Imperial College London

The Application of Computer-Assisted Translation Tools to the Teaching of Scientific and Technological Translation

English to Chinese

Ping He

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Abstract

This research project investigates the function and potentiality of translation technology – including computer assisted translation tools, electronic corpora and internet search engines – in the teaching of scientific and technological translation. English into Chinese is the language pair under discussion in this study.

The research is conducted on the basis of empirical methodology, which in this particular case consists of the following procedures: discussing and highlighting the key features of scientific and technological texts; analysing the ways in which translation technology are used in the teaching of translation; positing hypotheses on how the training in the use of translation technology influences the student's ability to translate; conducting experiments with control and experimental groups in order to test the validity of these hypotheses.

The author designed and implemented a controlled experiment on two groups of Master's students of Translation, in which the experimental group was trained with access to computer-assisted translation tools while the control group was not. Before their training, a translation test was given to students from both groups so as to define their level of translation competence at that time. Afterwards, the experimental group was trained with access to computer-assisted translation tools for four months, while the control group was not exposed to such training. On finishing the training, the students from both groups sat another test which was of approximately the same difficulty as the first test. In addition, a questionnaire was attached to each of the two tests in order to understand the factors behind the students' performance. The scores obtained for both tests were collected and analysed across horizontal and longitudinal dimensions, with the horizontal analysis comparing the scores of the same test between the two groups and the longitudinal analysis comparing the scores of the two tests done by the same group. The horizontal analysis yielded two major and some minor findings, while the longitudinal analysis led to three major and two minor findings.

The ultimate purpose of the thesis is to investigate the impact of translation technology training on the students' translation competence when dealing with scientific and technological texts.

Declaration of Originality

I, Ping He, declare that this thesis is my own work and is based on the research that I conducted during 2009-2014. It has not been submitted in any form for another degree or diploma at any university. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given in the bibliography

Copyright Declaration

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Chapter One

Introduction

1.1 Background for the current study

Traditionally, translation has been roughly divided into general translation and specialized translation, with the latter being defined in opposition to literary translation and covering specialist fields such as science and technology, industry, commerce, economics, finance, law, politics, media and press among others.

Early Translation Studies (TS) are concerned mainly with literary translation, whereas other areas such as technical and scientific translation are regarded as less demanding, inferior forms of mechanical translation (Snell-Hornby, 1998). With the development of computers and the internet as a fast way for communication, globalization has brought along an increasing number of international exchanges and cooperation in scientific, technological and commercial activities. Accordingly, the emphasis of TS seems to be shifting to the transfer of specialist knowledge by translators (Mayer, 2003). Among the specialist areas attracting the attention of the scholars, the translation of science and technology has become one of the most frequently discussed topics (Wright & Wright, 1993; Franco Aixelá, 2009) and technical translation has also become a popular term in TS (Hann, 1992; Merkel, 1998; Kingscott, 1996; Franco Aixelá, 2009; Byrne, 2012). Most research done on the topic tends to combine both areas and be referred to as ‘scientific and technical translation’, like

Pinchuck's (1977) *Scientific and Technical Translation*, and Byrne's (2012) *Scientific and Technical Translation Explained: A Nuts and Bolts Guide for Beginners*. On occasions, technical translation seems to be used as an inclusive term for the translation of any documents that are related to science and/or technology (Byrne, 2006), although, *stricto sensu*, the expression can only refer to the translation of practical documents, such as the manual, configuration, specification or presentation of an commercial product.

First of all, it is necessary to make a clear distinction between scientific and technological translation and technical translation. As defined by the *Encyclopaedia Britannica* (2009) science is "any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation". The same work defines technology as "a discourse or treatise on an art or arts; and scientific study of the practical or industrial arts collectively". In other words, science is concerned with understanding, describing, and explaining the nature of the universe whilst technology is concerned with how to design, operate, and control machines, devices and instruments. In this sense, they both adopt systematic approaches in their endeavours, aim at finding a theory that explains certain events, and are branches of knowledge that belong to the academic domain. The *Oxford Dictionary of English* (2010) defines technique as "a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure". Technique is associated with doing things rather than with coming up with theories able to explain how to do things. Accordingly, technical services are concerned with how to construct, use, maintain, or even promote and sell a specific machinery or device (Strevens, 1973), and, thus, belong to the industrial domain. From this perspective, it can be concluded that scientific and technological translation refers to the

translation of academic and scholastic documentation focused on science and technology such as science text books and journal articles; whereas technical translation is concerned with the translation of practical, industrial and mechanical texts pertaining to science and technology, such as manuals, configurations and specifications of a machinery or device.

