se atraerán el uno al otro, el más grande atrae al otro , y supongo que eso hará que haya órbitas que se,
que las órbitas no sean elípticamente perfectas, que se van un poco así, a ver, no sé si me he explicado. El caso es, a lo que se refiere es que tienen que haber muchos más cuerpos que lo atraigan hacia aquella zona, por eso, si están todos juntos, lo atraerán hacia allá, y por eso decía que tenía que haber algo.

[leyendo] vale, ya está .. propuso la existencia de un gran planeta, claro, como sus cálculos decían eso, lo que yo acabo de explicar, por eso tenia que haber un décimo planeta seguro, entonces eso la gente siempre tenía que estar buscando ..que ha sido una serpiente de verano quiere decir que ha sido como un enigma que han tratado de descubrir y tal tal con los telescopios, pero que mucho tiempo después de aquella muerte, se descubrió en 1916 que los cálculos eran erróneos, por tanto, que no existía tal, o sea, que no había anomalías realmente, y que ya estaba.

[leyendo] Tombaugh debe ser un discípulo de Lowell, quien descubrió Plutón, cuyas dos primeras letras son las iniciales de Lowell, que no lo entiendo, las primeras letras L O, pero bueno, [leyendo], vale eso quiere decir que Plutón no requería ningunas características para meterlos en un gran grupo, ni _ en el otro gran grupo, ahora miraremos cuales son los dos grandes planes del sistema.

A ver, demasiado pequeño en comparación con los gigantes de gas, que tienen mucho gas y son muy grandes y demás, como será Júpiter, etc, y demasiado ligero para planeta rocoso .. [leyendo] o sea, que este planeta Plutón era comparable a .. a satélites como lo la Luna, o los 7 anillos de Plutón y todas esas cosas, era de un tamaño parecido a los satélites, simplemente.

[leyendo] vale, entonces lo que quiere decir esto es que antiguamente se creía que Plutón era un satélite, pero que se había escapado de la órbita, que había conseguido la velocidad necesaria y se había podido escapar de

#2 El hallazgo de un gran objeto más allá de Plutón ... 4/8

la órbita de Neptuno, la cual cosa se abandonó, porque .. ya está claro, la cual cosa se abandonó porque la órbita realmente sí que pasa por Neptuno, y si pasa por allí debería de quedarse, supongo.

Continuemos .. [leyendo] veamos, con el descubrimiento de todos estos objetos en el cinturón de Kuiper, todo el enjambre de satélites .. bueno, satélites no, de partículas etc. Etc, ha salido una nueva idea al astronómico – se escuchan gritos – se está matando a alguien por lo que parece .. sigamos.

Plutón podría ser un satélite evadido, evadido no sé a qué se refiere, evadirse es escaparse, bueno claro, podría ser un satélite que se ha evadido, que se ha escapado de la tierra esta, pero también un intruso de la tribu Kuiper que .. pero también puede ser que se haya metido en esa zona, en la zona de Kuiper, y después que alguna carambola lo haya llevado a merodear alrededor del Sol, o sea, que las hipótesis que hacen aquí es que no saben cómo por algún .. alguna cosa que haya ocurrido en el universo como puede ser chocar un asteroide, o .. yo que sé, estoy haciendo hipótesis, el caso es que el planeta se ha metido en la zona esta donde están todo el conjunto de planetas, el enjambre este de cuerpos, y se ha metido en la zona de más .. la que se corresponde a la de los planetas más cerca del sol.

[leyendo] vale, ahora van a .. estoy seguro, convencido, de que van a empezar con lo de que cuando se descubrió Plutón unos decían que no era, otros que si era .. entonces van a ver, si Plutón es un planeta, porque Quaoar no, supongo.

[leyendo] vale, aquí está tratando de responder a la pregunta, lo que quiere decir que en los años 90, al descubrir Plutón aparecieron muchos problemas porque había gente supongo que diría que era un planeta, y habría otra gente que no, entonces se remitieron a las normas que habían impuesto como condiciones mínimas para ser planeta, y se revisó su definición.

[leyendo] Vamos a ver lo que es un planeta 'un objeto en órbita alrededor de una estrella, o sea, en nuestro caso el sol, que sea más pesado que Plutón y más ligero que la estrella más pequeña', que sea más pesado que Plutón y más ligero que la estrella más pequeña, esto lo encuentro un poco una tontería, porque se trata de medirlo con respecto a Plutón, bueno, sería como en química, como el Hidrógeno, pero bueno. Bueno, esto es una norma que han puesto para ver si llega a ser un planeta, o llega a ser un satélite etc.

#2 El hallazgo de un gran objeto más allá de Plutón ... 5/8

[leyendo] está claro, con esto lo que se coge es, Plutón es planeta, pero entonces todos los planetas que aparezcan.. todos los cuerpos que se descubran a partir de Plutón para hacia delante, como no pesen más que Plutón no van a ser tenidos en cuenta, o sea, que no van a ocurrir más casos como este, o sea, que si es como Plutón bien, y si no, no lo son.

[leyendo], ves, aquí supongo que .. desde luego esta resolución Salomónica, salomónica .. ya sabemos todos que Salomón que fue el de los niños.. que lo partió por la mitad cuando había un problema .. o sea, que esta es una manera de hacer justicia, o sea, choca con las definiciones clásicas de planeta, ahora veremos por qué.

Por ejemplo, la Real Academia Española según la cual un planeta es un cuerpo celeste .. [leyendo] vale, esto a lo que se refiere es que para tener la condición de planeta, lo único que hace falta es ser un cuerpo celeste, lógicamente, que gire alrededor de una estrella, como en este caso sería el Sol, y que se hace visible por la luz que refleja, o sea que tiene la capacidad de reflejar luz, entonces sería planeta Quaoar, y Plutón, está claro, y con la de la Real Academia de Ciencias.. que se trata de cuerpos celestes que describen órbitas alrededor del sol o de otra estrella a cuyo sistema pertenecen. Aquí a lo que se refiere es que si la órbita la hace en torno al sol realmente y no es otro punto, entonces debe ser tal.

[leyendo], ves lo que yo decía antes, que si estas definiciones de toda la vida clásica se tienen en cuenta, Quaoar sería un planeta, si no fuera por esta que han hecho de que Plutón tal tiene que ser más que Plutón, etc. Etc.

[leyendo] claro, es lo que yo pensaba antes, que con los .. significado semántico, o sea, el de la lengua española etc, etc, cualquier cuerpo celeste sin tener en cuenta el peso, todos giran alrededor de la Tierra, o sea, alrededor del Sol, el Sol es mucho más grande y los atrae, a parte de que.. entonces se quedan en órbitas y se atrapan dentro sus órbitas, y luego van en una órbita lógicamente, porque tienen una velocidad y están enganchadas a un hilo del Sol, entonces todos estos objetos que están dentro del Sistema Solar serían planetas.

[leyendo] aquí a lo que se refiere es que consideran esta persona que escribe este texto, considera que la decisión tomada por al IAU lo único que hace es resolver el problema de Plutón, este extremo, y poner unas condiciones demasiado severas, simplemente dice, ‘como Plutón o nada’, y que no les parece la forma más científica.

#2 El hallazgo de un gran objeto más allá de Plutón ... 6/8

[leyendo] a ver esto .. por lo contrario destila heliocentrismo, o sea, la teoría que los ponía a todos alrededor del sol, ya que en ella se convierte la masa de Plutón [leyendo]
bueno, esto es un poco complejo.

[leyendo] vale, eso lo que quiere decir es que la decisión de poner esta norma para que sea planeta, lo que va a hacer es que en el cinturón de Kuiper, donde se encuentran miles de cuerpos, cuando se vayan descubriendo se tendrán necesariamente un peso mayor o menor, si es mayor, entonces serán planetas, y en vez de ser 9 los planetas, serán tantos, y si no llegan, no serán planetas, simplemente serán cuerpos que hay por ahí.

[leyendo] correcto, esto es muy lógico, a lo que se refiere aquí es que, si Plutón hoy por hoy fuese descubierto, se consideraría simplemente otro cuerpo celeste que gira, pero que no es un planeta, sin embargo como se descubrió hace tiempo, cuando se habían descubierto pocos, y teniéndolo a él en cuenta como el peso más pesado, por qué tenía que ser él justo sobre el que se midiesen todas las cosas, si fuese otro más grande, Plutón se habría quedado fuera, si hubiésemos contado con vez de Plutón con el que está antes, que no sé si es Neptuno, Urano o cómo está la cosa, no sería planeta.

[leyendo] vigésima es una venteaba parte .. [leyendo] vale, cuando dice que las predicciones actuales son optimistas se refiere a que se ve que realmente los astrónomos quieren encontrar más planetas, o simplemente cuerpos, o por lo menos este autor, el autor de este texto, y aunque sólo, para lo que dice aquí, sólo se ha comprobado sistemáticamente tal tal tal una vigésima parte, o sea muy poco, una muy poca parte, lo que prácticamente todo el mundo está de acuerdo, que se van a encontrar cuerpos más grandes que Plutón, por tanto más planetas, o sea más difícil de estudiar para los niños, y que hay gente que aún va aún más allá y que se van a encontrar cuerpos del tamaño de la Tierra aproximadamente.

[leyendo] aquí se refiere a que si el planeta es lo suficientemente grande como para haber gases como la tierra para que se den las condiciones.. para la vida, aunque esté allí lejos, que está claro que va a hacer mucho frío, y no va a haber vida ahora, hoy por hoy, pero que bueno, que el sistema solar no se ha modificado mucho, porque es relativamente joven, supongo , pues sería muy importante hacer un estudio, cuando se pueda, cuando se viaje a esas distancias, como un estudio arqueológico para ver de donde venimos, a dónde vamos .. etc.

#2 El hallazgo de un gran objeto más allá de Plutón ... 7/8

[leyendo] vale, a lo que me refiero yo ahora es que igual, se refiere esto ahora es que igual , el dictamen que se ha tenido de poner la condición de que sean como Plutón tal, tal, igual después de estudiar todo el sistema solar, se quede obsoleto y decidan tomar otros, otras medidas porque no vamos a tener mil planetas, entonces, igual con el avance de los ordenadores y tal se toman otro punto, otro requisito parecido, pero con un sentido mucho más científico, no simplemente poner uno como patrón.

[leyendo], bueno está claro que se haga lo que se haga, hay un mogollón de cuerpos en ese enjambre y eso va a revolucionar el mundo de la astronomía, y no creas que va a ser dentro de mucho tiempo.

[leyendo] , [releyendo más despacio], supongo que eso se referirá a que pues como el Sol, en otros sistemas planetarios comparables al sol se han contado con telescopios con 101 planetas, o sea, si nosotros sólo tenemos 9, aún faltan por descubrir un buen cacho.

[leyendo] Bueno, esto a lo que se refiere es que en una parte, cuando te metes en un tema que nunca ha sido estudiado, todo te va a .. todo va a conllevar enigmas y sorpresas, entonces nosotros hasta ahora hemos estudiado una parte muy pequeña y tenemos, pensamos que está muy bien, pero que cuando descubramos lo que hay realmente nos vamos a dar cuenta de que está muy atrás, y que vamos a tener que hacer muchos cambios y muchos cambios de reglas.

[leyendo] aquí lo que está haciendo es para acabar el texto darnos ver, darnos a entender que por muy inteligentes que nos creamos y muy .. intentemos resolver todo esto, se nos queda muy grande, porque el universo es una cosa muy difícil de entender, y por muchos estudios que hagamos, hasta dentro de muchos años, no vamos a ser capaces de entenderlo todo, por eso se refiere a las muletas como algo poco práctico, unas muletas no es como un coche por ejemplo, si dices un coche, entonces muletas es algo que no va muy rápido, y que utilizamos las clasificaciones, decir 'Planeta: tal tal', simplemente no habría que poner limites, según este hombre y estudiar a saco, estudiar un montón, y luego cuando ya estuviese todo entonces decir, 'vale pues ahora a partir de aquí tal' o ni eso.

Vale, aquí se acaba el texto y nos vamos a...

[leyendo preguntas]

[scanning text] Quaoar se encuentra a 1200 millones de km más allá de Plutón, o sea, aquí, ... aquí .. ahí .. escribiendo...

#2 El hallazgo de un gran objeto más allá de Plutón ... 8/8

Una luz tarda 5 horas en alcanzar este mundo .. [escribiéndolo en texto]

Calculando la distancia matemáticamente...

[scanning] rocoso cubierto de hielo .. qué mas

[scanning] vale, por aquí ponemos los cometas, porque están .. que están muy lejos los cometas por aquí, y en medio .. [scanning] por aquí .. cinturón de Kuiper .. hacemos puntitos .. más de 100.000, qué más .. [scanning] de aquí a aquí más de 6000 millones de km.

Sigamos [scanning] writing...

Bueno yo creo que ya está, con esto acabo, te lo dejo aquí encima de la mesa y me voy a estudiar física que tengo examen mañana
Hasta luego.

Subject #3 **Introduction to Materials Selection 1/5**

En la primera frase lo entiendo prácticamente todo, 'purely' he supuesto que es puramente, pero deduciendo por su semejanza al castellano, y 'standpoint' también deduciéndolo, desde el punto de vista o algo así.

'Approach' no tengo ni idea de qué significa, ni por deducción.

El tercer punto lo entiendo todo.

Para el cuarto punto, eh, 'compromises' se parece mucho al castellano y me da a entender compromiso, pero dentro de la frase no tiene .. no tiene significado, entonces no sé lo que es.

En el quinto punto no entiendo 'appraisal', eh .. 'alloy' y 'weldability', que .. no .. no le encuentro tampoco relación al castellano para deducirlas y .. y sé que weldability es una característica de los materiales, pero no puedo deducir su significado tampoco, y 'appraisal' and 'alloy' ni idea.

En el punto sexto .. entiendo prácticamente todo, aunque competence, competence como se pronuncie, no estoy segura si será competencia y puede ser un false friend.

Para el punto 7 entiendo la frase, aunque 'facility' no sé realmente lo que quiere decir, pero no lo considero tampoco importante para entender lo que la .. la frase .. te dice.

Para el punto 8 mm .. 'procedure' creo que es proceso, también por deducción y similitud al castellano .. eso.

Para el punto 9, 'vary' también lo he deducido por similitud al castellano, o por el contexto, que supongo que es variedad, no, o sea, variedad no, varía, varía.

Para el punto 10, me ha costado bastante entender la frase, de hecho no la entiendo, sobre todo la última parte, a partir de 'centered on delivery time' hasta el final, eh .. centered centered no sé lo que .. lo que significa, 'time delivery' supongo que es tiempo de deliberación, por también similitud al castellano, pero tampoco lo tengo claro, eh .. 'ease' no tengo ni idea lo que es, y 'field' creo que es campo, pero dentro de la frase, no me concuerda, no le encuentro sentido a la frase.

Terminando con el primer apartado, la última frase, también la he visto .. he visto dificultad a la hora de entenderla, pero creo que la he entendido por deducción y .. o sea, eso, lo que realmente .. no por traducción directa de las palabras, sino por lo que la frase en sí me quiere decir. Creo

#3 Introduction to Materials Selection 2/5

que quiere decir que .. hay que .. hay que tener en cuenta eh .. la .. la vida de .. de ese equipo a reparar , para que no afectemos, para no ponerlo en peligro de nuevo ante la corrosión.

El punto .. 12, 'criteria' creo que es criterio, por la gran similitud al castellano, y .. 'desirable', creo que es deseable, también por similitud al castellano, no?, el resto lo he entendido.

En el punto 13, 'seldomly' no .. no sé lo que significa, creo que no tiene importancia a la hora de entender la frase, cada palabra, o sea, lo que es traducción directa al castellano la entiendo, pero lo que la frase en si me quiere decir no, no lo entiendo.

Para el punto 14, eh.. 'vessel' no sé lo que quiere decir, quizá puede ser nivel de presión, que realmente .. es que no tengo ni idea, no lo puedo intentar, y .. 'piping', no lo he oído en mi vida, y no tengo ni idea de lo que puede ser, ni por deducción si quiera.

En el siguiente punto, el final de la frase, 'setting of allowable stresses' mm .. no sé realmente lo que quiere decir, he .. he deducido por lo.. por que me suenan las palabras de haberlo visto en otros textos, o .. de haberlo visto anteriormente. 'Setting' no sé si sería .. no sé, sentamiento, no sé, y 'stresses allowable' creo que son con características fiables o .. o propiedades fiables, algo así, me suena.

La siguiente frase la he entendido toda.

En la siguiente frase, 'creep range', 'range' es rango, y 'creep' pues deduciéndolo puede ser .. mm .. definido rango, eh.. preciso, luego 'load carrying', 'carry' es cargar, y 'load' yo creía también que era cargar, entonces dentro de la frase no le encuentro .. sentido, aunque la frase en general, entiendo lo que quiere decir, pero sin saber esas dos palabras exactamente lo que me expresan.

En la siguiente frase 'outstanding' outstanding out- outstanding, vale, out- significa fuera, y standing- pues permanecer de pié , entonces, tampoco es que le encuentre mucha .. mucho sentido dentro de la frase, pero no lo considero tampoco importante .. o sea, su traducción directa no la encuentro importante, te puede dar a entender la frase que son materiales que no son.. fabricados, sino que se encuentran en la naturaleza.

En la siguiente frase, la entiendo .. todo, lo entiendo todo, menos 'aging' que .. lo considero importante, que no lo puedo deducir dentro de .. de la

#3 Introduction to Materials Selection 3/5

frase, y consideraría que .. que tendría que buscarlo en un diccionario, porque es .. es importante para el texto y para la frase.

La siguiente frase la he entendido toda.

En la siguiente frase, ‘wrought’ no sé lo que significa, tampoco creo que sea importante, y .. a lo mejor por deducción pues podría ser .. pues gran, o sea, la gran resistencia al calor .. la temperatura, si, podría ser gran, o .. la grande. Y .. ‘cast’ tampoco sé lo que significa, pero también por deducción, puede ser el resto, o algo así, o los demás

Para la siguiente frase, ‘cast alloy steels’ no sé lo que es, la deducción que había hecho anteriormente de ‘cast’ me parece que es errónea, porque aquí en esta frase no .. no le encuentro sentido, ese sentido, luego, ‘tolerate’ me parece que es un false-friend, porque me parece que no tiene sentido ‘tolerate’, o sea, tolerar, creo que es soportar o contener, luego.. ‘carbon, silicon, tungsten, molybdenum’ eh .. aunque no sepa, no haya visto estas palabras, las deduce, las puedo deducir por .. su similitud al castellano, y .. y ya está. Y .. y ‘enhance’, enhance no sé como se pronunciará, tampoco sé lo que es, pero .. creo que por su similitud al castellano se puede deducir que es enlazar .. combinar

La siguiente frase la entiendo toda.

La siguiente frase, entiendo las palabras independientemente, por traducción, pero al englobarlo no me deja entender del todo lo que la frase me quiere decir, no .. no lo encuentro mucho sentido.

En la siguiente frase lo entiendo todo prácticamente, ‘improvements’ .. eh .. realmente no sé lo que significa, pero por el contexto puedo deducir que son las mejoras , o .. o algo así, las innovaciones y las mejoras en el proceso de los materiales

En la siguiente frase, ‘novel’ no me sé la traducción directa, pero como .. se oye, eh.. normalmente, bueno, normalmente, eh .. ha ganado el premio Nobel, me da a entender que es una categoría elevada, eh .. de prestigio, entonces puede ser una metodología .. unos métodos de proceso de.. de gran prestigio, de gran calidad o algo así, y ‘research leading’, ‘research’ creo que es búsqueda, pero, ‘leading’ no .. no logro compaginarlo con research, aunque sí que .. sin saber lo que significa esta palabra, puedo entender lo que me quiere decir la frase.