Much emphasis seems to have been put on the study of technical translation, while scientific and technological translation seems to have been less frequently discussed in academic circles. I would argue that one of the reasons for this imbalance may lie in the fact that society as a whole tends to lean towards pragmatism. Pragmatists emphasize the practical function of knowledge as an instrument for adapting to reality and controlling it. Under this light, technical translation is more about practical translation, such as how to make a machine and how to use it. The high market demand for this type of translation, together with the commercial and industrial profit it generates, seem to be some of the main factors in attracting professionals to embark on the practice of technical translation and its scholarly study. On the other hand, scientific-technological translation concentrates on transferring pure academic knowledge from one culture to another. Despite the paradoxically little research conducted in this field, it can be argued that the communication and exchange of scientific and technological ideas and knowledge is crucial in today's society, where the transfer of information is so essential. I would like to suggest that more effort needs to be put into the study of scientific and technological translation as well as into the training of translators who will specialize in this kind of texts.

In the past decades, conventional translator training programmes, many of which are designed for undergraduate and postgraduate students, have taught students the skills

needed to become a general translator, while few programmes have focused on training the students in a way specifically designed to target the needs of a particular subject, profession, or occupation. Books concerned with the training of translators, such as Gouadec's (2007) and Kelly's (2005), contain very detailed information about numerous aspects of translation: definition of translation, translation processes, how to become a translator, the professional environment, the academic curricula, and so on. But, still, very limited research has been conducted on the training of scientific and technological translators and the curricula that should be covered.

Nowadays, translator training faces new challenges and opportunities as information and communication technologies are revolutionizing the way we communicate and, consequently, the translation profession. This has been a basic skill required of translators to be competent with computers, conversant with new technologies and skilled in the use of the internet in order to access information and to help them in the translation process (Austermühl, 2001). Likewise, computers and the internet also play an increasingly important role in translator training when it comes to corpora-based approaches, an area that has attracted much attention in scholarly debates (Baker, 1995; Laviosa, 2002; Ji, 2010). Nonetheless, there is little research on the value and potential of computer-assisted translation tools and internet search engines on translator training. This is why the study of the role that computerized language tools may have in the teaching and training of translators needs to be further probed.

To summarize, this research project intends to investigate the function and potentiality of computerized language tools – including computer assisted translation tools, electronic

corpora and internet search engines – in the teaching of scientific and technological translation. English into Chinese is the main language pair under discussion in this study.

1.2 Research aims and procedures

The main purpose of the research is to find out whether the application of translation technology in the early stage of the MSc of Translation program can influence the students' translation competence when working on the translation of scientific and technological texts and, if so, how.

This research adopts an empirical approach and is based on an experiment that compares the translational performance of two different groups of Master's students, before and after a four-month period of training. The experimental group will be trained in the use of computer assisted translation tools (CAT tools) during the first four months of their studies, while the control group will not have this type of training. It has been decided to focus on computer assisted translation tools, among many other computerized language tools, so that the variables and parameters are manageable in the data collection and analysis stages. The main reason for this decision is that the author found the use of corpora was not integrated into the training program of either the experimental or the control group.

Focusing on the translation of scientific and technological texts, the two groups of students will take a first test before the four-month training starts so as to define their translation ability at that moment. Afterwards, they will undergo a four-month period of translation

training, during which time the experimental group will be trained in the use of CAT tools, while the control group will not be trained in this area. After the four months, both groups of students will take a second test, also dealing with the translation of texts from the scientific and technological domains, so as to gauge their translation ability after the training. Comparisons will be done between the two groups' performances and conclusions will be reached in terms of whether the experimental group have made more or less improvement than the control group, and whether any difference in their improvement can be said to be significant enough to justify the inclusion of computerized language tools in the very early stages of translator training programmes focused on scientific and technological texts.

This research consists of the following eight phases:

1. discussion and highlighting of the key features of English scientific-technological texts;
2. discussion and highlighting of the key features of Chinese scientific-technological texts;
3. discussion and exemplification of the strategies normally used to deal with the translation of these key features when working from English into Chinese;
4. review of the extant literature on the role and potential of computerized language tools – i.e. CAT tools, electronic corpora and internet search engines – in the training of scientific-technological translators in particular;
5. design and implementation of the experiment with two groups of Master's students;
6. collection and statistical analysis of the data obtained;
7. scrutiny and discussion of the results; and

8. conclusion on the contribution made by this study towards research and suggestions for further research.