La siguiente frase también la he entendido en general, aunque ‘net’ no sé lo que significa, pero tampoco creo que sea muy importante a la hora de

#3 Introduction to Materials Selection 4/5

entender lo que la frase me dice, o lo que .. o que sea una palabra importante para el texto

La siguiente frase también la entiendo, pero .. 'purchasing' no tengo ni idea de lo que es, tampoco puedo deducirlo por las frases, ni por similitud ni nada, y sí puede ser importante.

La siguiente frase la he entendido toda.

La siguiente frase también la puedo entender, a pesar de .. no saber lo que significa 'prior to' .. no me puedo .. no tengo una idea concreta de lo que puede significar, pero .. no creo que .. no creo que me vaya a influir mucho en el significado de .. bueno, puede ser .. no sé, es dudoso, igual si que influye, pero bueno, va, entiendo la frase.

En la siguiente frase, también la entiendo toda.

En la siguiente frase, 'enter' no sé lo que significa, puede ser .. por deducción vamos de la frase, del contexto, pude ser .. eh.. los aspectos económicos o .. intereses económicos, o algo así.

La siguiente frase la entiendo toda.

La siguiente frase, en general entiendo, o sea, lo que es la .. la.. traducción también individual de cada palabra .. pero no llego a entender lo que me quiere decir la frase .. y.. bueno, y 'shut-downs' tampoco, no entiendo esa palabra, pero, vamos, esta no es la que hace que no entienda la frase realmente, lo cual lo puedo deducir .. eh .. desastre, o algo así, no?, pero bueno, en general no .. no sé, no .. no llego a entender lo que la frase me dice.

Para las siguientes frases, 'steel and cast' que no me acuerdo de lo que significaba, que lo di contigo el año pasado, que lo sé, pero que no .. vamos no me acuerdo.. entonces no .. ni puedo .. me lo imagino, o sea, me suena, que lo había dado, que es un material, o algo así, es que no me acuerdo, bueno, pero tampoco me afecta a la hora de entenderlo lo que me está diciendo la frase, que vamos, que si que la entiendo .. y tampoco entiendo 'readily' no sé tampoco lo que significa, pero bueno, es un adjetivo de .. un adjetivo, y tampoco veo que sea importante a la hora de entender la frase.

La siguiente frase no la entiendo, mmm, me cuesta bastante entenderla, porque, primera parte, 'reliably', que yo por deducción me había parecido que era realmente, pero luego me viene,

#3 Introduction to Materials Selection 5/5

‘high reliability’ entonces la deducción anterior no me sirve, no .. no me cuadra. Luego hay .. no sé, ‘rising’ tampoco lo entiendo, y .. vamos, me cuesta bastante entender lo que esta frase quiere decir.

La última frase lo entiendo todo.

#3 Rosetta Spacecraft Design 1/4

La primera frase, lo que quiere decir lo entiendo, aunque no entiendo la palabra 'rendez- vous'.

De la segunda frase, 'spacecraft' no .. supongo que por deducción, por descomposición de la palabra 'space' que es espacio, puede ser una nave espacial o algo así, por deducción.

De la siguiente frase, 'German-led', ese 'led' no sé lo que significa, pero tampoco considero importante saberlo para entender realmente lo que la frase expresa.

De la siguiente frase'goals' no sé lo que es, no sé deducir lo que es, y al final del párrafo, desde 'during the long cruise' hasta 'survival', esa frase no la entiendo muy bien, porque hay palabras sueltas que no entiendo, ni sé conectarlas entre sí. Lo otro, más o menos bien.

La siguiente frase lo entiendo todo, es bastante fácil, porque todas las palabras se parecen bastante al castellano, como 'asymmetric' asimétrico, o 'gravity' gravedad, 'gas', gas, pero .. 'jets' no lo entiendo pero tampoco creo que sea importante para saber lo que la frase dice en realidad.

De la siguientes frases, 'stowed' no sé lo que significa ni lo puedo deducir. 'selfeject' supongo que es.. ponerse en marcha o colocarse a si mismo, o partir, 'self-' que es a si mismo, y 'eject' que es lo que pone en la radio, que es para abrir la radio, que es ponerse a si mismo, ser capaz de ponerse a si mismo en el nave o .. algo así, o partir la nave por si misma, o salir despedida, algo así, por deducción. Y .. 'relay' tampoco sé lo que es, 'relay data', 'data' supongo que es fecha, por el valenciano, con relación al valenciano, y 'relay' no lo sé, no lo deduzco.

En el siguiente párrafo, *layout* no sé lo que es, pero como *out* es fuera, pues puede ser, .. *layout* puede ser la parte de fuera de la nave, o algo así. Antes había deducido que *data* podía ser algo de fecha, pero leyendo la frase de *the data rate need to be* .. hasta el final, pues no es fecha, porque no tiene sentido, y .. aunque más o menos se pueda entender la frase, pues esa palabra quizás, que es bastante clave de la frase, pues no logro deducir el significado de la frase *data rate*.

De la siguiente frase, vamos, a penas entiendo nada. 'remote-sensing' puede ser la sensibilidad remota de los instrumentos, por similitud al castellana, pues más o menos, que puede ser una inventada, y *accuracy*, ya me había salido antes también, no sé lo que puede ser, como no sea la curvatura de salida o algo así, no .. no logro deducir tampoco lo que significa.

#3 Rosetta Spacecraft Design 2/4

La siguiente frase también es bastante difícil de entender, sigo pensando que *layout* tiene que ser la superficie, la parte de fuera, *thermal layout* pues también por deducción puede ser pues climatizar el exterior, o algo así, o preparar, si, aclimatar el exterior.

En la siguiente frase, 'track' no sé lo que significa, por deducción puede ser aguantar, soportar, algo así, soportar el ataque de asteroides o algo así, por deducción un poco, inventándomelo también otro poco, creo que podría ser eso, pero el resto más o menos se entiende.

En la siguiente frase vamos, no entiendo nada, porque sigo sin saber lo que es 'accuracy', 'manoeuvring' y 'vicinity', entonces, como no entiendo las palabras, y son básicamente toda la frase, pues no puedo entender la frase.

De la siguiente frase entiendo todo, salvo 'propellant', aunque no es importante para, primero no es importante para entender la frase, ni siquiera creo que sea, es un adjetivo, o un adverbio, y tampoco creo que sea muy importante conocer su significado, puesto que la frase se entiende bastante.

La siguiente frase la entiendo toda, 'heliocentric' por similitud al castellano heliocéntrico o algo así, puede ser, aunque no sepa qué significa esa palabra, pero vamos, traducción del inglés al castellano, vamos perfectamente.

La siguiente frase la entiendo en general, por encima, 'cruise' no sabía lo que es, creo que puede ser algo del periodo de viaje, o algo así pude ser, 'cruise' viaje, misión o algo así, 'on board' supongo que es a bordo, por 'on' que es encima, en, y 'board' parecido al castellano y me lo he inventado un poco, pero tampoco creo que sea muy .. muy importante, quizás.

La siguiente frase la entiendo a medias, eh 'redundancy' no sé lo que es, quizás, no sé .. no sé lo que puede ser, no lo puedo deducir ni por el contexto, ni por similitud, no

De la siguiente frase, menos 'payload' lo entiendo todo, y como he dicho cuando la edad, para entender lo que la frase me quiere decir, no considero que sea importante saber el significado de 'payload'

De la siguiente frase 'giving a total span of about 32 m tip to tip' no entiendo, ese trozo no lo entiendo, porque no entiendo qué es 'tip to tip' ni 'span', dando una expansión total de unos 32 metros de pico a pico, o

#3 Rosetta Spacecraft Design 3/4

algo así se podría deducir, de parte a parte, pero que .. que no .. que no, que por mucho que lo deduzca no le encuentro sentido, y .. 'envisaged', como se pronuncie, tampoco entiendo lo que es, pues, como acompaña a 'mechanical', pues puede ser, la parte mecánica, la forma mecánica, o algo así se podría deducir.

De la siguiente frase lo que es palabra por palabra lo entiendo, o sea, la traducción al castellano, salvo 'payload' que lo llevo arrastrando desde hace ya tiempo, pero en realidad lo que me quiere decir la frase no lo entiendo, entiendo la traducción al castellano, pero lo .. el significado de la frase no.

La siguiente frase la entiendo toda.

De la siguiente frase no entiendo lo de 'two-axes steerable high-gain', pero como el resto lo entiendo, pues no considero que sea importante conocer el significado de estas palabras, simplemente, la frase me está diciendo dónde está colocada, o sea, que .. la nave pues tiene una antena en la parte de enfrente, pero tampoco creo que .. que, vamos, que sea importante.

La siguiente frase no la entiendo, porque no entiendo lo que es 'wing', no lo puedo decir, y aunque el resto de palabras las entienda de la traducción de inglés al castellano, lo que la frase me dice en sí no lo entiendo.

La siguiente frase, más o menos entiendo lo que me quiere decir.

En la siguiente frase, no entiendo 'shaded' ni 'louvres' como se pronuncie eso, pero en general, en realidad, no evita que más o menos entienda lo que la frase me quiere decir.

La siguiente frase también la entiendo toda.

De la siguiente frase no entiendo la palabra 'thrust', pero no le quita .. no es importante para entender realmente la frase, que te dice dónde está colocado el tubo ese de la nave.

Y en la última frase, sigo sin entender 'propellant', pero creo que ahora sí que puede ser importante, sobretodo para la última frase del todo que te habla de kg de propellant, entonces, no puedo deducir lo que es, y sí que considero que es importante para entender sobre todo lo que me dice la última frase del todo.

#3 Rosetta Spacecraft Design 4/4

El resto, pues sí que se puede entender, más o menos, aunque 'large' tampoco sé lo que es, también es importante, porque es una parte, o sea, algo que contiene el tubo, que aparece la definición.

#3 Nuevos Ojos en el Espacio para la Primera Luz 1/3

Primer punto entiendo todo.

En el siguiente punto he vuelto a leer quien era James Webb para .. entenderlo mejor.

Siguiente frase bien, la entiendo

La siguiente frase es un lio entre adjetivos, cifras de centésimas, cuadracentésimas y todo eso que para entenderlo hay que leerlo varias veces.

La siguiente frase es bastante sencilla de entender.

La siguiente frase la he leído otra vez, porque es muy larga y me puedo perder.

La siguiente frase es bastante sencilla de entender.

La siguiente frase se entiende muy bien, pero no está de más volver a leerlo porque utiliza muchos tecnicismos.

La siguiente frase es un poco difícil de entender el rollo este de que la luz de objetos que se adentra en el segmento rojo y térmico del espectro. Es un poco .. poesía.

La siguiente frase es bastante sencilla.

La siguiente frase también es sencilla de entender.

Lo mismo para la siguiente frase.

La siguiente frase, aunque es larga, también es fácil de seguir.

Las dos siguientes frases, al ser cortas y no muy complicadas, es fácil de entender también.

Las dos siguientes frases se entiende bien, lo que pasa es que a lo mejor habrá que leerlo un poco más despacio porque hay bastante, hay .. especificaciones como quien es Marcia Rieke, de dónde es, dónde estudia, qué instrumento es el primario.

La siguiente frase tirá, tirá tirá

#3 Nuevos Ojos en el Espacio para la Primera Luz 2/3

La siguiente frase también es sencilla, salvo que te dicen unos nombres que vamos, en inglés que no.. que no te vas a acordar si aparecieran nuevamente.

La siguiente frase es básicamente datos, que.. vamos, no hay que entender nada, simplemente leerlos, y también podrían ser datos que estaría bien anotarlos para.. no sé, como información importante.

La siguiente frase también es bastante sencilla.

La siguiente frase también es sencilla, pero he buscado en el texto, porque no sabía si John C. Mather había aparecido anteriormente, para saber quien era.

La siguiente frase, pues también eh .. se basa básicamente en dar datos como la duración del viaje, a qué distancia, como se llama el punto donde se va a estacionar.

La siguiente frase también es sencilla de entender.

La siguiente frase también es sencilla, lo que pasa es que a lo mejor es un poco lioso el .. L2, Tierra, opuesto al Sol, al lado del Sol .. te puedes liar si no lo lees atentamente.

La siguiente frase es bastante larga, por lo que o se lee muy lentamente y entendiéndola paso a paso, o hay que leerla varias veces para poder .. captar todo lo que me expresa la frase.

La siguiente frase también es sencilla.

No me acuerdo si he comentado la última frase del segundo .. del segundo apartado, de lo del centro del infrarrojo, por tanto lo voy a decir, y si estaba, pues me repito, y es bastante fácil de entender, que no tiene, no le da muchas vueltas a las cosas ni nada.

La siguiente frase quizás habrá .. es recomendable volverla a leer para quedarte bien con .. como va a funcionar, cómo se va a meter el espejo dentro del cohete.

La siguiente frase es lo mismo que anteriormente, hay que leerlo detenidamente, porque como son una serie de instrucciones, pues tienes que captar bien todo lo que te va diciendo de cómo funciona y todo eso.

La siguiente frase también es bastante sencilla.

#3 Nuevos Ojos en el Espacio para la Primera Luz 3/3

La siguiente frase he tenido que recurrir a párrafos anteriores para recordarme de quien era Mather, pero por lo demás, fácil.

La siguiente frase vamos, muy tirada, muy fácil.

Y las dos últimas frases también son bastante sencillas.

#3 El hallazgo de un gran objeto más allá de Plutón ... 1/3

La primera frase es bastante sencilla de entender, está todo bastante detallado, muy explicado.

En la siguiente frase, arrabales, no es una palabra que se utilice, ni que, o sea, que, si fuera suelta sería muy difícil de entender, pero mirándola en el contexto pues puede ser, en los alrededores del sistema solar, en el campo del sistema solar, o en el terreno del sistema solar, vale.

La siguiente frase es bastante sencilla de entender puesto que simplemente te dan un dato numérico y ya está.

La siguiente frase para entenderla realmente es conveniente leerla un par de veces, puesto que es muy larga, con muchas comas y datos.

La siguiente frase ocurre lo mismo que la que he dicho anteriormente, que si la lees dos veces mejor que una, porque es muy larga, y te puedes enredar un poco.

La siguiente frase es bastante sencilla de entender.

La siguiente frase es bastante sencilla también, porque es corta.

Lo mismo pasa con la siguiente frase, sencilla, que simplemente pues te da nombres, nombres propios.

La siguiente frase también bastante sencilla.

Lo mismo para la siguiente frase.

La siguiente frase es muy sencilla puesto que es muy corta y se entiende perfectamente.

La siguiente frase al ser may larga, pues también hay que leerla más detenidamente pues para .. entenderla con claridad, además utiliza un vocabulario, pues un tanto rebuscado.

Lo mismo con la siguiente frase.

En la siguiente frase pues también habrá que leerla pues, con más detenimiento, o releerla dos veces, puesto que se tiene, se tiene bastante con adjetivos, calificaciones, entonces puede resultar un tanto lioso.

La siguiente frase al ser más corta, pues se entiende bastante bien.

#3 El hallazgo de un gran objeto más allá de Plutón ... 2/3

La siguiente frase se puede entender, lo que pasa que es un poco así, tipo poeta, más rebuscada para que suene más bonito, o algo así, pues igual conviene también leerla un par de veces por si no se te da muy bien la poesía.

La siguiente frase es una pregunta que es bastante sencilla.

La siguiente frase es corta y sencilla de entender.

La siguiente frase también es sencilla.

Lo mismo con la siguiente.

En la siguiente frase sale la palabra salomónica, que es una frase hecha, más bien religiosa, que, claro, para entenderla tendrías que saber la historia del rey Salomón en la religión cristiana.

La siguiente frase es bastante sencilla.

Lo mismo pasa con la siguiente.

La siguiente frase es también larga, y como he dicho antes, que si lo lees dos veces mejor que una, para entenderlo, además lo de 'semántico que no científico' pues quizás no se pueda entender lo que es la palabra semántico, pero aunque no la entienda, la puedo eliminar de la frase, puesto que no es una palabra clave para entender lo que realmente dice la frase.

La siguiente frase, pues lo mismo, dos veces mejor que una, y si lo haces una, o sea, si lo lees una vez, que sea no muy rápida.

En la siguiente frase quizás 'destila heliocentrismo' puede ser un tanto difícil de entender, pero .. yo pienso, que tampoco tiene importancia realmente para entender lo que la frase me dice, así que puedo hacer como que no está, y seguir leyendo la frase y entenderla de igual modo.

La siguiente frase, bastante fácil de entender y lo mismo pasa con la siguiente.

La siguiente frase, o párrafo, pues claro, lo mismo que digo, si lo lees dos veces mejor que una.

La siguiente frase es bastante clara y fácil de entender.

#3 El hallazgo de un gran objeto más allá de Plutón ... 3/3

En la siguiente frase hay una palabra un tanto rara que es 'escudriñando' que vamos suena más a pueblo que científico, y por deducción pues puede ser que los ordenadores astrónomos sigan enviando placas fotográficas, o encuadrando, o haciendo útiles placas fotográficas o algo así, por deducción, vamos.

La siguiente frase bastante sencilla.

Lo mismo pasa con la siguiente que es muy corta y fácil de entender.

La penúltima frase también es sencilla.

Y la última frase es muy bonita, es muy poética también, y bueno, es fácil de entender también, bastante sencilla.

Subject #4 **Introduction to Materials Selection 1/1**

[too fast to understand!]

Cuando dice ‘which are added to enhance’, supongo que será para mejorar, ya que luego dice las propiedades, entonces como tiene que ser una finalidad, por el contexto supongo que significará eso.

Hasta la línea 51 sin problemas.

En la línea 53 empieza una frase y todo va bien, hasta que en la línea 54 siendo la misma frase no entiendo qué significa ‘spectrum of issues in the science of manufacturing be addressed’. No sé lo que quiere decir, porque ‘spectrum’ que pensaría que sería espectro, ‘issues’, por el francés ‘tissues’ puedo pensar que sean tejidos y fibras, y como está relacionado con manufactura y con vestidos .. voy a pensar que está relacionado, a no ser que posteriormente me de cuenta de que no. Así que me quedo con ese significado, y ya veré si lo modifico posteriormente que estaba equivocada.

Todo bien, pero en la línea 60 empieza una frase que lo entiendo bien qué significa, pero al final vuelve a decir ‘processing issues’ y no me llego a quedar claro si lo que yo pensaba que estaba referido, eso no es con el texto.

Todo bien hasta que en la línea 68 empieza por ‘prior’. Supongo que significará.. que primeramente, o principalmente o primordialmente, de todas formas, supongo que será un adverbio, con lo cual no tiene relevancia para el sentido del texto.

Sin problemas hasta la línea 77 donde pone ‘major shut-downs’ que no sé lo que quiere decir, pero por el contexto de la frase me imagino que querrá decir que hay más... pérdidas que ganancias, que gastan más de lo que van a obtener con ese material.

Todo bien hasta que en la línea 84 dice ‘rising labor costs’ no sé lo que quiere decir, por el contexto por ahora tampoco la he entendido.

No he llegado a entender lo que significa, pero de todas formas la idea del párrafo si que creo que la he cogido, con lo cual, no es importante para entender lo que significa el párrafo.

#4 Rosetta Spacecraft Design 1/2

La primera frase en la línea 4 dice 'rendez-vous' que es francés, que significa cita o encuentro y por el contexto de la frase supongo que significará, querrá referirse a una primera toma contacto.

Hasta la línea 10 sin dificultades.

Todo bien hasta la línea 15, en la línea 16 dice la palabra 'ensure' que no sé en sí qué significa, pero sure significa seguro, de estar seguro, ensure supongo que significará para asegurar, ya que delante lleva la preposición sure.

En la línea 18 dice una serie de propiedades, y de ellas 'weak' no sé lo que significa, porque el verbo wake up es levantarse, pero no le encuentro relación que pueda tener un significado parecido en esta frase. Al final también cuando dice 'enveloped by dust and gas jets', dust no sé lo que significa.