1.3 Thesis outline

This thesis consists of six chapters. Chapter One introduces the background for this research, specifies the main objectives, and lists the methodological steps to be followed.

Chapter Two starts by clarifying the concept of scientific and technological translation, differentiating it from that of technical translation. The features that characterise English and Chinese scientific and technological texts are then analysed and the various translation strategies used to deal with the transfer of these features from English into Chinese are discussed. To illustrate the various strategies, examples from real practice are provided.

Chapter Three elaborates some translation technology, including computer-assisted translation tools, electronic corpora, and internet search engines. The author then defines these three types of tools and discusses their function and potential in translator training.

Chapter Four establishes the experiment methodology, discusses the profile of the subjects that will participate in the experiment, presents and justifies the test materials to be used as well as the marking criteria to be employed for assessing the tests. The rationale and design of the two post-test questionnaires are also discussed in this chapter. The purpose of these

questionnaires is to help determine the factors that may have had an impact on the students' performance during the first and second tests.

In Chapter Five, the students' test results are collected, categorized, and marked. The scores are input in tables and then analysed in a statistical manner. The analysis mainly focuses on three aspects of the score obtained for each test, namely, the final score (the overall score for a test), the score part one (the score awarded based on the DipTrans marking standards), and the score part two (the score awarded based on how the students have dealt with the specific features of scientific and technological texts). On the one hand, the goal of this approach is to gauge how much students' overall performance has improved by contrasting the final scores for the first and the second tests. On the other hand, by comparing the quantitative improvement made by students regarding score part one and score part two, more detailed information can be inferred as to the particular aspects in which the students have improved most or least. The students' answers to the two post-test questionnaires are also analysed in a qualitative manner to decide on the factors that may lie behind the test results. A correlation is then established between the factors and scores, revealing some of the findings of this research.

The final chapter, Chapter Six, recapitulates the findings and their significance, discusses the contributions and limitations of the current study, and finally suggests potential topics for further research.

Chapter Two

Features of Scientific and Technological Texts

In this chapter, it is the author's intention first to differentiate the concepts of scientific, technological and technical translation and then review some of the most important studies carried out in these three areas, to then conclude that technical translation has been intensively studied in the last few decades while scientific and technological translation need more academic attention. The chapter also provides a generalization of the linguistic features that characterize scientific and technological texts both in English and Chinese. These features also apply to academic journal articles because they belong to the category of academic works on science and technology. The features of English and Chinese research papers are classified in the categories of grammatical, syntactical, lexical, functional and genre characteristics.

2.1 Scientific, technological and technical translation

In this research, scientific and technological translation refer to the translation of academic works, such as text books, journal articles, conference papers and the like that concentrate on the fields of science and technology. These research areas will certainly benefit from

more work being done on them. As Swales (1990) states, the rapid growth of discourse studies on English language has meant a wider coverage and adequate treatment of areas such as international business communication and the processing and production of technical manuals. However, according to the same scholar, the training of people to process and produce academic and research English remains a major international endeavor, both in countries where English is the first language as well as in those where it acts as a second or foreign language.

In view of this situation, and in order to narrow down the research topic and to contribute to less-explored yet valuable research areas, the author has chosen to study the translation of academic journal articles on science and technology between English and Chinese. This decision was made because, on the one hand, it is vital to inform Chinese scholars of how to write English academic articles and how to translate their Chinese research results into English since most authoritative and well-known journals requires the publishing language to be English, and on the other hand, it is beneficial for translators specializing in academic translation to have a better understanding of the key features of English and Chinese scientific academic texts to be able to produce more Chinese translations of English academic works of good quality to keep Chinese scholars updated of recent developments in science and technology.

2.1.1 The concepts of 'science' and 'scientific'

The *Oxford English Dictionary* (2010) defines science as "the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment". Although this definition is quite self-explanatory, a trace-back of the historical use of the word 'science' can provide a more profound understanding of its features. In what follows, a summary of the definition and historic evolution of the term 'science', based on contents from *The Encyclopedia Britannica* (2009), is presented.