'Dust' me suena que quiere decir basura o suciedad, pero no puedo estar segura.

En la línea 20 'stowed' no sé lo que significa, pero por el contexto supongo que se querrá referir a estar preparada.

Hasta la línea 24 todo bien.

En la línea 25 'spacecraft layout' and 'performance features' no entiendo lo que quieren decir. 'Spacecraft layouts' supongo que serán más misiones para ir .. para usarla en más sitios, pero 'performance features no entiendo por ahora lo que quiere decir'.

En la línea 29 dice 'high pointing accuracy' no entiendo qué significa, hace una aclaración entre paréntesis que pone (few arcsec), que supongo que se referirá cerca del arco secante, matemáticamente hablando, pero no acabo de estar segura de lo que quiere decir esa frase.

En la línea 31 dice 'thermal layout' que no sé qué quiere decir, pero por la explicación que da supongo que tiene que ver con las temperaturas que tiene que estar adapatadas..

En la línea 35 vuelve a aparecer la palabra 'accuracy' y pienso que puede querer decir la magnitud, o el tipo de unidades que se usan. También en la misma frase dice 'manoeuvring' que no me imagino qué quiere poder decir ni por el contexto de la frase.

#4 Rosetta Spacecraft Design 2/2

Hasta la línea 43 sin problemas.

Hasta la línea 48 sin problemas.

En la línea 51 dice 'the envisaged' que.. no sé qué quiere decir, pero yo sé que en francés por ejemplo, 'visage' significa la cara, con lo cual, siguiendo el resto de la frase
supongo que se refiere a ver el frontis de la figura, que es como si dijéramos la cara de la Rosetta.

Todo bien hasta que en la línea 69 me dice el final de la frase 'offering a good location for radiators and louvres', no sé qué significa la última palabra, porque a mí me suena al Louvre, en Francia, pero no sé ni siquiera lo que quiere decir esa palabra. Por el contexto no sé lo que podrá ser, pero no creo que tenga relevancia para el resto del texto.

Hasta el final del texto sin problemas.

#4 Nuevos Ojos en el Espacio para la Primera Luz 1/2

Las dos primeras líneas sin problemas. En el primer párrafo al final .. dice ‘puede ver en la luz visible’. Por el contexto del párrafo, si que puedo entender lo que quiere decir, pero supongo que si lo pongo en otro idioma me parecería redundante, y no llegaría a comprender lo que quiere decir en realidad.

El siguiente párrafo sin ningún problema. Todas las palabras son sencillas, y fáciles de entender.

El cuarto párrafo no tiene dificultad, pero en el quinto, en la segunda línea dice ‘El telescopio espacial Hubble subió la apuesta inicial’. Eso pasado a otra traducción puede no entenderse bien lo que quiere decir, porque si lo pasas literalmente es imposible entender su significado por el contexto. Yo creo que otra frase sería mejor para poder entenderlo.

El resto del párrafo no tiene ningún problema.

En el párrafo 6 no hay ningún problema, lo único que podría tener alguna dificultad, aunque sería mínima, sería la penúltima frase cuando dice ‘éramos conscientes de esta percepción pública cuando hicimos nuestras recomendaciones’, porque lo de percepción pública no creo que pueda estar bien expresado de esta forma, habría muchas otras formas de decirlo mejor, mucho más sencillas .. intentar revisar el significado de la frase.

El párrafo 7 no tiene ninguna dificultad.

El párrafo 8 sin problemas.

En el párrafo 9 no hay ningún problema, pero por ejemplo en la tercera frase, cuando dice ‘énfasis’ al pasarlo por ejemplo al inglés, yo lo cambiaría por otra palabra que quedara más claro, por un conjunto de palabras que explicaran más el significado en lugar de sustituir una palabra por otra.

El párrafo 10 sin problemas.

El párrafo 11 tampoco tiene dificultad, es bastante sencillo de entender.

Y.. el párrafo 12 no encuentro ningún problema salvo que hay un vocabulario un poco más específico, y podría ser un poco más difícil de comprender.

El párrafo 13 sin ningún problema.

#4 Nuevos Ojos en el Espacio para la Primera Luz 2/2

En el último párrafo tampoco encuentro nada de complicado, a no ser, que en la línea 3, la palabra 'relevante' pueda dificultar un poco lo que quiere decir esa primera frase del párrafo, pero tampoco es tan importante para entender el significado global del párrafo.

Lo que queda del párrafo sin ningún problema. Todo el vocabulario es sencillo y las frases están bien ordenadas.

#4 El hallazgo de un gran objeto más allá de Plutón ... 1/2

En los dos primeros párrafos no hay ningún problema, ya que lo que nos da es alguna referencia histórica, y explica de forma breve y sencilla la introducción al resto del texto.

El tercer párrafo tampoco tiene ningún problema ya que sigue utilizando dentro de que es un texto técnico un vocabulario bastante sencillo, y asequible.

Los párrafos 4 y 5 tienen las mismas características que los anteriores. Vocabulario sencillo y asequible, y las frases bien ordenadas y con mucha claridad.

El párrafo 6 sin problemas.

En el párrafo 7, en la tercera línea dice 'una resolución Salomónica' yo creo que si por ejemplo hubiese estado en inglés y hubieran hecho una referencia de este tipo, no la hubiera entendido, ya que esta la entiendo porque hace referencia al rey Salomón, y conozco la historia, pero de otro modo no creo que la hubiera podido entender.

En el párrafo 8 hace referencia a las siglas IAU que ya habían hecho referencia en el párrafo 6, y como en el párrafo 6 sí que explican qué significan, ahora sí que se entiende y no hace falta volverlas a aclarar. Si no lo hubieran hecho, las hubiéramos arrastrado todo el texto sin saber qué querían decir.

En este párrafo se usa alguna expresión un poco más científica, como por ejemplo decir 'destila heliocentrismo' que no puedo imaginar cómo se diría en otro idioma, y sería mucho más difícil de traducir si el texto hubiese estado por ejemplo en inglés, creo que no hubiera sabido su significado, pero ahora está en castellano y sí que lo entiendo.

El párrafo 9 sin ningún problema.

El párrafo 10 sin problemas, pero en el párrafo 11 cuando dice la palabra en la línea 3 'escudriñando' yo sé qué significa en castellano, pero no sé cómo se podría decir por ejemplo en Inglés, y no sé qué sinónimo podría tener para poder decir una frase similar en inglés. Creo que es un poco complicada para conforme está hecho el texto. Todo el resto se entiende perfectamente.

El último párrafo sin problemas, pero la frase que dice 'esas muletas que empleamos para caminar a través de ella' que es un poco compleja, y se

#4 El hallazgo de un gran objeto más allá de Plutón ... 2/2

podría haber dicho de muchas otras formas más fáciles de entender para una persona que no sea castellanoparlante.

Todo lo demás sin problemas.

Subject #5 **Introduction to Materials Selection 1/3**

En la frase .. entenderla la he entendido.

La segunda frase la he entendido bien.

Con solo leer la frase una vez he entendido .. todo el significado.

La frase, hay una palabra que no sabía, pero por el contexto he sacado su significado y la he entendido.

Esta frase .. no la entiendo, porque hay palabras que no sé su significado y no .. no acabo de entender la frase.

La frase .. el trozo lo he entendido bien con solo leerlo, alguna palabra he tenido que pensar para traducirla, pero leyéndolo en ingles la he entendido, y cojo apuntes.

Este párrafo .. con solo leerlo en ingles lo he entendido, no ha hecho falta traducirlo ni nada.

Esta frase .. hay una palabra que no .. no la entiendo, pero no .. la frase la entiendo igual.

La frase la he entendido.

Y .. tomo nota de un cacho de la frase.

La frase la he leído en inglés, pero quitando de dos palabras que he tenido que pensar en la traducción .. lo demás lo he entendido bien.

El último parrafito lo he entendido. Con solo leerlo ya sabía lo que significaba.

Con leer la frase la he entendido.

El párrafo .. quitando de unas cuantas palabras que no las he entendido, el resto del párrafo y su significado, creo que si.

He entendido la frase leyéndola.

He entendido la frase con sólo leer.

Entiendo la frase y .. y cojo un apunte.

#5 Introduction to Materials Selection 2/3

En esta frase, hay una palabra que no la he entendido, pero lo que es la frase en general la entiendo.

La frase la entiendo, lo que pasa es que hay una palabra en el principio que no sé lo que significa , entonces se me queda la frase grande, el resto lo entiendo, pero se me queda grande.

El párrafo lo he entendido .. el significado con leerlo un par de veces, y he tomado un pequeño apunte.

Entiendo la frase.

He entendido el párrafo leyéndolo en inglés

Esta frase no la entiendo, hay varias palabras que no las entiendo, entonces la frase .. no entiendo el significado.

La frase la he entendido, más o menos, porque hay palabras que no sé el significado, quitando eso, el resto si .. no he tenido que hacer nada para entenderlo.

Esta frase .. no .. la he leido varias veces, pero no acabo de entenderla, porque hay palabras que no sé su significado.

Esta frase la he leído y la he entendido con solo verla, y he apuntado parte de la frase como apunte.

Esta frase, no .. la he leído varias veces pero no la entiendo, no logro entender el significado global de la frase.

Esta frase la he entendido el significado leyéndolo un par de veces , y he cogido, he apuntado parte de la frase como apunte importante.

Este párrafo me ha costado un poco entenderlo, pero lo de leerlo varias veces y .. pararme en algunas palabras para entender su significado lo he entendido y lo he puesto como apunte importante.

Esta frase no .. no acabo de entender el significado.

Esta frase la he entendido con sólo leerla.

Esta frase no .. no acabo de coger el significado de lo que significa.

He entendido la frase con solo leerla en inglés.

#5 Introduction to Materials Selection 3/3

Esta frase la he leído un par de veces palabra por palabra pero no la entiendo.

La frase la he entendido con leerla simplemente.

He entendido la frase con sólo leerla y la he apuntado como apunte.

Esta frase la he leído un par de veces pensando en algunas palabras que no entendía .. no he llegado a entender el significado de la frase.

Este párrafo .. creo saber lo que significa, y como creo que es importante, pero no lo pongo, porque como no acabo de entender el significado, todo el significado del párrafo .. pues no .. no lo apunto, pero creo que es importante.

En este párrafo, me pasa lo mismo que en el anterior, no acabo de entender el significado de todo lo que .. de muchas de las palabras que hay, entonces creo que .. debe de haber algo importante pero no apunto porque no sé lo que es.

La última frase, he entendido el significado leyéndola un par de veces y he apuntado un trocito. Tomo nota.

#5 Rosetta Sacecraft Design 1/2

Este punto .. se entiende bien.

Este punto, lo tengo que leer dos veces para entender todo el significado.

Este punto lo entiendo bien.

En este punto, ha habido palabras que no .. he entendido, porque no me sé el significado, pero lo que es el contexto de la frase más o menos lo he entendido.

Este punto lo he entendido sin.. entero.

En este punto no he entiendo .. había unas palabras que no he entendido, pero lo que es el contexto de la frase .. lo he entendido sin tener que leerla dos veces.

Este párrafo lo he traducido al español para entenderlo.

Este párrafo lo entiendo.

En este párrafo sólo con leerlo lo he entendido.

Este párrafo para entenderlo he .. traducirlo al castellano y buscar las palabras que no entendía y deducir su significado.

Este párrafo hay varias palabras que no sé su significado, entonces no lo entiendo, no lo puedo entender el significado de la frase.

Este punto .. __ alguna que otra palabra para entenderla, buscando el significado en castellano, qué podría ser esa palabra.

Este párrafo al leerlo lo he entendido.

Este punto lo he entendido, hay algunas palabras que he tenido que traducirlas al español para saber su significado.

En este punto .. lo he entendido bien sin tener que hacer nada.

Este punto .. al leerlo lo he entendido, sin traducirlo ni nada.

Este punto .. lo he tenido que leer.. algunas palabras buscar el significado en español, pero por el resto bien.

Este párrafo leyéndolo lo he entendido.

#5 Rosetta Sacecraft Design 2/2

Este punto leyéndolo lo he entendido también.

Este punto lo he entendido leyéndolo.

En este párrafo he traducido algunas palabras al español para entender su significado.

Este párrafo tengo que traducirlo al español para entender el significado entero, pero como hay algunas palabras que no sé el significado en español, no lo entiendo.

Este párrafo leyéndolo lo he entendido.

Esta frase leyéndola bien.

Esta frase tengo que traducirla al español algunos cachos para poder entender el significado.

#5 Nuevos Ojos en el Espacio para la Primera Luz 1/2

En esta frase, recuerda el telescopio Hubble, y además da mucha información.

Esta frase habla del Apolo, que fue el que llevó el hombre a la Luna.

Esta frase no.. están todos los datos bien, no .. no he pensado en nada.

En este trozo .. está todo claro.

Esta frase supongo que .. con el observatorio, __ creo que se menciona el párrafo 3.

En esta frase .. no tengo que .. Big bang y nada más.

Esta frase no .. se refiere al telescopio, a un laboratorio, no __

Esta frase pues es el comienzo del párrafo, por lo que __

En este párrafo pues hay términos que no.. los sé, que son términos técnicos de física y no.

Este párrafo no tiene ningún problema.

Este párrafo eh .. hay que fijarse en el anterior para saber quién es Dressler, y en el parrafo anterior se dice quien es.

Este párrafo es una continuación del anterior en el que explica los motivos del nuevo telescopio.

El párrafo este no tiene ningún problema

Este párrafo vuelve a hacer mención de Alan Dressler, donde tienes que pensar en el párrafo anterior para saber quien es.

Este párrafo .. ningún problema

Este párrafo no hay ningún problema en este párrafo.

En este párrafo no hay ningún problema

Este párrafo no hay .. están las empresas que son, las empresas son .. lo demás ningún problema.

El párrafo este no tiene ningún problema

#5 Nuevos Ojos en el Espacio para la Primera Luz 2/2

Este párrafo no tiene nada complicado

Este párrafo no tiene ningún problema ___

Este párrafo lo entiendo, no hay ningún problema, no hay ningún dato así que no sepa.

Este párrafo hace mención al punto L2 en el que se explica lo que es en el párrafo anterior.

Este párrafo no tiene ningún problema

Este párrafo lo entiendo quitando de algunas palabras técnicas que no sé, pero más o menos puedo intuir de lo que se trata.

Este párrafo no tiene ningún problema.

Este párrafo tiene una .. hace referencia a la primera parte del texto en el que habla del espejo.

Este párrafo hace mención al anterior.

Este párrafo no tiene ningún problema.

Este párrafo no tiene ningún problema.

Este párrafo hace mención también al espejo como el resto de estos, ningún problema.

#5 El hallazgo de un gran objeto más allá de Plutón ... 1/2

En este punto, no hay ninguna palabra así científica, sólo hay una, pero que sé el significado.

Este punto no tiene mucho .. dificultad, nombre que no sé de quién es, y ya está, bien.

Este punto, leyendo se entiende bien.

En este párrafo, hay citas históricas, pero .. no sé, no las sé, claro.

Este punto, se entiende bien, te imaginas el tamaño del Quaoar respecto a la luna.

Este punto no tiene ninguna dificultad.

Este párrafo __ telescopio, y el observatorio en Granada.

Este párrafo no tiene ninguna dificultad.

Este párrafo ni tiene nada especial, no hay que hacer nada especial para entenderlo.

Este párrafo no tiene dificultad para entenderlo.

Este punto lo he entendido, o sea, el dato __.

Este punto se entiende bien, con leerlo se entiende, no hay que hacer nada.

Este punto hace referencia a planetas, entonces para entenderlo, te acuerdas de los planetas en la situación en la que están.

Este punto no tiene ninguna complicación.

Este punto .. hace referencia a puntos anteriores del texto, con lo que para .. para entender su significado recuerdas lo que has leído antes.

Este punto tiene una pregunta, pero no tiene ninguna complicación.

Este punto no tiene ninguna dificultad.

Este punto no tiene .. con leerlo se entiende bien.

#5 El hallazgo de un gran objeto más allá de Plutón ... 2/2

En este punto, leyendo se entiende.

Este punto se entiende bien sólo con leerlo.

Este punto se leyéndolo se entiende sin hacer ninguna cosa en especial.

Este punto __ leyendo se entiende.

Este punto hace referencia a puntos de textos anteriormente leídos.

Este punto no es .. se entiende, hay un dato que hay que leer lo anterior para saber el significado de las siglas.

Leyéndolo se entiende.

Este punto leyéndolo se entiende.

Este punto que estoy leyendo se entiende bien.

En este punto, lo lees, se entiende, no tienes que volver a atrás ni hacer nada.

Este punto leyéndolo se entiende las terminaciones del punto de arriba.

Este punto no tiene .. ninguna dificultad.

Este punto no .. leyéndolo se entiende .

Este punto .. leyendo .. se entiende bien.

Este punto se lee bien, se entiende bien, ningún probema.

Subject #6 **Introduction to Materials Selection 1/4**

En la frase uno, no entiendo el significado hasta la primera coma, pero luego llego a entender que necesitamos materiales para .. para las exigencias de nuestro mercado.

De la frase 2 no entiendo la palabra approach, pero creo que no tiene gran significado en la frase.

Frase 3: la resistencia a la corrosión no es la única propiedad que consideran al hacer los materiales, hay otras más importantes en los procesos químicos para producirlos.

La frase 3, no entiendo la palabra choice, pero por el contexto que está parece que sea como si se refiriese al conjunto .. al campo de los materiales.

En la frase 3 no entiendo la palabra appraisal ni le doy significado, ya que no entiendo en el contexto para darle el significado correcto. En esta frase entiendo que en un material existe la resistencia a la corrosión, pero también hay que considerar otras propiedades tales como dureza, 'weldability', que no sé lo que quiere decir.

Frase 6: entiendo que para construir algún material, o emplearlo en la industria, es necesario considerar varios factores, tales como el precio, evaluar el material necesario, etc.

En la frase 7 no sé qué significado le dan a la palabra facility, si será el de facilidad para reparar o modificar otros sistemas.

La frase 7 la entiendo perfectamente.

Línea 20: la frase nos muestra que la resistencia de cada material será diferente según el material que usemos.

De la frase, en la línea 21 entiendo que en los procesos de reparación es más difícil diseñar o rediseñar el material que en el momento de producirlo, aunque hayan varias palabras que no sepa su significado, he intentado deducir sobre el contexto el significado que acabo de decir.

De la frase de la línea 24, la última frase de 'Introduction to Materials Selection' .. no llego a unir todas las palabras, ya que no sé el significado de muchas, o el significado que le quieren dar en este contexto.

De la frase primera entiendo que el criterio tiene que seguirse buscando un material que cumpla las exigencias para nuestra necesidad.

#6 Introduction to Materials Selection 2/4

De la frase dos, la palabra seldomly no sé lo que quiere decir, ni llego a entender su significado dentro de esta frase, pero parece que sea una propiedad de dicho material.

De la frase 3 y 4 entiendo que , para producir dicho material, se necesitan cumplir con unos códigos o reglas que están establecidas.

De la frase 5 entiendo que las propiedades del material, las propiedades mecánicas del material son las que el primer criterio que debemos mirar en un material, a la hora de aplicarlo en .. cualquier campo.

De la última frase muestra la importancia de algunos materiales en cuanto a su .. respuesta frente a cambios de temperatura.

Frase 1. entiendo que existen muchos materiales que tienen muy buenas propiedades, pero no se pueden fabricar o tratar.

Frase 2: entiendo el significado igual o muy parecido al de la frase 1.

La frase 3 no llego a unir las palabras para coger un significado claro.

De la frase 4 no sé qué quiere decir la palabra 'wrought' pero hay una comparación que dice que algunas aleaciones son mejores que otros materiales.

De la frase 5 muestra un ejemplo que una aleación de varios materiales pueden ser o adquirir mejores propiedades al unirlos. Y no entiendo la última palabra de esta frase que es 'both'.

La frase 6 no llego a tener claro el significado que me quiere dar.

Frase 7, entiendo que en algunos procesos sobre materiales necesitamos cumplir unas determinadas especificaciones.

De la frase 8 no entiendo muy bien las palabras, pero tomo como significado la competencia de las compañías en el mercado sobre la .. sobre la manufacturación de materiales, y los precios que pueden llegar a adquirir estos materiales.

Frase 8, no entiendo la palabra 'relationships' pero creo .. que muestra como las relaciones entre el proceso del material y los resultados.

#6 Introduction to Materials Selection 3/4

Frase 9, la palabra 'novel' yo le doy el significado de nuevo, para que me case el significado de que las nuevas o nuevos procesos en los materiales puedan abrir oportunidades durante el desarrollo del producto.

La palabra 'leading' no sé lo que quiere decir.

Frase 9 y última, el significado importante que yo entiendo de esta frase es el avanzado, los avanzados sistemas que ayudan mucho al proceso o manufacturación de los materiales.

Frase 1: hay palabras que no entiendo, pero por lo que veo, nos quiere mostrar sobre que existen limitaciones sobre el número de productores y de cantidad de producción sobre materiales.

Frase 2: Es el resultado de la frase 1, que muestra que por haber pocos materiales o estar limitados, a veces no podemos terminar tareas por la falta de alguna pieza de este material.

De la frase 3 entiendo que.. el material se puede reparar o reemplazar la forma de otros materiales antes usados.

De la última frase, no sé exactamente lo que quiere decir, pero parece que.. como identificar los materiales que vayamos a reemplazar.

Texto 5: 'Materials Cost'

La frase 1 la entiendo perfectamente.

De la frase 2, entiendo que el precio del material no es lo importante, sino el ciclo para producirlo o transformarlo.

La frase 3 no la entiendo muy bien, pero creo que dice que en caso de fallo será más caro llevar el material a sitios o que tengan dificultad de cambiar o reparar en el caso de algún fallo.

De la frase 4 entiendo que hay que considerar varios aspectos económicos en cuanto la elección del material.

De la frase 4 entiendo pues, que los bajos costes son los de comprar el material en un principio, y luego siguen incrementándose al hacer aleaciones, o al tratar o procesar dicho material.

#6 Introduction to Materials Selection 4/4

Frase 5 habla sobre un sistema basado para hacer aleaciones de materiales y tratamientos que si es correcto, tiene muy baja o bajo mantenimiento, y funciona bien.

A partir del punto, no sé lo que quiere decir la palabra 'rising labor', pero a lo mejor, por dentro del contexto en el que está, debe ser como labores de transformación en las industrias.

Y de lo que hay a continuación no llego a unir el significado.

Y de la última frase, entiendo que muchos sistemas de .. de procesar los materiales, son los que incrementan el valor de dicho material por culpa de los costes o gastos del mantenimiento de dichos sistemas.

Ya he terminado pero .. no sé si lo habré hecho bien.

#6 Rosetta Spacecraft Design 1/3

Introduction

La primera frase no sé lo que quiere decir 'to rendez-vous' pero queda bastante claro el contenido el cual nos dirá la misión que tiene el roseta.

La segunda y tercera frase queda bastante claro el contenido.

'Mission requirements'

En el primer requerimiento, no entiendo que necesita estar a 1 km de proximidad al cometa .. y que los instrumentos se calientan, la última palabra 'survival' no sé lo que quiere decir, y no llego a entender el significado de la última oración dentro del apartado uno.

El segundo requerimiento de esta misión si que lo llego a entender, que habla sobre la forma y .. los componentes exteriores que tiene el Rosetta.

En el tercer requerimiento no entiendo hasta el primer punto, que habla sobre el Rosetta, y el viaje sobre el cohete. Y de la segunda frase, lo de la órbita puede navegar con 10 cm no sé a qué se refiere en cuanto al movimiento del Rosetta.

'Design-driving requirements'

La primera frase habla sobre los apartados que necesita el cohete para su diseño, que .. tales como

El primer punto habla sobre distancias que deben darle al cohete sobre la tierra para que él lo comprenda y no pueda perder su trayectoria,

Del segundo punto no sé lo que quiere decir, pero habla sobre algún control remoto de los instrumentos.

El tercero habla sobre un .. una capa térmica que tiene el cohete por su exterior, y a partir de la coma, dice que sobre una distancia de 1 km y eso, y no se a qué se refiere esa distancia sobre el cometa.

Cuarto punto. Lo del principio no lo entiendo muy bien, pero luego parece que habla sobre el viaje que está bajo control.

En el quinto punto creo que habla sobre la velocidad de acoplamiento que es mejor que en mm por segundo, en la maniobra que puede realizar sobre el cometa.

#6 Rosetta Spacecraft Design 2/3

En el 6 habla sobre el peso que tiene el fuel que va a llevar este cohete, y sobre el 50% del 'propellant' no sé lo que quiere decir, pero supongo que será como una reserva o algo que lleve el cohete.

El séptimo punto no sé ..11 años en 'heliocentric trajectory' no sé lo que quiere decir, pero habla sobre la trayectoria que va a llevar el cohete en un tiempo determinado.

En el octavo punto, habla sobre las condiciones que va a tener este cohete en el viaje, como hace frío, hay componentes que pueden dejar de funcionar, y tienen que asegurar la autonomía de todos los sistemas, y que puedan funcionar bien durante el viaje.

En el noveno punto habla sobre los sistemas que son principales y vitales para que pueda funcionar esta misión, y no se interrumpa por ninguna circunstancia que lo pueda producir.

'Mechanical Design Overview'

Habla sobre la forma del roseta, que es una forma de caja, que luego se desplegará, y que de punta a punta del panel solar, tendrá unos 32 metros. Luego muestra las figuras 1 y 2 que es la forma que va a tener el roseta plegado. Este párrafo me ha sido fácil de entender porque como son datos, y son palabras no muy difíciles, se entiende perfectamente.

Después de los dibujos, habla sobre la parte superior y la parte inferior del Rosetta, que se divide en 2 módulos.

En la línea 64 no entiendo dónde me sitúa. El Lander dice como que está atacado sobre la cara opuesta de .. 'two-axes' que no sé lo que quiere decir, creo que es a la otra parte a la parte en la que está la antena, pero no sé muy bien exactamente lo que me quiere decir esta frase. Sé que me quiere posicionar algún objeto sobre el cohete, pero no sé muy bien cúal.

En la lína 65 habla sobre las partes del cometa, por ejemplo diciendo que las antenas y .. los rayos solares como si reflejaran sobre la tierra, y con esto, se ve que sacaría la distancia .. entre, hasta la tierra del cometa. Vamos, esto es lo que entiendo yo de este, de la línea 65 hasta la 68.

La línea 68 y 69 habla sobre los radiadores que tiene el cometa, que están detrás de los paneles, y en la línea 69-70 habla que la forma que ha obtenido el cometa, es para .. la forma que ha obtenido el cohete es para minimizar los efectos que tiene el polvo que va dejando el cometa, y poder trabajar mejor.

#6 Rosetta Spacecraft Design 3/3

La línea 71 habla que todos los componentes están alrededor de un tubo con un diámetro determinado.

La línea 72 habla que este tubo tiene en la parte superior un depósito como de carburante, y en la parte inferior tiene como un contenedor oxidante, o como un catalizador .. y habla al final que el combustible serán 1578 kg y .. nada más.

Es un texto que es bastante difícil de entender muchas palabras, porque hay muchas palabras que son técnicas, y nada más.

#6 Nuevos Ojos en el Espacio para la Primera Luz 1/3

Del texto entiendo pues que van a enviar un nuevo, telescopio al espacio que sustituira al actual telescopio más potente que existe .. será muchísimo mejor .. que el actual .. más pequeño y el reflector será mucho mayor lo cual dará una mejor definición.

Tambien pretenden que, su gran pretensión .. llegue a captar la luz de las estrellas, cuando se creó el universo, pues que he dicho a, pues irá a una velocidad determinada, y ellos con el telescopio llegarán a, a alcanzar, ese haz luminoso que lleva catorce años, a la velocidad, 14 millones de años, a la velocidad de la luz.

Este telsecopio es muchísimo más sensible al brillo o a la luz que producen las cosas, y, por tanto .. puede captar objetos luminosos que antes con el actual telescopio no se podrá, no se podrían, captar.

Con este telescopio pues, intentarán averiguar sobre las origenes de la creación de las planetas .. y la gran diferencia de este telescopio, con el actual Hubble es que el Hubble está situado en nuestra planeta y el nuevo telescopio pretenden que s, pretenden lanzarlo en órbita y que pueda leer y que pueda, ser un observatorio pero desde el espacio.

Según cuentan las dos primeras frases dicen que el nuevo telescopio, er, no solamente podrán ver los haces de luz sino que llegará hasta el centro de dichos haces que el, la, el antiguo telescopio no llegaba a, a observar, o a ver, y que el motivo del lanzamiento de este nuevo telescopio es averiguar el origen de las galaxias y poder ver la primera luz de las estrellas que he dicho antes que están la luz está a catorce millones de años luz nuestra y con este telescopio pretenden captar dicha luz .. que este telescopio también pueden captar, fotos de las imagenes con una definición bastante buena, aunque el Hubble ya lo hacia pero con este nuevo telescopio pues pretenden que sean mucho mejor definidas, las fotos, para el apoyo de la gente que .. no crea en estos, descubrimientos.

Esta cámera, del nuevo telescopio será, una cámera por infrarrojo, y también, con luz normal, o visible.

Luego nos habla, del precio que pueda tener el nuevo observatorio .. que según se nos quiere hacer entender, va a ser mucho más barato que el del Hubble por que, no va a tener, coste de mantenimiento como el, actual telescopio.

También ahí, dice, que .. para que ningúna interferencia en, er .. pueda afectar a dicho telescopio lo enviarán a una distancia determinada de la

#6 Nuevos Ojos en el Espacio para la Primera Luz 2/3

Tierra llamada el punto de Lagrange, donde la gravedad de la Tierra y el Sol se compensan.

Este punto de Lagrange está justo a la parte opuesta .. de la Tierra frente al Sol, por tanto supongo que será un sitio como de sombra, o de penumbra.

Luego más adelante no entiendo muy bién [rie] porque llegan a poner una pista de tenis para aislar de la luz a los componentes, de dicho telescopio.

También esta pista de tenis, erm, aislará del calor producido por el Sol y producido por la Tierra.

La posición en la que dejarán este observatorio en el Punto de Lagrange .. y un filtro que llevará dicho observatorio dejará la temperatura de entorno a unos ciento noventa grados, centígrados por debajo de zero .. que mejorará muchísimo la lectura por inf, por infrarrojos del observatorio.

Este texto, ha sido mucho mejor de entender, que la parte primera, y no me ha dejado ningún punto en dudas.

Parte tres. Espejo segmentado

Ya comentábamos en el texto uno, que el nuevo observatorio tiene un espejo de, seis metros de diámetro frente a los dos, con cuarenta tres que tiene el actual Hubble, y, esta gran superficie es un problem para que, para lanzarlo al espacio .. entonces con su dimensión er, lo harán en un tipo de, por partes o por paneles, hexagonales, que se plegarán, luego una vez en el espacio se desplegarán por mando dicho espejo de, de tal superficie.

Todo este sistema estará controlado por ordenador, para que la forma del espejo pues se modifique, en funcción de de la luz que queremos reflejar, ya en el espacio.

La NASA está haciendo un hincapie en todos estos espejos, er, para que trabajen en una condición óptima y están esperando a, a buscar nuevas materiales, y es una, una de las principales causas que prolongan el lanzamiento del nuevo observatorio, que será en fecha entorno de dos mil diez.

Y la NASA pues tiene un año para .. escoger cual es el tipo de espejo, entre dos candidatos que tiene, para luego ya poder seguir avanzando en la nueva, estación, que será el observatorio.

#6 Nuevos Ojos en el Espacio para la Primera Luz 3/3

Y nada este último texto, ha sido bastante fácil de entender. Lo único que no entiendo ya pues tipo de cristales, que es el último apartado, pero nada.

#6 El hallazgo de un gran objeto más allá de Plutón ... 1/2

De la línea 1 a la 5 lo entiendo todo bien, a partir de la línea 5 hasta la 10 menciona que el hallazgo del nuevo cuerpo u objeto por Plutón, ha sido en tiempo mucho más corto que antiguamente debido a las nuevas tecnologías.

También habla de la distancia a la que está situada el objeto hallado.

De la 10 a la 15 nos habla de que es un planeta muy frío al estar muy alejado del sistema solar, y que existen varios objetos a partir de la órbita de Plutón, que aún no han sido descubiertos.

De la línea 15 a la 20 habla sobre un astrónomo que le llaman Kuiper, que .. halló una serie de objetos, dispuestos sobre un círculo, un cinturón, y habla también sobre las dimensiones que tiene el nuevo hallazgo junto a Plutón.

De la línea 20 a la 25 pues, ya ves, nos habla de , pues que gracias a los telescopios tan modernos, y el telescopio Hubble, pues se ha podido ver realmente la dimensión que tiene pese a la distancia a la que está situado respecto a la tiera.

De la línea 25 a la 30 pues hablan de, pues debido a la ciencia y tecnología tan avanzadas que estamos, han podido medir la temperatura de un planeta a tanta distancia.

De la 30 a la 35 hablan que, a principios del siglo 20, solamente se conocía hasta Urano, y de momento ahora se conoce hasta, del planeta hasta el sistema solar, hasta Plutón.

De la 35 a la 40 habla sobre el hallazgo que hizo Tombaugh, que halló, que había descubierto el planeta Plutón, pues entorno, a principios del siglo XX.

De la línea 40 a la 45 habla que los descubridores de Plutón, en un principio pensaban que era un satélite de Neptuno, y .. también pensan que podría haber sido un planeta, o un objeto que se había dispersado del cinturón de Kuiper y ha llegado a nuestro sistema solar.

De la 45 a la 50 habla ya de cómo estuvieron preguntándose si era Plutón un satélite o era un propio planeta.

De la línea 50 a la 55 habla sobre los problemas que tuvieron de, según las definiciones que tiene la Real Academia, o la Real Academia de las

#6 El hallazgo de un gran objeto más allá de Plutón ... 2/2

Ciencias, o la de la Unión astronómica, tuvieron que modificar, han tenido

que modificar las, los significados que tenían porque no concordaban los .. el significado que le habían dado a un planeta, y ..

Bajo todas estas se cumple que el objeto hallado más allá de Plutón, el Quaoar, sí que cumple las definiciones, que sería un planeta más, además de todos los planetas u objetos que están en el cinturón de Kuiper.

De la página 60 a la 65 sigue debatiendo los problemas que tiene la definición de la unión astronómica para la .. la definición que le dan a planeta. También habla que utilizan la masa de Plutón para, como objeto de medida o comparación para comprobar la dimensión o masa de otro planeta.

De la 70 a la 75 están hablando de si los objetos que están descubriendo en el cinturón de Kuiper, si son mayores que Plutón, los catalogarán como planetas, o no, están aún debatiéndolo.

Hablan también si encontrarían un objeto de dimensiones similares a las de nuestro planeta, y que sería objeto de estudio, porque podría darnos información sobre el comienzo del sistema solar.

A partir de la línea 80 habla que todas estas investigaciones seguirán en marcha, y con nuevos equipos y nuevos ordenadores podrán llegar a .. a encontrar nuevos planetas y nuevos objetos de una manera mucho más rápidamente que años anteriores.

De la línea 85 hasta el final habla sobre los hallazgos que se llevan hasta día de hoy, que han encontrado 87 sistemas planetarios y 101 planetas, y que posteriormente al .. al descubrir muchos más tendrá que llegarse a una manera de clasificarlos para no .. liarse.

Subject #7 Introduction to Materials Selection 1/6

El primer punto, la verdad es que no lo entiendo la mayoría de las palabras, imagino que me están hablando sobre los problemas de la corrosión, porque hay dos palabras, esas dos palabras son las únicas que entiendo, más o menos, y sobre la resistencia de los materiales.

En el segundo punto, hay palabras como ‘approach’, lo demás, aquí en este punto pasa una cosa muy curiosa, entiendo las mayoría de las palabras menos esa, pero no soy capaz de enlazar el significado de la palabra.

En el tercer punto, la frase es demasiado larga, con lo que olvido lo que voy traduciendo anteriormente y me pierdo. Sé que me están hablando sobre lo mismo de los anteriores puntos, porque vuelve a salir la misma palabra, que es corrosión, pero en este caso supongo que será sobre .. los procesos industriales, porque me lo dice al final de la frase.

Para intentar entender el significado de toda la frase entera, intento buscar palabras que tengan una cierta relación, para así saber de lo que me hablan.

En el siguiente punto, aunque es muy cortito .. ‘choice’ no entiendo lo que significa, el resto de la frase sí que lo tengo bastante claro. Bueno, ‘choice’ .. me da a mi algo de .. puede ser de elegir, no lo sé, no tengo ni idea.

En el siguiente punto .. hay es muy largo y hay muchas palabras que no entiendo .. pero me está me está intentando a .. por la palabra ‘between’ que significa entre .. entre algo y algo, o sea me está haciendo una pequeña.. creo que me está haciendo una pequeña comparación sobre dos cosas .. Pero hay muchas palabras como por ejemplo ‘appraisal’ .. ‘allow’ que no entiendo .. ‘such’ y esa es una palabra que sabia pero que me he olvidado .. ‘strength’ ‘weldability’

En el siguiente punto .. también es demasiado largo .. [reading text] __ .. en este punto entiendo la mayoria de las cosas, pero volvemos otra vez a lo mismo, que si me si me centro en lo que estoy leyendo olvido lo que ya he leido .. y entonces pues uff, como no vaya apuntando palabra por palabra.

En el siguiente punto .. sé que me estan hablando sobre la selección de materiales, sobre el proceso de la selección de materiales porque es es lo que .. lo único que entiendo .. ‘either’ no entiendo lo que significa.

En el siguiente punto .. sé que también me habla de los materiales, pero está vez en la construcción .. el equipamiento sobre la construcción .. y

#7 Introduction to Materials Selection 2/6

sobre la selección de .. de ese material vamos .. pero aún así tampoco sería capaz de decirlo palabra por palabra.

En el siguiente punto .. hay muy poquitas palabras que entiendo .. la construcción 'will often' no se lo que significa 'will' será del futuro pero .. 'often' no .. sé que .. al final de la frase me dice que varia según el material usado y al principio de la frase pone corrosión o sea que .. creo que se me estará hablando sobre .. uff .. algo que está diseñado para evitar la corrosión y que varia según la material

¡Madre mia!, en el siguiente punto no entiendo nada pero nada uff .. 'less' no sé lo que significa.

'Delivery' me suena a algo de deliberado o pero es que no consigo enlazar el sentido con lo que .. con lo otro ..'field' tampoco sé lo que significa, uff.

El último punto de este .. de esta parte tampoco entiendo muy bién el significado pero sé que me están siguen hablando sobre el equipamiento .. y al final de la frase pone 'corrosion' será .. será un tipo de equipamiento para evitar la corrosión.

En el siguiente punto lo acabo de leer y me acabo de olvidar de lo que sabia por lo que vamos a empezar otra vez .. [reading] de todas formas .. hay palabras que comprendo 'criteria' me suena criterio .. el criterio de selección usado en material de la ingenieria [translating] .. no .. el criterio de selección usado .. para la elección de materiales en la ingenieria .. incluye una lista de cualidades .. 'item' no sé lo que significa, 'desirable' tampoco.