In the Greek philosophical tradition, 'science' is defined by Aristotle as a type of reliable knowledge which is built up logically from strong premises and can be communicated and taught, thus foregrounding the theoretical nature of science. From the Middle Ages to the Enlightenment, science had the same sort of broad meaning as philosophy did, reinforcing its philosophical and abstract nature. After the 18th century, with the promotion of the experimental scientific method propelled by people such as Sir Francis Bacon, science started showing its methodological side. Over the 20th century, scientists such as Feynman (Feynman *et al*., 1963: 1) have argued that, "the test of all knowledge is experiment and experiment is the sole judge of scientific truth". According to this argument, the finding of scientific truth includes two procedures: generalizing in order to make a hypothesis and testing it. The procedure of generalizing or hypothesizing is done by the scientist's observation, while the process of testing is fulfilled through experiments. Therefore, science gains another two attributes, namely, observational and experimental. As a way to sum up,

science can be said to be embodied with the following features: systematic, logical, theoretical, philosophical, abstract, methodological, observational and experimental. It may seem that some of these attributes contradict each other, but they actually coexist.

2.1.2 The concepts of 'technology' and 'technological'

Technology is defined by *The Cambridge Encyclopedia* (2003) as "the systematic study of techniques for making and doing things", which means that it is not the same as techniques, but instead occupies itself with the study and research of techniques. In this sense, technology is systematic. *The Chambers Dictionary* (2008) defines technology as "the practice of any or all of the applied sciences that have practical value and/or industrial use; and technical methods in a particular area of industry or art". This definition shows that technology is systematic, methodological and experimental.

The Oxford English Dictionary (2010) defines technology as "a discourse or treatise on an art or arts; and scientific study of the practical or industrial arts collectively". Discourse is defined by the same dictionary as "a formal discussion of a topic in speech or writing", and treatise as "a written work dealing formally and systematically with a subject". This definition again displays the nature of technology as being systematic and formal.

To sum up, technology is concerned with how to design, operate, and control machines, devices and instruments and shows the features of applied science of being systematic, scholastic, academic, methodological and formal.

2.1.3 The concepts of 'technique' and 'technical'

The Oxford Dictionary of English (2010) defines technique as "a manner of artistic execution or performance in relation to formal or practical details; and the manner of execution or performance in any discipline, profession, or sport". This highlights the nature of technique as executive, performative and practical. *The Online Oxford Dictionary* also defines technique as "a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure", thereby showing that technique is 'specific'.

According to the *Collins English Dictionary* (2011), technical means "of, relating to or specializing in industrial, practical, or mechanical arts and applied sciences". *The New Oxford American Dictionary* defines the term as "of or pertaining to the useful or mechanic arts, especially appropriate to any art, science or engineering field". Based on these two definitions, it can be seen that technical is related to 'industrial and mechanical'. Therefore, technical is embodied with the following features: executive, performative, practical, specific, industrial and mechanical. Therefore, technical texts belong to the industrial regoster.

2.1.4 Scientific-technological vs. technical

Before establishing any comparisons and differentiations between these various concepts, let us first offer a list of the main salient features that characterize the concepts of scientific, technological and technical, as discussed above:

Table 1: Features of the concepts of scientific, technological and technical

Scientific	**Technological**	**Technical**
Theoretical	Applied science	Practical
Philosophical	Formal	Industrial
Systematic	Systematic	Specific
Methodological	Methodological	Mechanical
Experimental	Scholastic	Executive
Observational	Academic	Performative
Logical		
Abstract		

Historically, science and technology developed as different and separate activities until the 19th century, when they became somehow inseparable. They share the same features when it comes to being methodological, as both science and technology look for laws and principles. However, while science focuses on the search for knowledge, technology concentrates on the search for solutions to practical problems using the knowledge provided by science. Or to put it in a different way, science is the systematic attempt to understand and interpret the world, while technology is the systematic study of techniques for making and doing things. In this sense, both science and technology belong to the academic register. On the contrary, technical language is used when discussing how to construct, use, maintain, or even promote and sell a specific machinery or device.

A persuasive example of the difference between scientific and technical texts can be found in Byrne (2006:8). As the author states, translating a scientific paper which deals with the concept of electromotive force and the effects of currents passed through conductors, complete with formulae, hypothesis, discussions and calculations is a scientific translation, whereas translating an installation guide for an electrical motor is technical translation. Both texts are based on the knowledge that if an electrical current passes through a piece of wire, a magnetic field is created which exerts a force, but the difference is the way in which knowledge is used and presented. In the scientific paper on electromotive force, the goal is to discuss, explain and justify the information in a serious and impressive way, so the text needs to be formal, logic, and persuasive. Therefore, scientific texts will be conceptually more difficult and abstract than technical ones. On the other hand, the technical text of an installation guide is written to help someone do something. The aim here is to convey the information an engineer needs in order to install, connect and commission the motor. Consequently, the language is kept at a reasonably simple register, and is unambiguous, concise and practical. In this sense, technical language tends to contain less information, is more concrete, more colloquial and easier to understand than the language used in scientific texts. As the author have discussed earlier in Section 2.1.1 and 2.1.2, the scientific and technological texts are of very similar nature, and therefore these two types of texts are deemed to have similar features that differentiate them from technical texts.