En el siguiente punto .. 'unfortunately' un fortun A TE LY [deletrea] no sé lo que significa .. 'each' tampoco .. 'seldomly' tampoco .. 'be all found' tampoco .. no llego a entender el significado de la frase, hay demasiadas palabras que no .. que no me concuerdan.

Sé que me están hablando de la selección .. pero de que .. supongo que será de lo que me estaban hablando en el punto anterior sobre los materiales elegidos.

En el siguiente punto, creo que me están, creo que me están hablando sobre el equip .. los procesos de equipamiento en las fábricas .. 'vessel' no sé lo que significa y 'piping' tampoco.

#7 Introduction to Materials Selection 3/6

En el siguiente punto hay una pequeñas palabras que no me dejaron enlacer un sentido. Sé que me está hablando sobre unos, unos códigos .. para probar los materiales .. y que establecen una base para algo .. pero aquí entra palabras como 'setting', 'allowable' y 'stresses' [pronunciation] que no se lo que significan con lo que ya no puedo entender el significado de la frase.

En el siguiente punto hay palabras como por ejemplo 'thus' no sé le que significa .. 'apply' tampoco .. pero supongo que me estarán hablando sobre un proceso de selección .. sobre los materiales mecánicos, es que, no lo sé, hay muchas palabras que no entiendo .. hay alguna que entiendo pero que no las encuentro enlace con .. con las demás.

En el siguiente punto me dicen algo que es especialmente importante .. para applicaciones en temperaturas .. no sé si altas o bajas porque no entiendo lo que pone después .. pero me están hablando sobre el punto anterior o sea lo que en este punto lo que es importante pero debido al anterior y como en el anterior no me he enterado de nada .. pues ya no sé de lo que están hablando aquí tampoco aunque lo entiendo .. la palabra 'creep' no me suena .. 'carrying' tampoco.

En el siguiente punto .. sé que me está hablando sobre .. materiales .. para evitar la corrosión .. materiales fabricados para evitar la corrosión y aún así no estoy muy seguro porque .. por ejemplo en la palabra 'outstanding' 'desirable' 'highly', 'seldom' .. no sé no sabria que decir intento buscar las palabras que .. intento buscar algunas palabras que me den el significado de la frase pero es que .. el vocabulario auí puesto es muy difícil para mi. Podría deducirlo por alguna palabra que me ha dado una pista pero en este caso sé que me están hablando sobre materiales de fabricación pero .. si ya me preguntan por el sentido literal de la frase.

En el siguiente punto .. hasta la primera coma puedo decir que entiendo todo, están hablando sobre algún material que tiene unas excelentes propiadades .. pero a partir de la coma salen una serie de palabras que no tengo claras y ahora me trastocan todo. Por ejemplo 'aging' .. 'exposure' bueno 'exposure' me suena expuesto .. pero esta palabra me trastoca todo el significado.

En el siguiente punto, no tengo muchas palabras claras pero por ejemplo salen materiales y fa 'fabrica, bility' que supongo será fabricación luego seguimos hablando sobre lo mismo o sea sobre los materiales de fabricación pero, no entiendo o sea no lo sé lo que me dice la frase .. 'therefore' no sé lo que significa .. 'main, tainability' bueno

#7 Introduction to Materials Selection 4/6

‘maintainability’ se parece mucho a mantenimiento ¿no? [piensa] no no sé, no sé lo que quiere decir.

En el siguiente punto no entiendo nada .. lo primero que pone ‘in general’ en general, luego ya ‘wrought’ [pronunciation] no sé lo que significa, ‘heat’ tampoco. me suena cabeza, heat he-ad cabeza, no tengo idea, a .. ‘alloys’ no sé lo que significa, ‘cast’ tampoco .. uff

En el siguiente punto empezamos otra vez con lo mismo ‘cast alloy’ que no y ‘steels’ que no sé el significado de estas palabras .. y seguramente será lo que significa será lo que .. el importante de la frase el significado de la frase .. Además también es un punto muy largo y no .. no entiendo .. me habla sobre .. bueno .. carbón silicio .. o silicona no sé debe ser, ‘silicon’ debe ser silicio o silicona .. supongo que habla sobre materiales.

En el siguiente punto .. me hablan también sobre los elementos mencionados en el anterior. Creo que me están hablando sobre que tienen .. unas adversidades que afectan al original .. entiendo muchas palabras en este punto pero no soy capaz de enlazarlas.

En el siguiente punto no tengo idea de lo que me habla ... procesos de materiales .. es lo único que entiendo ... ‘manufacture’ será . ya no me acuerdo ni ni en castellano ... ‘manufacture’ me suena a mi de una palabra en castellano pero no... no recuerdo ahora cuál es tampoco .

En el siguiente punto .. sé .. creo que me están hablando sobre una competencia en el mercado .. pero hay palabras que no me dejan entender .. lo bien, bien .. ‘ever’ no sé lo que significa .. ‘cost’ .. bueno, ‘cost’ supongo será el precio .. ‘faced’ o sea fa-ced .. no sé lo que significa tampoco .. ‘spectrum’ tampoco .. usues usues no sé lo que significa .. no sé.

En el siguiente punto .. en el siguiente punto es demasiado largo uhh .. ‘understanding’ no sé lo que significa .. ‘relationships’ tampoco me suena algo a relaciones .. luego aquí al final de la frase me dice algo ‘between the process’ entre el proceso de material .. y el resultado del producto .. pero es que como no entiendo el principio de la frase no sé que tiene .. qué relevancia tiene con esto.

En el siguiente punto además de largo es muy complicado . uhh .. ‘novel’ no sé lo que significa // ‘open up’ tampoco , ‘open’ sé que es abrir pero ‘open up’ no se lo que significa .. ‘research’ tampoco ‘leading’ tampoco .. ‘improvements’ tampoco .. ‘performance’ tampoco .. no lo sé es que no sé el significado de esta frase

#7 Introduction to Materials Selection 5/6

En el siguiente punto más de lo mismo del anterior .. demasiado largo muchas palabras que no entiendo .. que no consigo enlazar .. luego el significado de la frase no sale .. y me quedo sin entender nada .. 'behind' no sé lo que significa .. lo he olvidado el significado de esta palabra .. nanotechnologia si que me suena . porque se parece a la palabra original nanotecnología .. 'net shape' no sé lo que significa .. 'research' tampoco .. usus [issues] tampoco .. uff.

En el siguiente punto .. entiendo algunas palabras pero, por ejemplo 'purchasing' .. no sé lo que significa .. 'trying' tampoco .. y luego me dice aquí .. o sea leo la palabra 'volume' 'volume' supongo será volumen pero qué tiene que ver eso .. aquí no consigo enlazar un sentido con las poquitas palabras que sé .. uff.

El siguiente punto es cortito, pero .. no, hay algunas palabras que me impiden conocer el significado. 'amount' no sé lo que significa, 'needed' es algo de .. necesidad, me imagino, 'replace' tampoco.

El siguiente punto es .. un poco largo .. y no consigo tampoco entenderlo .. 'prior' no sé lo que significa, 'given' me suena de haber .. de haber conocido esa palabra .. pero es que ahora mismo no me acuerdo, 'availability' .. no consigo encontrar .. esa pequeña palabra que me dé la pista de lo que se me está hablando claramente.

En el siguiente punto, más de lo mismo, hay muchas palabras que no entiendo, sé que me están hablando sobre materiales, 'materiales deben ser identificados' no sé, me están hablando sobre una identificación sobre los materiales, pero no sé .. lo anterior no lo conozco .. 'those' no sé lo que significa, 'might' tampoco .. no lo sé.

En el siguiente punto, supongo que me están hablando sobre el coste de los materiales, de hecho, ese es el titulo, 'materials cost', luego es una pequeña pista que me indica sobre qué va a tratar el siguiente texto, pero por ejemplo, en el primero, 'enter into every business decission' no sé lo que significa, la verdad.

En el siguiente punto, no sé .. hay muchas palabras que no entiendo. 'Criteria' me suena a criterio en español, 'initial cost' no sé lo que significa .. el coste inicial será .. es que no .. me centro en la palabra que estoy traduciendo y olvido la anterior .. y encima hay palabras que no .. que no entiendo, luego se multiplica la dificultad.

¡Madre mia! El siguiente punto es muy largo. Hay muchas palabras que no entiendo, uff, 'usually' será usualmente, pero no lo sé. 'is much' .. mach

#7 Introduction to Materials Selection 6/6

..uff .. ‘shut-downs’ no sé lo que significa, ‘failures’ tampoco .. no sé, demasiadas palabras, no consigo enlazar el significado, y hay otras que no entiendo. Así es imposible saber de lo que te están hablando.

Aquí en el siguiente punto, aunque no lo entiendo muy bien, y es largo, me dice eh.. ‘economic factors when selecting materials’ supongo que serán algunos factores económicos que hay que tener en cuenta cuando seleccionamos el material para un .. un servicio específico.

Los factores que hay que tener en cuenta en el mismo punto del que estábamos hablando, pues no tengo ni puñetera idea. Porque ‘low’ no sé lo que significa. ‘Largely’ tampoco, ‘steel’ tampoco, ‘cast’ tampoco, ‘iron’ tampoco .. ‘such’ tampoco, ‘reasonable’ tampoco, ‘choice’ tampoco, ‘low’ tampoco, ‘readily’ tampoco, ‘available’ tampoco, uff.

En el siguiente punto que .. ‘mainly’ no lo entiendo tampoco, ‘alloy’ tampoco, ‘reliably’ tampoco, ‘rising’ tampoco .. ‘together’ una palabra que sabía y la he olvidado, luego no la sé tampoco .. ‘high’ tampoco .. ‘trend’ tampoco .. es que aquí no sé ni de lo que me están hablando .. sé que me están hablando sobre los .. unos factores económicos que hay que tener en cuenta cuando se .. para elegir un material .. para un uso específico, pero .. si tuviera que deducirlo por este punto que acabo de leer, no sabría de lo que me están hablando.

Y en el último punto, ‘mixture’ no sé lo que significa, ‘high initial’ inicial, pero .. la otra palabra no lo sé, luego la construcción ‘maintenance costs of the other’ no sé .. no le encuentro significado tampoco.

#7 Rosetta Spacecraft Design 1/4

En el primer punto, aunque hay muchas palabras que no consigo entender, sé de lo que me están hablando, porque la primera parte del texto sí que la tengo clara, luego ya está la otra, en la otra mitad de la frase, que no .. que no sé de lo que me están hablando .. hay palabras como por ejemplo, 'rendez-vous', 'in-situ', 'comet' y luego me da una fecha, que supongo.. que no sé, no sé si es la fecha de lanzamiento de esto .. no tengo ni idea., entiendo que me dice que está en una misión.

En el segundo punto no entiendo nada, no hay .. no veo la pista que me indique de qué se me está hablando. Ni una palabra que se parezca al castellano ni nada, no sé, no lo entiendo, no entiendo casi ninguna de las palabras.

Y en el tercer punto, pues más de lo mismo.

En el tercer punto, aunque hay muchas palabras que están claras, me vuelve a pasar lo de siempre, que voy .. voy avanzado las palabras y olvido las que ya he leído, con lo que el significado del.. de ese pequeño texto pues se me olvida, de todas formas, el título me da la pista que necesito, los requerimientos de la misión. O sea, sé de lo que se me está hablando, pero no sabría decirlo literalmente.

En el segundo punto no entiendo nada. 'low' no sé lo que significa, 'around' tampoco, 'weak' me suena a fin de semana, no?, no tengo ni idea, 'dust' tampoco sé lo que es, no sé, es que aquí por ejemplo en este punto, no hay .. no hay nada que me de una pista de lo que se me habla.

En el tercer punto me hablan un poco de la velocidad y lo que recorre eh .. 'the orbiter' supongo que será la órbita, no lo sé, me da esa pista y me da también , una medida, no?, una distancia por segundo, supongo que me estará diciendo la velocidad a la que se desplaza. Tampoco sé realmente de lo que me están hablando, supongo que será el .. la leche esta, ¡coño!, del satélite, no me salía la palabra.

En el siguiente punto, me hablan un poco del diseño .. o sea, de sobre cómo se ha diseñado, no es que lo entienda perfectamente el .. el .. el pequeño texto siguiente, pero 'design' sí que sé que es diseñar, y 'requirements' también sé lo que es, por lo que se me da una pista de lo que se me habla, de todas formas tampoco hay muchas pistas, si no es por el título, tampoco lo hubiese sabido, porque hay muchas palabras que no entiendo, y el texto no queda claro.

En el siguiente punto, pues .. sigo sin entender nada, pero como sé de lo que se me está hablando anteriormente, lo he dicho, sobre diseñar los

#7 Rosetta Spacecraft Design 2/4

requerimientos del diseño y todo, pues sé de lo que se me habla, pero si tuviera que adivinarlo por lo que acabo de leer, pues no tendría ni puñetera idea.

En el siguiente punto, aunque no lo tengo claro, hay palabras que se parecen al castellano, como por ejemplo, 'thermal', que me recuerda a térmico, diseño térmico. Luego sé de lo que se me habla en este punto, pero no sé lo que se me dice en concreto. También hay una palabra que sale que es temperatura, luego sé que se está hablando del térmico, del diseño del térmico.

El siguiente punto no está nada claro, 'able' no sé lo que significa. 'Autonomously' no sé lo que significa, me parece a una palabra en castellano que es autonomía, no?, 'flybys' tampoco sé lo que es .. 'far' tampoco, 'ground' tampoco. No sé, hay muchas palabras que no entiendo y se me nubla el significado.

El siguiente punto, pues bueno, más de lo mismo, aquí por ejemplo en este punto es que no sé ni de lo que se me está hablando, porque no hay una pista, no hay una palabra que se parezca al castellano .. no hay dos palabras .. no entiendo que haya dos palabras que estén relacionadas, que me indiquen .. está hablando de esto .. no.

En el siguiente punto supongo que se me está hablando de la capacidad del depósito, porque me dice 'fuel', 'spacecraft and fuel' me suena como si fuera el espacio del depósito. También me da una cantidad, supongo que será la cantidad que le cogen, que no sé si será eso, pero.

El siguiente punto me da .. me da un periodo de tiempo, y me dice 'trajectory' que supongo que será una trayectoria, pero es que no sé lo que a lo que se refiere con esa fecha ni con lo de la trayectoria. 'Spacecraft' no sé lo que significa, 'lifetime' tampoco, 'heliocentric' supongo que será heliocéntrico, me recuerda mucho a las palabras en castellano. Pero no sabría decirlo a ciencia cierta.

El siguiente punto, a parte de ser muy largo para mi, no tengo claras la mayoría de las palabras, y si la tengo clara, al intentar traducir la siguiente, ya la he olvidado .. hay una palabra aquí que me dice que no es operacional, el sistema eléctrico no es operacional, supongo que me estará hablando del sistema eléctrico. Pero es que luego me están hablando de hibernación, no sé, no consigo enlazarlo.

El siguiente punto, no sé tampoco de lo que se me está hablando. Hay algunas palabras que me indican algunas pistas, pero .. por ejemplo, nada

#7 Rosetta Spacecraft Design 3/4

más empezar el texto me dicen ‘subsystem’, será subsistema, no? .. Pero al final de la frase, al final del texto, me dice también ‘during critical misión phases’, será durante las fases críticas de la misión, pero es que entre medias de esas dos no hay .. no veo ninguna pista que me ayude a enlazar una con otra, para saber perfectamente de lo que me están hablando.

El siguiente punto me lo dice bien claro el .. __ bueno, ‘bien claro’, me lo dice claro el título el diseño de la mecánica. Luego a parte también me da unas dimensiones que es de la .. digamos, por así decirlo, de la caja, del satélite, me da unas medidas pues que me .. me .. dan un poco de claridad para saber de lo que se me habla.

El siguiente punto me habla un poco de los paneles solares, de su distancia, o sea , de lo que miden, y también me habla un poco de .. por así decirlo de .. de.. de la forma, de qué aspecto tiene, de la caja .. digo la caja porque no sé cómo se llama, el diseño de la caja, por así decirlo, me da dos figuras de muestra .. Tampoco es que tenga muy, muy claro todo lo que estoy leyendo, pero aquí se me da una bastante pista, además se me da una ilustración, que me pone más, me da más claridad de lo que estoy viendo y lo que estoy leyendo, pero tampoco es que lo entienda todo al 100 por 100, ni muchísimo menos. Hay muchas palabras que no entiendo, pero aquí te da muchas más pistas que en los textos anteriores.

El siguiente punto .. es que no sabría decirlo a ciencia cierta .. creo que me está hablando sobre lo que es capaz de albergar la citada caja que habíamos dicho antes, no metería la mano
en el fuego a que es eso, pero .. porque también me habla .. o sea, me dice, ‘accomodates’ y luego un poquito más adelante ‘instrumments’, será para acomodar los instrumentos, no?

El siguiente punto sí que está muy claro, aunque no entiendo todas las palabras, porque por ejemplo, ‘spacecraft’ no sé lo que significa, pero tiene que ser algo de espacio, porque esa palabra es muy parecida al castellano.

Además también me dice que hay una parte del satélite que se separa en dos módulos, y luego me da los dos módulos, o sea, me da los nombres de los dos módulos.

El siguiente punto, si no fuese porque me lo dice bien claro la palabra ‘antenna’, no sabría de lo que se me está hablando, porque ‘lander’ no sé lo que es , ‘attached’ tampoco, ‘face’ es cara, pero.. qué significará?, alguna cara de .. del satélite, no lo sé. ‘Two axes’, no sé lo que significan

#7 Rosetta Spacecraft Design 4/4

axes, 'steerable' tampoco, 'high- gain' tampoco, la única que está muy, muy clara y porque es idéntica al castellano es 'antenna', o sea, sé de lo que me están hablando, de antena.

En el siguiente punto me habla de algo que hacen los dos paneles solares, pero .. no sé lo que hacen, porque no lo entiendo. 'Wings' no sé lo que es, 'side' tampoco, y 'faces' vuelvo a repetir que serán caras, rostros .. pero .. no sé lo que tienen que ver aquí los dos .. es que tampoco, tampoco llega a decir paneles solares .. dice los dos .. 'the two solars', los dos solares, supongo que serán los dos paneles solares.

El siguiente punto es .. es un poco complejo además, o sea, además de largo es un poco complejo, porque creo que me habla de dos cosas, de dos partes del sistema, uno la instrumentación del panel, y lo otro .. la otra parte no lo sé, me da .. me da dos puntos cardinales, como son el .. yo que digo dos puntos cardinales, me dice, 'the Sun and the Earth', y me dice algo también de distancias de la Tierra, y algo de una dirección, vuelvo a repetir que son palabras que se parecen mucho al castellano, luego también sé .. o sea, me da una pista de lo que se me habla, pero hay muchísimas palabras que no entiendo. 'Almost' no sé lo que es, 'towards' tampoco, 'comet' tampoco, 'arrays', tampoco, vuelve a salir otra vez 'towards', 'such' tampoco.

En el siguiente punto, pues .. no entiendo nada salvo .. 'a good localization.. location', supongo que me estará hablando de una buena localización, pero tampoco sé de lo que se me está hablando, literalmente, me refiero, hay muchísimas palabras que no tengo claras tampoco aquí ... 'Such' no sé lo que es .. 'shaded' tampoco, 'throughout' tampoco .. 'radiators' no sé si se referirá a radiadores .. porque se parece algo al castellano, pero no sé lo que es tampoco, 'louvres' tampoco.

El siguiente punto no entiendo nada .. me dice algo de minimizando los efectos .. pero minimizando los efectos de qué?

El siguiente punto sí que está claro. Me dice que el .. el 'spacecraft' ese está construido sobre un tubo vertical, y me da un diámetro también, luego en este punto si que .. se puede decir que es el único que .. el que más claro tengo de todo el texto.