The author would like to argue that it is necessary to establish a clear difference between scientific-technological texts and technical texts so that the characteristics that define them can be taken into account when translating them. In the past decades a substantial amount

of research has been conducted in these fields, but sometimes it has been conducted under the umbrella term of 'technical translation', irrespective of whether the actual subject of research is technical, technological or scientific texts. Examples of such research are the works by Holmstrom (1957), Hann (1992), Wright (1993), Merkel (1998), Kingscott (2002), and Franco Aixelá (2009) to name but a few. For some scholars, technical is a synonym of specialized translation, and technical translation seems to be an inclusive term for the translation of science and technology, as well as for the translation of practical documents, such as manuals, configurations, specifications or introductions of industrial products. This overemphasizing of the importance of technical translation is responsible for the dearth of material written on scientific and technological translation, which is one of the fundamental means of science communication and exchange. Arguably, scientific-technological translation can be more challenging and difficult than technical translation, because it deals with highly abstract and scholastic texts, while technical language tends to be simpler and more user-friendly. In other words, technical language is more similar to general language for everyday use.

As for the use of these terms, the word 'technical' seems to be employed much more widely and frequently than 'scientific' and 'technological'. Using three internet search engines, namely, Google, Yahoo and Baidu, to retrieve references for four words and phrases – i.e. scientific, technological, technical, scientific-technological –, the following results have been obtained:[1]

[1] Data retrieved at 11:13 on 27th January 2011.

Table 2: Occurrence of the terms: scientific, technological, technical, and scientific-technological

	Google.com		Yahoo.com		Baidu.com	
	x 10^6	%	x 10^6	%	x 10^6	%
Scientific	170	28.7	955	29.3	17	26.9
Technological	36	6.1	196	6	7	10.7
Technical	363	61.3	2,070	63.4	38	60.4
Scientific-technological	23	3.8	43	1.3	1	2
Total	592		3,264		63	

Table 2 above shows that data retrieved from the three search engines display similar patterns. For instance, the occurrence of the adjective technical is the highest, followed by scientific and then technological, and the combined term scientific-technological is the one with the lower number of hits. The results prove that people seem to use the term technical more often than the rest and that they are somehow more familiar with the concept of technical than with the concepts of scientific and technological.

The above data analysis only shows the frequency with which the terms scientific, technological, technical and scientific-technological are used on the internet daily. To prove that technical translation is also emphasized more in academic research, data has been retrieved from the Translation Studies Abstracts Online by the St Jerome Publishing, which

can be found in the following link www.stjerome.co.uk/tsa. The entries are retrieved based on three criteria, 'Category', 'Word(s) in Abstract', and 'Published Between'. The 'Category' and 'Published Between' are the invariables, which are set to 'Specialized and Technical Translation' and '1950-2010' respectively, while 'Word(s) in Abstract' is the variable which is set as 'scientific', or 'technological', or 'technical' or 'scientific and technological' for each time of retrieving. The following data has been obtained:

Table 3: Occurrences of the terms- scientific, technological, technical, and scientific-technological within the category of 'specialized and technical translation' in St Jerome TS Abstract online)

	Entries	Percentage
Specialized and technical translation	744	100%
Scientific	96	12.9%
Technological	9	1.2%
Technical	125	16.8%
Scientific and technological	0	0%
Entries without any of the three terms	514	69.1%

Translation Studies Abstracts Online divides TS into 27 translation subcategories, such as audio-visual and multimedia, Bible and religious, interpreting studies, literary, corpus-based studies, theory, translator and interpreter training, specialized and technical, etc. To have an overview of how much attention has been given to 'specialized and technical translation' within TS academia, I have also retrieved all entries of works in this database, retrieving a total of 12,437 hits. Dividing all the 12,437 entries by 27 categories, I get the average number of 460 entries for each category. The total entries under the category of 'specialized

and technical translation' are 744, which is much higher than the average. It shows the research field of 'specialized and technical translation' is taken much account of by the academics.