El siguiente punto pues me habla un poco del dicho tubo del que habíamos hablado antes, sus dimensiones que contiene, de que está formado .. o sea, de qué material está hecho .. supongo que me dará también el peso, porque me da aquí un peso .. supongo que será el peso del tubo del que estábamos hablando.

#7 Nuevos Ojos en el Espacio para la Primera Luz 1/3

Básicamente el texto, es un texto bastante sencillo, aunque tiene muchas palabras técnicas, pero .. entiendo bastante bien. Básicamente lo que hace es hablarme sobre el nuevo telescopio y sus .. y sus características, no?, digamos sus nuevos avances sobre el anterior telescopio. Básicamente, pues, un poco así resumido dice que pesa mucho menos, que es capaz de captar luz .. eh .. a ver cómo lo explicaría yo .. mmm, digamos un poco, te explica un poco los avances, no? Que tiene el .. el nuevo telescopio con respecto al anterior. Dice que tiene más captación de luz, es capaz de detectar objetos más pequeños, más pequeños y que se ven menos, porque también hay una parte en la que dice 'detectar objetos con la centésima parte del brillo', o sea, que con menos brillo, más .. o sea, objetos más pequeños y con menos brillo que el otro es capaz de detectarlo.

Vuelvo a repetir que, aunque tiene muchas palabras técnicas, no es .. no es un texto que no se pueda coger

La primera parte del .. del texto, se completa diciendo que será capaz también de .. de observar una débil y cálida luz producida hace .. millones de años, no? Eh .. también se usará para estudiar formación de planetas y buscar un .. aquí en el texto como una materia oscura, oculta, que no sé lo que será porque científico no soy .. pero bueno.

Según leo la segunda parte del .. o sea, la primera parte del segundo párrafo, o sea, es básicamente una continuación sobre las características que te da en el .. en el primero. La única diferencia es que en el primer texto daba unas características globales de lo que era el telescopio. En este segundo párrafo pues se centra en cómo trabaja una característica del telescopio que es la luz de infrarrojos. Básicamente va hablando sobre cómo trabaja esa luz, sobre lo que, en qué se centra, vamos, por así decirlo, esa luz que es .. dice aquí que es la que el ojo humano percibe.

Habla también de las intenciones de .. digamos .. de lo que querían los astrónomos que diseñaron este telescopio, lo que buscaban, que no querían un simple telescopio de muchas dimensiones. Querían algo, pues .. por así decirlo dar un salto, algo que supusiera un gran avance. Algo que pudiera ver, como aquí en el texto dice, la primera luz de las estrellas, que vuelvo a repetir que como no soy .. o sea, lo entiendo perfectamente, pero como no soy científico, no sé exactamente decir lo que buscan con eso, la primera luz de las estrellas.

La segunda parte del segundo texto pues, básicamente habla un poquito sobre referencias de gente que ha visto unas imágenes con este telescopio, comentarios de otros científicos que afirman que el Hubble tiene que ser algo superior, básicamente referencias. Simplemente referencias. ¿Qué

#7 Nuevos Ojos en el Espacio para la Primera Luz 2/3

saco en claro en relación con los dos textos? pues lo mismo que he dicho antes, que uno básicamente habla de unas características a nivel general, y en el segundo se centra más en cómo va a ver el .. cómo se va a poder .. o sea, cómo trabaja el telescopio. Desde las luces que capta, hasta digamos unas dimensiones que tiene, referencias sobre gente que lo ha visto, que lo ha visto, o sea, que .. ha trabajado con él, sobre lo que buscaban esos científicos a la hora de diseñarlo .. sobre lo que se espera de él, vamos .. está todo un poco relacinado, no? Aunque son dos textos diferentes. Esta un poco relacionado no, está todo relacionado.

La segunda parte del segundo texto, básicamente nos habla un poco a nivel de costes, lo que va a costar digamos el laboratorio, que se va a encargar de .. de trabajar con él. Los costes que puede .. traer el .. el mantenimiento del telescopio, que como según dice aquí van a ser más baratos que el anterior, ya que no necesita mantenimiento una vez lanzado, el .. digamos el primer trabajo, por así decirlo que se le va a dar al telescopio, que es aislarlo de las .. las interferencias infrarrojas de la tierra y el sol, mmm el periodo de duración que va a estar, digamos, una fase de prueba para el telescopio.

En el segundo texto observo que también, o sea .. el telescopio .. se va .. a ver, cómo lo diría .. digamos, habla un poquito también sobre ..un vehículo espacial que ayudará a aislar al telescopio, y habla más o menos un poquito sobre a qué distancia se va a lanzar, de las características del vehículo espacial .. habla también de una serie, vuelvo a repetir una serie de características internas de ese vehículo, lo que va a aguantar la luz del sol .. en qué posición estará, cómo va a trabajar .. pero básicamente, todo está relacionado con el telescopio, o sea, ese vehículo espacial lo que va ha hacer es ayudar las lecturas en infrarrojo del telescopio.

En el tercer y último texto habla un poquito sobre el .. el espejo digamos que se va a montar en el vehículo espacial citado en el anterior texto, y pues habla un poco del .. del reporte de costes para eh .. para dicho espejo, qué tipo de espejo se va a utilizar .. eh .. habla también un poquito de una serie de problemas que se tuvieron que se retrasó el lanzamiento del telescopio del 2008 que estaba previsto al 2010 que es ahora el plazo que está previsto. Habla también un poquito de la forma en que están montados los espejos, o sea, el espejo que tiene 6m de diámetro

Básicamente, la diferencia entre los 3 textos, vuelvo a repetir, el primero es un, una visión global del telescopio, el segundo se centra más en cómo trabaja el telescopio, y en .. un poquito más de las condiciones de funcionamiento que va a tener, sus primeras pruebas, sus costes, cómo trabaja un poco .. las luces, los diferentes tipos de luces con los que va a

#7 Nuevos Ojos en el Espacio para la Primera Luz 3/3

trabajar .. Y el tercer texto, pues básicamente es el tipo de espejo a utilizar, sus costes, no sé, los diferentes tipos de espejo que va a utilizar, el retraso que ha tenido debido a un problema de recorte de costes .. de recorte de costes no, perdón el desarrollo de la tecnología de los espejos, pero bueno, es un texto que se entiende bastante bien, aunque vuelvo a repetir que tiene muchas palabras técnicas, y algunas difíciles de comprender, no?, porque debido a que es un texto científico, y yo no soy científico, pues me cuesta un poco, pero bien, creo que lo he entendido bastante bien.

#7 El hallazgo de un gran objeto más allá de Plutón ... 1/3

Bueno, los dos primeros puntos, bueno .. pues como está en castellano no hay .. no hay duda ninguna. Habla un poquito pues de .. de un hallazgo de un planeta que se .. que está más allá de Plutón y que tardan 7 meses en descubrirse, comparado con los 15 años que tardó un científico en encontrar Plutón. Básicamente está muy claro.

Los dos siguientes puntos, pues también más de lo mismo, te habla sobre el mismo planeta ya mencionado anteriormente y te dice un poco pues la distancia a la que se encuentra, lo que tarda el Sol a llegar a ese planta, de qué está compuesto, ya que dice que es una gran esfera rocosa cubierta de hielo, y pues te dice también un poquito el.. la cantidad de miembros que componen el sistema solar y de que hasta ahora sólo se han descubierto unos pocos.

Y en el siguiente punto, pues habla sobre un astrónomo que .. propuso una idea sobre .. sobre un cinturón de asteroides mucho más lejano y .. más poblado. También se habla de que .. esa idea, esa predicción, pues no se hizo realidad hasta el '92.

Los tres siguientes puntos, pues básicamente, pues te habla un poquito sobre la importancia de ese descubrimiento, lo que ha significado para la prensa, eh .. también lo importante que es debido a sus dimensiones, es .. aproximadamente un tercio de la Luna, y pues, te dice también pues que es .. el mayor descubrimiento desde Plutón. Y también dice que es.. que es importante porque eh .. a ver cómo lo explicaría .. por ver tales dimensiones del planeta telescópicamente, o sea, se han verificado los datos telescópicamente.

En los dos siguientes puntos pues te habla de cómo se ha descubierto, o sea, qué técnicas se han utilizado para descubrir el .. este pla.. este planeta por así decirlo, por así llamarlo. Nos habla de .. medir la temperatura, o sea, es una técnica que se centra sola .. básicamente en el calor solar que.. que refleja, y que depende de su distancia, y de su temperatura y del tamaño. Es un texto, aunque no es .. o sea, no es..no es difícil de ent.. es un poco difícil de entender por la cantidad de palabras técnicas que hay, o sea, no es .. no es imposible entenderlo, pero sí cuesta un poquito, no?, porque es un texto, o sea, con muchas palabras científicas.

Ves, aquí por ejemplo, en .. en los dos siguientes puntos, pues, entiendo las palabras, pero me cuesta un poquito entenderlo, ya que se.. es un... son dos puntos muy complicados, hay mucho .. mucho tecnicismo, muchas palabras científicas y esas cosas, lo cual complica mucho más el texto. Aunque también en parte llego a entender la idea, no quiero decir que no

#7 El hallazgo de un gran objeto más allá de Plutón ... 2/3

lo entienda, o sea, nos está hablando sobre un .. una serie de preguntas que se plantearon a la hora de buscar por .. por donde se encontró el planeta, o sea, no es que no lo entienda, o por lo menos creo que lo entiendo, pero hay muchas palabras difíciles de entender.

En los dos siguientes puntos, pues habla un poquito sobre .. sobre lo que fue, lo que significó el descubrimiento de Plutón, que se ponían una serie de pegas, pues si era demasiado ligero.. para un planeta rocoso, o si .. era demasiado pequeño .. etc, etc. no?

En los siguientes puntos, pasa lo mismo que antes, o sea, demasiadas palabras técnicas, incluso hace comparaciones de palabras, lo cual dificulta mucho el significado del .. de los dichos puntos, se complica bastante debido a tanta palabra científica, ahora incluso meten comparaciones de planetas con .. eh .. por ejemplo, dominio de los planetas, carambola astronómica, o sea, son palabras, son comparaciones pues que yo .. ahí particularmente no les encuentro el sentido, no?.

El siguiente punto está bastante claro, no tiene dificultad ninguna.

El siguiente párrafo, o sea, trata, o sea, habla, mejor dicho de una especie de polémica, eh .. de cómo se .. cómo se clasificarían los planetas por así decirlo, no? Es un .. una teoría que choca por ejemplo con la de la Real Academia Española, o con la de la Real Academia de Ciencias. Ambas proponen teorías diferentes .. y soluciones diferentes .. habla un poquito sobre una pequeña polémica. Aquí en este párrafo también pasa lo mismo que anteriormente, o sea, muchas palabras complicadas, ahora también introduce en este texto comparaciones .. algunas palabras que no entiendo, por ejemplo semántico, no recuerdo lo que era semántico.

El siguiente párrafo, o sea, en pocas palabras me dice algo que para.. cuando se encuentra un planeta, o yo lo entiendo así, cuando se encuentra un planeta nuevo, o sea, lo que hacen es compararlo como si fuera Plutón, o sea, como Plutón, y ahí se dice si .. si merece la clasificación de planeta o no. También dice que, hoy por hoy, si se descubriese Plutón hoy, no sería considerado un planeta.

El siguiente párrafo, aunque pequeño, está bastante claro, habla sobre que no se ha .. no se .. no se ha buscado en todo el cinturón ese del que hablamos, y de que .. corre la esperanza de encontrarse algún planeta que sea tan grande como la Tierra.

El siguiente párrafo, o los dos siguientes párrafos, uno habla sobre .. el hallazgo que significaría encontrar un planeta similar a la Tierra, y en el

#7 El hallazgo de un gran objeto más allá de Plutón ... 3/3

siguiente pues lo que significaría para los .. para los astrónomos investigar dicho planeta, no?

Y en .. el último párrafo pues .. dice un poco sobre .. pues te habla un poquito sobre lo que hay descubierto hasta ahora, no?, y te dice en pocas palabras pues que .. a medida que se vaya aprendiendo se irán modificando, y a medida que se vayan descubriendo planetas, pues se irán modificando.

Haciendo una vista general al texto es .. es bastante complicado, o sea, habla un poquito de todo, habla un poquito sobre .. el sistema solar y los planetas .. sobre lo que significó el descubrimiento de Plutón, lo que ha significado el nuevo descubrimiento del planeta Quaoar, lo que significaría encontrar otro planeta similar a la Tierra .. etc, etc, no? Vuelvo a repetir que es .. bastante.. complicado por toda la cantidad de palabras técnicas y .. y científicas que hay, no?, a parte es un texto bastante largo .. pero bueno, en líneas generales, la idea se queda.

Appendix E

The texts used in the main experiment

Appendix E1. Details of the training texts used.

	Text	No. of words	Source
1	Mini DV camcorders	234	Adapted from a magazine article.
2	Travel and the environment	306	Adapted from: Getting Around in a Better Environment. *Today's Engineer online*. <http://www.todaysengineer.org/policyperspectives/sept01/sept01features/rail.html> Date retrieved: September 27, 2001
3	Plastics	233	Adapted from: Uses of Plastics, The American Plastics Council. http://www.plasticsresource.com/s_plasticsresource/sec.asp?TRACKID=&CID=125&DID=227> Date retrieved: September 28, 2001
4	Batteries	351	Adapted from 'A Brief History of Portable Batteries' <http://www.houseofbatteries.com/articles.asp?pageid=14> Date retrieved: September 2004
5	Indoor air pollution	850	http://www.arb.ca.gov/research/indoor/rediap.htm
6	Galvanizado en caliente y en frio	119	http://www.asimet.cl/galvanizado.htm
7	Corrosion theory	684	http://www.corrosion-doctors.org/Principles/Theory.htm
8	Galvanic corrosion	474	http://www.corrosion-doctors.org/Aircraft/galvdefi.htm
9	Putting it together - composite materials	1608	http://www.science.org.au/nova/059/059print.htm
10	Introduction to materials selection	955	http://www.corrosion-doctors.org/MatSelect/Frames.htm

Appendix E1. Details of the training texts used

Appendix E2: The training texts

Training text 1

MiniDV Camcorders

MiniDV stands for Mini Digital Video and there are two choices: pocket- or full-size. Both record video and sound onto MiniDV cassette tapes. Standard tapes last 60 minutes. The advantages of a pocket-size camcorder are obvious, but there are disadvantages, too. Firstly, the smaller the camera, the smaller the LCD viewing screen, which makes reviewing and editing your tapes more difficult. Moreover, many of the camera's functions (editing, focus, exposure, etc.) are controlled by onscreen menus, so the smaller the screen the harder they are to see. In addition, the control buttons are smaller and closer together making them harder to press.

Another disadvantage of the pocket-size models is that they usually have smaller optical-zoom magnification. There are two kinds of zoom: optical and digital. The former magnifies the image through the lens, while the latter simply enlarges the size of the pixels resulting in reduced image quality. Digital zoom specifications are often very high (200x, 300x), while optical zoom numbers are much lower (10x-25x). Nevertheless, if picture quality is important, you should pay more attention to the optical zoom capabilities.

There are also two types of image stabilization – the process which reduces or removes completely a shaking or unsteady picture. Again, the two types are optical and digital, and again optical is better as the digital system can result in reduced picture quality. Most digital cameras, though, use digital image stabilization.

Training text 2

Travel and the Environment

Imagine a transportation alternative that got commuters and travelers to their destinations efficiently, was more environmentally friendly than automobile and airplane transport, and didn't require using vast areas of countryside. Imagine a travel option that reduced congestion on our highways. Sound too good to be true? For moving people and products from one place to another, perhaps it's time for us to make rail transport a more widely accepted transportation alternative.

For a long time now, road and air travel have been more popular choices than trains. But as we struggle to contend with overcrowded road infrastructure, look for alternatives to an airline industry that is going through some struggles of its own, and consider ways to address the huge environmental impact of these more popular transportation methods, perhaps our answers lie with rail transport.

Many major cities have passenger rail systems that provide efficient, economical service. Light rail and subway transit reduce air pollution, since the prime movers are electric motors. Even diesel-electric locomotives produce less air pollution compared to auto travel.

Cities such as Boston, New York, Philadelphia, Chicago, Los Angeles and San Diego have found the use of rail transport systems reduces vehicle congestion on streets and highways. In the last two or three years, these cities' systems have accommodated significant increases in passengers as commuters have realized that they can save both time and money when they use rail, as well as reducing stress. One indirect advantage to commuting by rail is that, because you use it less, your car will last longer.

For intercity travel at distances of 450 to 800 kilometres, rail travel offers travel times that are competitive with air travel. What's more, commuter services often connect to downtown rail stations, eliminating long, time-consuming trips to airports that are often located far from city centres.

Training text 3

Plastics

Plastics play an important part in our lives. The versatility of plastic means it can be used in everything from soft drink bottles to refrigerators. From cars to dolls to televisions. So why are plastics so widely used? Why have they become the material of choice for so many varied applications?

One simple answer is that plastics help make your life easier and better. Plastics can be manufactured to meet very specific functional needs for consumers. Whatever the need; safety, performance, value, plastic can probably satisfy it and help make your life easier and better.

For example, in the supermarket plastic wrap helps keep meat fresh while protecting it from bacteria and the dirty hands of other shoppers. Plastic bottles mean you can actually lift an economy-size bottle of fruit juice. Should you accidentally drop that bottle, it's shatter-resistant, it won't break! Plastics also help make portable 'phones, computers or radios really portable. They help domestic appliances such as refrigerators and washing machines resist corrosion, last longer and operate more efficiently. Plastic parts and insulation have helped to improve the energy efficiency of air conditioners by 30 to 50 percent since the early 1970s. This energy saving helps reduce your own electricity bills. And appliances which use plastic run more quietly than designs that use other materials. Finally, plastic car body panels resist bumps and scratches and can be repaired more easily.

Training text 4

Batteries

Energy can be stored in many forms. Batteries, however, do not store electrical charge, they generate electrical current through chemical reactions. In primary cells (or “one time use” batteries), once the chemical reaction has taken place and all the chemicals have been used up, the cell loses its ability to produce energy and is described as ‘flat’. It then has to be discarded and replaced with a fresh battery. Secondary batteries, on the other hand, are “rechargeable”; the chemical reaction that takes place within the cell is reversible and repeatable for perhaps thousands of times depending on the chemistry.

The latest developments in batteries, both primary and rechargeable, have focused on the use of lithium. Lithium is the lightest of all metals, has the greatest electrochemical potential, and provides the most energy. Lithium primary batteries have replaced the alkaline cell in most photo aplications and are better suited to scientific and military uses than any other type.

Attempts to make lithium rechargeable batteries go back to the 1980s. Problems with safety prevented the commercial use of the technology at that time. Finally rechargeable cells that use lithium metal were abandoned and research concentrated on the use of lithium ions found in chemicals like lithium-cobalt dioxide. Since then lithium-ion batteries have become the most popular choice for use in high tech applications such as cellular phones and laptop computers.

Low cost is often thought of as the biggest factor when selecting a battery type. We would all like to see a battery the size of a finger nail with thousands of ampere hours of capacity and be able to download it for free off the Internet. The reality is, however, that many times a higher initial battery cost pays for itself in long term benefits. Low cost is not always best.

As a result of the semiconductor revolution, we have seen a dramatic reduction in the size of portable electronic devices over the last decade. In terms of size reduction, battery development is not as advanced as silicon and batteries are often the largest single component of a portable electric device.

Training text 5

Indoor Air Pollution: A Serious Public Health Problem

We spend most of our time indoors surrounded by sources of air pollution: consumer products, gas appliances, building materials, cigarettes, and furniture can all contribute to the problem. Yet, the toxic emissions from many of these sources are not controlled or are only partially controlled by federal, state, or local laws.

This brochure will tell you about indoor air pollution and what the California Air Resources Board (ARB) is doing about it.

Evaluating the Risk
In a 1987 study, the U.S. Environmental Protection Agency (EPA) ranked indoor air pollution fourth in cancer risk among the 13 top environmental problems analyzed. Indoor radon ranked first. What factors contribute to the high risk from indoor air pollution?

First, people spend most of their time indoors. A recent ARB-sponsored study found that Californians spend an average of 87% of their 24-hour day indoors. If pollutants are present indoors, people will almost certainly inhale them.

Second, indoor air pollutant levels are often higher than those outdoors. Research by the ARB, the EPA, and others has shown that indoor levels of some pollutants, such as formaldehyde, chloroform, and styrene, range from 2 to 50 times higher than outdoor levels. Exposure to pollutants such as environmental tobacco smoke and radon occurs almost entirely indoors. For most of us, the amount of air pollution that we breathe is primarily determined by what is in the indoor air.

What is Indoor Air Pollution?
Indoor air pollution consists of toxic gases or particles that can harm your health. These pollutants can build up rapidly indoors to levels much higher than those usually found outdoors. This is especially true if large amounts of a pollutant are released indoors. Moreover, "tighter" construction in newer homes can prevent pollutants from escaping to the outdoors.

Health Effects
The effects of indoor air pollutants range from short-term effects - eye and throat irritation - to long-term effects - respiratory disease and cancer. Exposure to high levels of some pollutants, such as carbon monoxide, can even result in immediate death. Also, some indoor pollutants can magnify

the effects of other indoor pollutants. Based on cancer risk alone, federal scientists have ranked indoor air pollution as one of the most important environmental problems in the US.

"Sensitive" Groups
Many groups are especially susceptible to the health effects of indoor pollutants. These include infants and the elderly, those with heart and lung diseases, people with asthma, and individuals who have developed extreme sensitivity to chemicals. Unfortunately, these are the people who often spend the most time indoors.

Economic Impacts
The economic impacts of indoor pollution - including health care costs, lost productivity, legal costs, and human welfare impacts - have been estimated at billions of dollars each year.

What Can You Do About Indoor Air Pollution?
The most effective way to protect your family and yourself from indoor air pollution is to prevent or minimize the release of pollutants indoors in the first place.

Use Products Safely
Products such as cleaning agents, paints, and glues should be used outdoors whenever possible. Directions on the label should be followed carefully. If the product must be used indoors, lots of ventilation should be provided. Also, it may be possible to use safer consumer products, such as baking soda instead of harsher cleaners, or products in solid or liquid form rather than aerosol sprays.

Restrict Smoking
Restricting cigarette smoking to outdoor areas is especially important because cigarette smoke contains many toxic pollutants. It is harmful to both smokers and nonsmokers.

Use Appliances Properly
Use gas appliances, wood stoves, and fireplaces only as intended. Gas stoves should never be used to heat the house since high pollutant levels can result. Wood stoves and fireplaces should only be used to burn properly sized and aged wood, since other types of fuel may emit toxic compounds.

These combustion devices pollute less when properly maintained. Annual inspections and cleaning by your gas company's service personnel or by other qualified individuals will help reduce pollution and save energy.

Select Building Materials and Furniture Carefully
Many products, including some types of plywood and particleboard, emit significant amounts of formaldehyde or other gaseous pollutants. Try to avoid those products if possible.

You might request that new carpets or furniture be aired out by the manufacturer or distributor prior to delivery. Otherwise, you may want to air them in your garage or yard before bringing them inside.

Practice Good Housekeeping
Proper storage of solvents and frequent housecleaning to remove dust and molds are necessary steps in maintaining good indoor air quality.

Provide Adequate Ventilation
Adequate ventilation is another easy and effective way to maintain good indoor air quality, although it may not completely remove all pollutants. Increase ventilation by opening windows and doors when the weather permits. This is particularly important when using products or engaging in activities that may generate pollutants. Kitchen and bathroom exhaust fans that are properly vented to the outdoors are very effective at removing pollutants generated during cooking and showering. For effective ventilation while conserving energy during extreme weather, consider installing a heat recovery ventilator.

Training text 6

Galvanizado en caliente y en frio

El galvanizado en caliente se utiliza desde hace más de 100 años para proteger el acero de la corrosión. El recubrimiento protector se produce al sumergir productos de acero en un baño de zinc fundido. La película de zinc que se forma sobre el acero lo protege de dos maneras, protección de barrera y protección galvánico (catódica). Es este último tipo de protección la que permite que productos de acero puedan permanecer sin corrosión durante décadas. Esto se explica porque en presencia de humedad el zinc actúa como ánodo y el acero como cátodo, de manera que el zinc se corroe en una acción de sacrificio y evita que el acero se oxide.

Training text 7

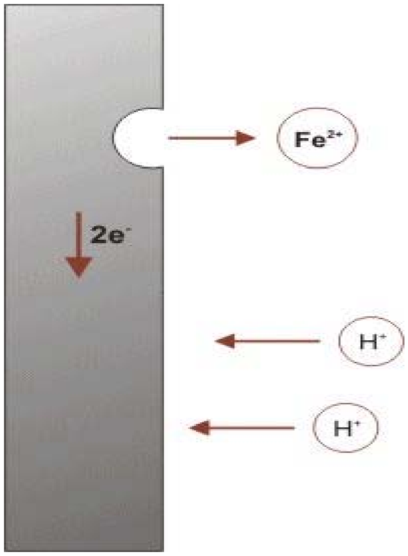
Corrosion theory

Humans have most likely been trying to understand and control corrosion for as long as they have been using metal objects. The most important periods of prerecorded history are named for the metals that were used for tools and weapons (Iron Age, Bronze Age). With a few exceptions, metals are unstable in ordinary aqueous environments. Metals are usually extracted from ores through the application of a considerable amount of energy. Certain environments offer opportunities for these metals to combine chemically with elements to form compounds and return to their lower energy levels.

Corrosion is the primary means by which metals deteriorate. Most metals corrode on contact with water (and moisture in the air), acids, bases, salts, oils, aggressive metal polishes, and other solid and liquid chemicals. Metals will also corrode when exposed to gaseous materials like acid vapors, formaldehyde gas, ammonia gas, and sulfur containing gases.

Corrosion specifically refers to any process involving the deterioration or degradation of metal components. The best known case is that of the rusting of steel. Corrosion processes are usually electrochemical in nature, having the essential features of a battery. When metal atoms are exposed to an environment containing water molecules they can give up electrons, becoming themselves positively charged ions, provided an electrical circuit can be completed. This effect can be concentrated locally to form a pit or, sometimes, a crack, or it can extend across a wide area to produce general wastage. Localized corrosion that leads to pitting may provide sites for fatigue initiation and, additionally, corrosive agents like seawater may lead to greatly enhanced growth of the fatigue crack. Pitting corrosion also occurs much faster in areas where microstructural changes have occurred due to welding operations.

Corrosion is the disintegration of metal through an unintentional chemical or electrochemical action, starting at its surface. All metals exhibit a tendency to be oxidized, some more easily than others. A tabulation of the relative strength of this tendency is called the galvanic series. Knowledge of a metal's location in the series is an important piece of information to have in making decisions about its potential usefulness for structural and other applications.



The corrosion process (anodic reaction) of the metal dissolving as ions generates some electrons, as shown here, that are consumed by a secondary process (cathodic reaction). These two processes have to balance their charges. The sites hosting these two processes can be located close to each other on the metal's surface, or far apart depending on the circumstances. This simple observation has a major impact in many aspects of corrosion prevention and control, for designing new corrosion monitoring techniques to avoiding the most insidious or localized forms of corrosion.

The electrons (**e**$^-$ in this figure) produced by the corrosion reaction will need to be consumed by a cathodic reaction in close proximity to the corrosion reaction itself. The electrons and the hydrogen ions react to first form atomic hydrogen, and then molecular hydrogen gas. If the acidity level is high (low pH), this molecular hydrogen will readily become a gas as it is *demonstrated by exposing a strip of zinc* to a sulfuric acid solution.

As hydrogen forms, it could inhibit further corrosion by forming a very thin gaseous film at the surface of the metal. This "polarizing" film can be effective in reducing water to metal contact and thus in reducing corrosion. Yet it is clear that anything which breaks down this barrier film tends to increase the rate of corrosion. *Dissolved oxygen* in the water will react with the hydrogen, converting it to water, and destroying the film.

High water velocities tend to sweep the film away, exposing fresh metal to the water. Similarly, solid particles in the water can brush the hydrogen film from the metal. Other corrosion accelerating forces include high concentrations of free hydrogen ions (*low pH*) which speed the release of the electrons, and high water temperatures, which increase virtually all chemical reaction, rates. Thus a variety of natural and environmental factors can have significant effects on the corrosion rate of metals, even when no other special conditions are involved.

Training text 8

Galvanic corrosion

Galvanic corrosion (also called ' dissimilar metal corrosion' or wrongly 'electrolysis') refers to corrosion damage induced when two dissimilar materials are coupled in a corrosive electrolyte. It occurs when two (or more) dissimilar metals are brought into electrical contact under water. When a galvanic couple forms, one of the metals in the couple becomes the anode and corrodes faster than it would all by itself, while the other becomes the cathode and corrodes slower than it would alone. Either (or both) metal in the couple may or may not corrode by itself (themselves) in seawater. When contact with a dissimilar metal is made, however, the self corrosion rates will change:

corrosion of the anode will accelerate
corrosion of the cathode will decelerate or even stop.

The driving force for corrosion is a potential difference between the different materials. The bimetallic driving force was discovered in the late part of the eighteenth century by Luigi Galvani in a series of experiments with the exposed muscles and nerves of a frog that contracted when connected to a bimetallic conductor. The principle was later put into a practical application by Alessandro Volta who built, in 1800, the first electrical cell, or battery: a series of metal disks of two kinds, separated by cardboard disks soaked with acid or salt solutions. This is the basis of all modern wet-cell batteries, and it was a tremendously important scientific discovery, because it was the first method found for the generation of a sustained electrical current.

The principle was also engineered into the useful protection of metallic structures by Sir Humphry Davy and Michael Faraday in the early part of the nineteenth century. The sacrificial corrosion of one metal such as zinc, magnesium or aluminum is a widespread method of cathodically protecting metallic structures.

In a bimetallic couple, the less noble material will become the anode of this corrosion cell and tend to corrode at an accelerated rate, compared with the uncoupled condition. The more noble material will act as the cathode in the corrosion cell. Galvanic corrosion can be one of the most common forms of corrosion as well as one of the most destructive.

The relative nobility of a material can be predicted by measuring its corrosion potential. The well known galvanic series lists the relative nobility of certain materials in sea water. A small anode/cathode area ratio is highly undesirable. In this case, the galvanic current is concentrated onto a small anodic area. Rapid thickness loss of the dissolving anode tends to occur under these conditions. Galvanic corrosion problems should be solved by designing to avoid these problems in the first place. Galvanic corrosion cells can be set up on the macroscopic level or on the microscopic level. On the microstructural level, different phases or other microstructural features can be subject to galvanic currents.

Training text 9

Putting it together – composite materials

In an advanced society like ours we all depend on composite materials in some aspect of our lives. Fibreglass, developed in the late 1940s, was the first modern composite and is still the most common. It makes up about 65 per cent of all the composites produced today and is used for boat hulls, surfboards, sporting goods, swimming pool linings, building panels and car bodies. You may well be using something made of fibreglass without knowing it.

What makes a material a composite?
Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite you can easily tell the different materials apart – they do not dissolve or blend into each other.

Composites exist in nature. A piece of wood is a composite, with long fibres of cellulose (a very complex form of starch) held together by a much weaker substance called lignin. Cellulose is also found in cotton and linen, but it is the binding power of the lignin that makes a piece of timber much stronger than a bundle of cotton fibres.

Not a new idea
Humans have been using composite materials for thousands of years. Take mud bricks for example. A cake of dried mud is easy to break by bending, which puts a tension force on one edge, but makes a good strong wall, where all the forces are compressive. A piece of straw, on the other hand, has a lot of strength when you try to stretch it but almost none when you crumple it up. But if you embed pieces of straw in a block of mud and let it dry hard, the resulting mud brick resists both squeezing and tearing and makes an excellent building material. Put more technically, it has both good compressive strength and good tensile strength.

Another well-known composite is concrete. Here aggregate (small stones or gravel) is bound together by cement. Concrete has good strength under compression, and it can be made stronger under tension by adding metal rods, wires, mesh or cables to the composite (so creating reinforced concrete).

Making a composite
Most composites are made up of just two materials. One material (the matrix or binder) surrounds and binds together a cluster of fibres or fragments of a much stronger material (the reinforcement). In the case of

mud bricks, the two roles are taken by the mud and the straw; in concrete, by the cement and the aggregate; in a piece of wood, by the cellulose and the lignin. In fibreglass, the reinforcement is provided by fine threads or fibres of glass, often woven into a sort of cloth, and the matrix is a plastic.

The threads of glass in fibreglass are very strong under tension but they are also brittle and will snap if bent sharply. The matrix not only holds the fibres together, it also protects them from damage by sharing any stress among them. The matrix is soft enough to be shaped with tools, and can be softened by suitable solvents to allow repairs to be made. Any deformation of a sheet of fibreglass necessarily stretches some of the glass fibres, and they are able to resist this, so even a thin sheet is very strong. It is also quite light, which is an advantage in many applications.

Over recent decades many new composites have been developed, some with very valuable properties. By carefully choosing the reinforcement, the matrix, and the manufacturing process that brings them together, engineers can tailor the properties to meet specific requirements. They can, for example, make the composite sheet very strong in one direction by aligning the fibres that way, but weaker in another direction where strength is not so important. They can also select properties such as resistance to heat, chemicals, and weathering by choosing an appropriate matrix material.

Choosing materials for the matrix
For the matrix, many modern composites use thermosetting or thermosoftening plastics (also called resins). (The use of plastics in the matrix explains the name 'reinforced plastics' commonly given to composites). The plastics are polymers that hold the reinforcement together and help to determine the physical properties of the end product.

Thermosetting plastics are liquid when prepared but harden and become rigid (ie, they *cure*) when they are heated. The setting process is irreversible, so that these materials do not become soft under high temperatures. These plastics also resist wear and attack by chemicals making them very durable, even when exposed to extreme environments.

Thermosoftening plastics, as the name implies, are hard at low temperatures but soften when they are heated. Although they are less commonly used than thermosetting plastics they do have some advantages, such as greater fracture toughness, long shelf life of the raw material, capacity for recycling and a cleaner, safer workplace because organic solvents are not needed for the hardening process.

Ceramics, carbon and metals are used as the matrix for some highly specialised purposes. For example, ceramics are used when the material is going to be exposed to high temperatures (eg, heat exchangers) and carbon is used for products that are exposed to friction and wear (eg, bearings and gears).

Choosing materials for the reinforcement

Although glass fibres are by far the most common reinforcement, many advanced composites now use fine fibres of pure carbon. Carbon fibres are much stronger than glass fibres, but are also more expensive to produce. Carbon fibre composites are light as well as strong. They are used in aircraft structures and in sporting goods (such as golf clubs), and increasingly are used instead of metals to repair or replace damaged bones. Even stronger (and more costly) than carbon fibres are threads of boron.

Polymers are not only used for the matrix, they also make a good reinforcement material in composites. For example, Kevlar is a polymer fibre that is immensely strong and adds toughness to a composite. It is used as the reinforcement in composite products that require lightweight and reliable construction (eg, structural body parts of an aircraft). Composite materials were not the original use for Kevlar – it was developed to replace steel in radial tyres and is now used in bulletproof vests and helmets.

Choosing the manufacturing process

Making an object from a composite material usually involves some form of mould. The reinforcing material is first placed in the mould and then semi-liquid matrix material is sprayed or pumped in to form the object. Pressure may be applied to force out any air bubbles, and the mould is then heated to make the matrix set solid.

The moulding process is often done by hand, but automatic processing by machines is becoming more common. One of the new methods is called pultrusion (a term derived from the words 'pull' and 'extrusion'). This process is ideal for manufacturing products that are straight and have a constant cross section, such as bridge beams.

In many thin structures with complex shapes, such as curved panels, the composite structure is built up by applying sheets of woven fibre reinforcement, saturated with the plastic matrix material, over an appropriately shaped base mould. When the panel has been built to an appropriate thickness, the matrix material is then cured.

In many advanced composites (such as those used in the wing and body panels of aircraft), the structure may consist of a honeycomb of plastic sandwiched between two skins of carbon-fibre reinforced composite material. Such sandwich composites combine high strength, and particularly bending stiffness, with low weight. Like everything to do with aircraft, they can be very costly!

So why use composites?
The greatest advantage of composite materials is strength and stiffness combined with lightness. By choosing an appropriate combination of reinforcement and matrix material, manufacturers can produce properties that exactly fit the requirements for a particular structure for a particular purpose.

Modern aviation, both military and civil, is a prime example. It would be much less efficient without composites. In fact, the demands made by that industry for materials that are both light and strong has been the main force driving the development of composites. It is common now to find wing and tail sections, propellers and rotor blades made from advanced composites, along with much of the internal structure and fittings. The airframes of some smaller aircraft are made entirely from composites, as are the wing, tail and body panels of large commercial aircraft.

In thinking about planes, it is worth remembering that composites are less likely than metals (such as aluminium) to break up completely under stress. A small crack in a piece of metal can spread very rapidly with very serious consequences (especially in the case of aircraft). The fibres in a composite act to block the widening of any small crack and to share the stress around.

The right composites also stand up well to heat and corrosion. This makes them ideal for use in products that are exposed to extreme environments such as boats, chemical-handling equipment and spacecraft. In general, composite materials are very durable.

Another advantage of composite materials is that they provide design flexibility. Composites can be moulded into complex shapes – a great asset when producing something like a surfboard or a boat hull.

The downside of composites is usually the cost. Although manufacturing processes are often more efficient when composites are used, the raw materials are expensive. Composites will never totally replace traditional materials like steel, but in many cases they are just what we need. And no doubt new uses will be found as the technology evolves. We haven't yet seen all that composites can do.

Training text 10

Introduction to materials selection

From a purely technical standpoint, an obvious answer to corrosion problems would be to use more resistant materials. In many cases, this approach is an economical alternative to other corrosion control methods. Corrosion resistance is not the only property to be considered in making materials selection but it is of major importance in the chemical process industries.

The choice of a material is the result of several compromises. For example, the technical appraisal of an alloy will generally be a compromise between corrosion resistance and some other properties such as strength and weldability. And the final selection will be a compromise between technical competence and economic factors. In specifying a material, the task usually requires three stages:

- Listing the requirements
- Selecting and evaluating the candidate material
- Choosing the most economic material.

The materials selection process is also influenced by the fact that the materials are either considered for the construction of a new system, or for the modification or repairs in an existing facility. For the construction of new equipment, the selection procedure should begin as soon as possible and before the design is finalized.

The optimum design for corrosion resistance will often vary with the material used. In a repair application, there is usually less opportunity for redesign, and the principal decision factors will be centered on delivery time and ease of fabrication in the field. It is also advisable to estimate the remaining life of the equipment so that the repair is not over-designed in terms of the corrosion allowance.

Mechanical Properties of Engineering Materials
The selection criteria used by materials engineers in choosing from a group of materials includes a list of qualities that are either desirable or necessary. Unfortunately, the optimum properties associated with each selection criteria can seldomly be all found in a single material, especially when the operating conditions become aggressive.

Most chemical process equipment is designed and fabricated to the requirements of specific pressure vessel and piping codes. These codes include only approved materials and establish the basis for and the setting of allowable stresses. Thus, the mechanical properties of a material are usually the first criteria that materials engineers apply in the selection process. This is especially important for applications at temperatures in the creep range where a minor difference in operating temperature can significantly affect the load carrying ability of the material.

Materials Fabrication

There are many outstanding materials with highly desirable mechanical properties and corrosion resistance that are seldom used because they cannot be fabricated. There are some materials which have excellent properties that can be fabricated as produced but, because of aging, cannot be modified or repaired after exposure to operating conditions. Materials should therefore be selected on the basis of their maintainability as well as their original fabricability. In general, the wrought heat resistant alloys have greater fabricability than the cast materials. Cast alloy steels, for example, can typically tolerate significantly higher concentrations of carbon, silicon, tungsten, molybdenum, etc., which are added to enhance mechanical properties, corrosion resistance, or both. But, these elements also can adversely affect the original, as-produced fabricability and make maintainability, particularly weldability, difficult, if not impossible.

In materials processing, parts are manufactured from a variety of materials to meet defined product specifications. The ever increasing concerns with performance and cost faced by companies competing in the global marketplace require that a spectrum of issues in the science of manufacturing be addressed. Innovations and improvements in the processing of materials result from advances in the fundamental understanding of the relationships between the process, the material, and the resulting product. Novel processing methodologies or the processing of new materials can open up opportunities for new product development, for research leading to next-generation machines and/or improvements in product performance and cost. The advances being made in rapid prototyping, thin film and nanotechnologies, and net shape manufacturing are illustrations of the application of fundamental research to materials processing issues.

Availability of Materials

Materials engineers and purchasing agents become frustrated in trying to obtain materials that have a limited number of producers or a limited production volume. Such frustration can be particularly high when a small amount of material is needed to finish a job or replace a failed piece. Prior to the original specification of a material, consideration should be given to its future availability for repairs or replacement in the form or forms that it will be used. In those cases where it might not be available, alternative replacement materials should be identified.

Materials Cost
Economics enter into every business decision. But, the important criteria should not be the initial cost of a material, but its life-cycle cost or cost effectiveness. It usually is much more cost effective to specify a material that will provide an extended life, particularly in areas that are difficult to repair or in components that would cause major shut-downs in case of failure. The following two extreme alternatives describe the consideration given to economic factors when selecting materials for specific service:

· A low initial cost system largely based on carbon steel and cast iron which will require considerable maintenance over the life of the plant. Such a system is a reasonable choice in areas where labor costs are low and material is readily available.

· A system based mainly on alloy materials which, if correctly designed and fabricated, will require minimum maintenance and will function reliably. Rising labor costs in most industries, together with the need for high reliability in capital intensive plant has produced a trend to this type of system.

In practice many systems are a mixture of these extreme options resulting in the high initial costs of one and the high maintenance costs of the other.

Appendix E3: Details of the target texts.

Target text	No. of words	Source
Composite Materials in Aviation	512	Adapted from: <http://www.centennialofflight.gov/essay/ Evolution_of_Technology/composites/Tech40.htm>
Electrical Power Supply and Distribution Subsystems	1059	Adapted from: <http://www2.jpl.nasa.gov/basics/bsf11-3.html>

Appendix E3. Details of the target texts.

Appendix E4: Target texts and questions

Target text 1

Composite Materials in Aviation

Composites are the most important materials to be adapted for aviation since the use of aluminum in the 1920s. Composites are materials that are combinations of two or more organic or inorganic components. One material serves as a "matrix", which is the material that holds everything together, while the other material serves as a "reinforcement", in the form of fibers embedded in the matrix. Until recently, the most common matrix materials were thermosetting materials such as epoxy, bismaleimide, or polyimide. The reinforcing materials can be glass fiber, boron fiber, carbon fiber, or other more exotic mixtures.

Fiberglass is the most common composite material, and consists of glass fibers embedded in a resin matrix. Fiberglass was first used in the Boeing 707 passenger jet in the 1950s, where it comprised about two percent of the structure. By the 1960s, other composite materials became available, in particular boron fiber and graphite, embedded in epoxy resins.

The greatest value of composite materials is that they can be both lightweight and strong. However, despite their strength and low weight, composites have not been a miracle solution for aircraft structures. Composites are hard to inspect for defects. Some of them absorb moisture. Most importantly, they can be expensive, primarily because they are labor intensive and often require complex and expensive fabrication machines. Aluminum, by contrast, is easy to manufacture and repair.

Modern airliners use significant amounts of composites to achieve lighter weight. About ten percent of the structural weight of the Boeing 777, for instance, is composite material. Modern military aircraft use composites for at least a third of their structures, and some experts have predicted that future military aircraft will be more than two-thirds composite materials. But for now, military aircraft use substantially greater percentages of composite materials than commercial passenger aircraft primarily because of the different ways that commercial and military aircraft are maintained.

Aluminum is a very tolerant material and can take a great deal of punishment before it fails. It can be dented or punctured and still hold together. Composites are not like this. If they are damaged, they require immediate repair, which is difficult and expensive. An airplane made entirely from aluminum can be repaired almost anywhere. This is not the case for composite materials, particularly as they use different and more exotic materials. Because of this, composites will probably always be used more in military aircraft, which are constantly being maintained, than in commercial aircraft, which have to require less maintenance.

Aluminum still remains a remarkably useful material for aircraft structures and metallurgists have worked hard to develop better aluminum alloys (a mixture of aluminum and other materials). In particular, aluminum-lithium is the most successful of these alloys. It is approximately ten percent lighter than standard aluminum. Its adoption by commercial aircraft manufacturers has been slow, however, due to the expense of lithium and the greater difficulty of using aluminum-lithium (in particular, it requires much care during welding). But it is likely that aluminum-lithium will eventually become a widely used material for both commercial and military aircraft.

Source: adapted from
<http://www.centennialofflight.gov/essay/Evolution_of_
Technology/composites/Tech40.htm>
Date retrieved: 15 July 2004
Nº of words = 512

Text 1 Comprehension questions

Instructions

Answer the questions as completely and as fully as you can. Each question carries 0-3 marks, so the more fully you answer the more marks you'll get. You may answer in Spanish if you prefer. Do not copy from the text and do not translate from the text. Use your own words.

1. What is the main advantage of composite materials?

2. The aviation industry has been one of the driving forces behind the development of composite materials. Why do you think this is?

3. What are some of the problems with manufacturing composites?

4. Composite materials have many advantages over metals. Why is aluminium still being researched and developed for use in aircraft structures?

5. How can composite materials be manipulated in order to obtain specific properties?

6. Was fibreglass first used in a military or a commercial aeroplane?

7. Why do aircraft designers want their planes to be as light as possible?

8. Aluminium was first used for aircraft in the 1920s. What material(s) were used before aluminium?

9. Why aren't composite materials used more in commercial aircraft?

10. Despite the greater cost and greater difficulties of working with aluminum-lithium, why do you think this material will become more widely used in aircraft structures?

11. Some composite materials absorb moisture. Why is this a problem?

Target text 2

Electrical Power Supply and Distribution Subsystems

On today's interplanetary spacecraft, roughly between 300 W and 2.5 kW of electrical power is required to supply all the computers, radio transmitters and receivers, motors, valves, data storage devices, instruments, hosts of sensors, and other devices. The Cassini spacecraft, for example, uses roughly 1 kW. A power supply for an interplanetary spacecraft must provide a large percentage of its rated power over a lifetime measured in years or decades.

How does a spacecraft meet these demanding electrical power needs? Choices of technology to meet these requirements are today constrained largely to two: photovoltaics (PV) and radioisotope thermoelectric generators (RTGs). Battery power is an option for use only on short-lived missions such as the Galileo or Huygens atmospheric-entry probes.

Future interplanetary missions of the Prometheus Project, including JIMO, the Jupiter Icy Moons Orbiter, are planning to use nuclear fission reactors to produce hundreds of times more electrical power than today's spacecraft, to supply ion propulsion engines, powerful radar sensors and other components.

Photovoltaics
As the term suggests, photovoltaic materials have the ability to convert light directly to electricity. An energy conversion efficiency of about 29% was achieved in July 2000, and gains of a few more percent may be possible over the next decades. Crystalline silicon and gallium arsenide are typical choices of materials for deep-space applications. Gallium arsenide crystals are grown especially for photovoltaic use, but silicon crystals are available in less-expensive standard ingots which are produced mainly for consumption in the microelectronics industry.

When exposed to direct sunlight at 1 AU, a current of about one Ampere at 0.25 volt can be produced by a 6 cm diameter crystalline silicon solar cell. Gallium arsenide is notably tougher and more efficient. Amorphous silicon, less expensive and less efficient than crystalline, is employed in ultra-thin layers for residential and commercial PV applications.

To manufacture spacecraft-grade solar cells, crystalline ingots are grown and then sliced into wafer-thin discs, and metallic conductors are deposited onto each surface: typically a thin grid on the sun-facing side and a flat sheet on the other. Spacecraft solar panels are constructed of these cells trimmed into appropriate shapes and cemented onto a substrate, sometimes with protective glass covers. Electrical connections are made in series-parallel to determine total output voltage. The resulting assemblies are called solar panels, PV panels, or solar arrays. The cement and the substrate must be thermally conductive, because in flight the cells absorb infrared energy and can reach high temperatures, though they are more efficient when kept to lower temperatures.

Farther than about the orbit of Mars, the weaker sunlight available to power a spacecraft would require panels larger than practicable because of the increased launch mass and the difficulty in supporting, deploying, and articulating them. The Hubble Space Telescope, and most other Earth-orbiters use solar power.

Solar panels typically have to be articulated to remain at optimum sun point, though they may be off-pointed slightly for periods when it may be desirable to generate less power. Spinning spacecraft may have solar cells on all sides that can face the Sun. Prolonged exposure to sunlight causes photovoltaics' performance to degrade in the neighborhood of a percent or two per year, and more rapidly when exposed to particle radiation from solar flares.

In addition to generating electrical power, solar arrays have also been used to generate atmospheric drag for aerobraking operations.

Radioisotope Thermoelectric Generators
Radioisotope thermoelectric generators (RTGs) are used when spacecraft must operate at significant distances from the sun where the availability of sunlight, and therefore the use of solar arrays, is otherwise infeasible. RTGs as currently designed for space missions contain several kilograms of an isotopic mixture of the radioactive element plutonium in the form of an oxide, pressed into a ceramic pellet. The primary constituent of these fuel pellets is the plutonium isotope 238 (Pu-238). The pellets are arranged in a converter housing where they function as a heat source to generate the electricity provided by the RTG. The natural radioactive decay of the plutonium produces heat (RTGs do not use fission or fusion), some of which is converted into electricity by an array of thermocouples made of silicon-germanium junctions. An RTG uses no moving parts to create electricity. Waste heat is radiated into space from an array of metal fins.

Plutonium, like all radioactive materials and many non-radioactive materials, can be a health hazard under certain circumstances and in sufficient quantity. RTGs are designed, therefore, with the goal of surviving credible launch accident environments without releasing plutonium. The safety design features of RTGs are tested to verify the survival capabilities of the devices.

Since they remain thermally hot, RTGs present advantages and disadvantages. The Cassini spacecraft employs much of its RTGs' radiant heat inside its thermal blanketing, to warm the spacecraft and propellant tanks. On the other hand, RTGs must be located on the spacecraft in such a way to minimize their impact on infra-red detecting science instruments. Galileo's RTGs are mounted behind shades to hide the near-infrared mapping spectrometer from their radiant heat. Shades are used on Cassini for similar reasons.

RTGs performance degrades in flight about one to two percent per year, slightly faster degradation than for photovoltaics.

Electrical Power Distribution

Virtually every electrical or electronic component on a spacecraft may be switched on or off via command. This is accomplished using solid-state or mechanical relays that connect or disconnect the component from the common distribution circuit, called a main bus. On some spacecraft, it is necessary to power off some set of components before switching others on in order to keep the electrical load within the limits of the supply. Voltages are measured and telemetered from the main bus and a few other points in the electrical system, and currents are measured and telemetered for many individual spacecraft components and instruments to show their consumption.

Electrical Power Storage

Spacecraft which use photovoltaics usually are equipped with rechargeable batteries that receive a charge from the main bus when the solar panels are in the sunlight, and discharge into the bus to maintain its voltage whenever the solar panels are shadowed by the planet or off-pointed during spacecraft maneuvers. Nickel-cadmium (Ni-Cad) batteries are frequently used. After hundreds of charge-discharge cycles, this type of battery degrades in performance, but may be rejuvenated by carefully controlled deep discharge and recharge, an activity called reconditioning.

Source: adapted from: <http://www2.jpl.nasa.gov/basics/bsf11-3.html>
Date retrieved: 16 July 2004
Words = 1059

Text 2 Comprehension questions

<u>Instructions</u>

Answer the questions as completely and as fully as you can. Each question carries 0-3 marks, so the more fully you answer the more marks you'll get. You may answer in Spanish if you prefer. Do not copy from the text and do not translate from the text. Use your own words.

1. What can happen if a solar panel becomes too hot?

2. What are the factors that can cause photovoltaic cells to lose their capacity to convert light into electricity?

3. Apart from supplying power, what other function can solar panels have?

4.How is the heat produced by Cassini's RTG used?

5. What are the differences between the silicon used for deep space applications and that used in a solar cell for a house.

6. What kind of power system will interplanetary spacecraft use in the future?

7. Solar cells are cemented onto a substrate. Why is it important that both the cement and the substrate can conduct heat?

8. Why should solar panels not exceed a certain size?

9. If you were designing a spacecraft to explore the moons around the planet Neptune, what currently available power system would you choose and why?

Appendix E5: Performance criteria

Text 1. Composite materials in aviation

1. What is the main advantage of composite materials?

	Subject No.					
Q. 1	1	2	3	4	5	etc
lightness						
Strength						
can be given specific properties						

2. The aviation industry has been one of the driving forces behind the development of composite materials. Why do you think this is?

Q. 2	1	2
Aircraft need materials which are: strong		
light		
to develop/improve materials		
lighter so less fuel		
more profit for company		
military reasons		

3. What are some of the problems with manufacturing composites?

Q. 3	1	2
Expensive		
labour intensive		
require complex and expensive machinery		
raw matrials are expensive		
X hard to detect defects		
X absorb moisture		
X repair is difficult		

4. Composite materials have many advantages over metals. Why is aluminium still being researched and developed for use in aircraft structures?

Q. 4	1	2
Because al is easier to repair		
easier to manufacture		
cheaper		
tolerant/resistant		
useful properties		
requires less maintenance		
alloy has advantages		

5. How can composite materials be manipulated in order to obtain specific properties?

Q. 5	1	2
selecting the materials used		
varying the % of each material		
alignment of fibres		
fabrication process		
X alloys		

6. Was fibreglass first used in a military or a commercial aeroplane?

Q. 6	1	2
commercial		
military		

7. Why do aircraft designers want their planes to be as light as possible?

Q. 7	1	2
They will require less fuel		
faster/more speed		
bigger payloads		
easier to manoeuver/fly		
cheaper running costs		
companies earn more profit		

8. Aluminium was first used for aircraft in the 1920s. What material(s) were used before aluminium?

Q. 8	1	2
steel		
wood		
fabric/cloth		
other metals		

9. Why aren't composite materials used more in commercial aircraft?

Q. 9	1	2
composites harder to repair		
hard to inspect for defects		
more costly to maintain		
military requires more maintenance		
commercial needs less maintenance		

10. Despite the greater cost and greater difficulties of working with aluminium-lithium, why do you think this material will become more widely used in aircraft structures?

Q. 10	1	2
comps have several problems		
not a miracle solution		
aluminium still useful		
aluminium-lith – 10% lighter		

11. Some composite materials absorb moisture. Why is this a problem?

Q. 11	1	2
can cause corrosion		
extra weight		
damage the structure		
and repair is difficult		

Text 2. Electrical Power Supply and Distribution Subsystems

1. What can happen if a solar panel becomes too hot?

Q. 1	1	2
panel becomes less efficient		

2. What are the factors that can cause photovoltaic cells to lose their capacity to convert light into electricity?

Q. 2	1	2
overheating		
prolonged exposure to sunlight		
exposure to particle radiation from solar flares		
panels not set at optimum		
poor materials/connections		

3. Apart from supplying power, what other function can solar panels have?

Q. 3	1	2
aerobraking and drag		

4. How is the heat produced by Cassini's RTG used?

Q. 4	1	2
to warm the spacecraft and propellant tanks		
for generating electricity		
(waste heat into space)		
X "radiant heat inside thermal blanketing"		

5. What are the differences between the silicon used for deep space applications and that used in a solar cell for a house?

Q. 5	1	2
silicon used for houses is less efficient		
less expensive		
less tough		
space - crystalline silicon		
space - gallium arsenide		
house – amorphous silicon		

6. What kind of power system will interplanetary craft use in the future?

Q. 6	1	2
nuclear fission reactors		
X ion propulsion		

7. Solar cells are cemented onto a substrate. Why is it important that both the cement and the substrate can conduct heat?

Q. 7	1	2
to conduct heat away from the solar panels		
cells absorb infra-red		

8. Why shold solar panels not exceed a certain size?

Q. 8	1	2
because of difficulties in supporting / deploying / articulating the panels		
increased size = increased mass at launch – heavier		
over certain size < efficient		
more expensive		

9. If you were designing a spacecraft to explore the moons around the planet Neptune, what currently available power system would you choose and why?

Q. 9	1	2
RTGs		
X photovoltaics		
X nuclear fission		
X battery		
X mixture		

Appendix E6: The possible number of items of information versus the actual number of items identified.

Tables E.6a and E6b show, respectively, the number of relevant items possible according to the Performance Criteria which had been established. The 'Max. nº. of correct items per question' row shows the maximum number of relevant items identified by the researcher and his colleague for each question. Thus for Question 1 of Text 1, for example, there were three acceptable answers which could be given. For Question 6, only one correct answer was possible (see the Performance Criteria in Appendix E5). The 'Maximum nº. of correct items per question x 26' row shows the maximum number of correct and relevant answers possible for each question multiplied by the number of students in each group (26).

All the questions for Target Text 1 could be answered with several pieces of both relevant and irrelevant information with the exception of Question 6: according to the information in the text, there was only one correct answer to this question with no correct alternatives in the text. With respect to Target Text 2, according to the information in the text there was only one correct answer to each of Questions 1, 3, 6 and 9, although only the answer to Q3 was stated in an obviously explicit way. To answer the remaining three questions correctly; that is, to satisfy the conditions for a correct answer established by the Performance Criteria, some degree of interpretation was needed. The reader had to understand the situation described in the text in order to be able to select the correct alternative from among the several possibilities contained in the text.

What the Tables show is that the student L2 readers in fact identified less than half (47%) of the information identified by the two expert readers.

Text 1 Week 7	Questions											
Group	1	2	3	4	5	6	7	8	9	10	11	*Total*
Max. nº. correct items/ question	*3*	*6*	*5*	*7*	*4*	*1*	*6*	*4*	*5*	*4*	*4*	
Max nº. items / question x 26	78	156	130	182	104	26	156	104	130	104	104	*1274*
NTG	56	55	60	80	39	26	65	38	57	42	40	*558*
AQG	49	41	49	63	31	26	43	25	45	34	28	*434*
CG	39	37	52	51	14	26	38	23	28	23	17	*348*

Table E6a. Text 1, Week 7: Maximum number of relevant items possible plus the total number of relevant items mentioned for each question by group.

Text 2 Week 7	Question Nº.									
Group	1	2	3	4	5	6	7	8	9	*Total*
Max. nº. of correct items per question	*1*	*5*	*1*	*3*	*6*	*1*	*1*	*4*	*1*	
Max. nº. of items per question x 26	26	130	26	78	156	26	26	104	26	*598*
NTG	26	50	25	31	79	24	23	44	20	*322*
AQG	26	42	25	18	73	24	14	37	20	*279*
CG	26	21	21	13	44	20	6	36	18	*205*

Table E6b. Text 2, Week 7: Maximum number of relevant items possible plus the total number of relevant items mentioned for each question by group.