Within the category of 'specialized and technical translation', there are 230 entries that contain either 'scientific' (96), or 'technological' (9), or 'technical' (125), while there is a large number of entries, 514, that do not contain any of the three terms. This can be considered reasonable because specialized and technical translation can be referred to in a more specified way by the researchers. For example, they can use 'medical translation', 'business translation', and other subcategories which show the specific areas they are studying. But what are comparable here are the entries and percentages between 'scientific', 'technological', and 'technical'. Table 2 shows that the occurrence of 'technical' is the highest with a total of 125 hits (16.8%), while there are only 9 entries (1.2%) of 'technological' and the total number of entries of 'scientific' is 96 (12.9%). These results seem to show that researchers tend to use 'technical' to refer to any texts that are related to science and technology, without discriminating whether these texts are abstract academic works of science and technology or whether they are practical documents such as manuals and mechanical configurations. In some occasions, the researchers also use technical to refer to other subfield, such as business and legal. It is also significant that no entries of abstracts contain the phrase 'scientific-technological', somehow indicating that researchers tend to classify texts related to technology as 'technical' texts rather than discriminate them into 'technical' or 'technological' based on what types of texts they are.

Given this state of affairs, in which scientific-technological translation has been paid less attention, I would like to highlight the importance of this type of translation and to contribute to promote research in this field. One of the first steps in this direction is to analyse the linguistic features that are characteristic of scientific-technological texts.

2.2 Features of English scientific and technological texts

As a particular kind of text type, scientific-technological texts have their own distinctive language features and functions. The translation of a certain text type into a target language must accurately take into account these features and transfer them in a way that they successfully perform in the target culture a similar function to the one the original text played in the source culture (Colina, 2008: 15). Thus, to translate a scientific-technological text, translators must first have a clear understanding of its language features, both in the source as well as in the target cultures.

As far as English is concerned, Newmark (1988:9-17) states that English scientific and technical texts are noted for three language characteristics, categorized as terminological, grammatical and stylistic:

1. Terminology takes up about 5 to 10% of the whole text.
2. Grammatical features include the use of mainly passive constructions, nominalizations, third persons, empty verbs and present tense.
3. Formats such as technical reports, instructions, manuals, notices and publicity put special emphasis on forms of address and on the use of the second person.

According to a prior study by Pinchunck (1977), the field of science and technology is a continuous chain of processes from research to development and application and there is a particular form of documentation for each of the processes. For example, there are many text formats such as textbooks, dissertations, theses, pamphlets, monographs, conference papers, patents, catalogues, manuals, sales brochures and advertisements and each of these document formats has its own characteristics, as regards to both content and language. The problem with Pinchunck's approach is that he does not establish a distinction between scientific-technological and technical texts. However, according to the classification offered in chapter one, scientific-technological texts are, for the purposes of this thesis, only concerned with activities within the academic domain, which means that they only refer to the following documents: textbooks, dissertations, theses, monographs, and conference papers.

As for the salient features of scientific language, Pinchunk (ibid.) thinks that the range of application of any particular feature of a language varies on a number of different levels, namely, grammatical, morphological, syntactical, lexical, denotative, connotative, and cultural. He goes on to propose a classification of linguistic features and contextual features. The range of linguistic features encompasses the grammatical, morphological, syntactical, and lexical dimensions, while contextual features are mainly concerned with the function and style of the text i.e. the denotative, connotative and cultural dimensions.

The following section discusses the main linguistic and contextual features that are significant when translating scientific-technological texts from English.

2.2.1 Grammatical features

According to (Pinchunk,1977), the term 'grammatical', in a restricted sense, covers categories such as tense, number and gender; word classes such as noun, verb and so on; structures such as co-ordination and modification; and rank of expressions such as words, phrases, clauses, and sentences.

With regard to scientific-technological texts, there are a few prominent phenomena in the grammatical level, namely the recurrent use of passive constructions, empty verbs (such as have, make, give, and take), and modal verbs (such as might, may, can, and could) as well as certain collocations and logico-grammatical items.

A typical example of collocation used in scientific works is 'solve + problem'. As for the term 'logico-grammatical', it subsumes a number of linguistic categories that do not fit into any single grammatical category and is first mentioned by Strevens (1973). He goes on to state that science and technology are based on advanced and fundamental thoughts, and concludes that scientific-technological language is logic in essence and that certain concepts are common to all advanced and complex thoughts. These general concepts are expressed in English by the use of lexical items such as 'apart from, in addition to, accordingly, consequently, it follows that, necessary but not sufficient condition, conclude, it would seem that', etc. (Strevens, 1973). These lexical items can be grouped into a number of categories according to the notions they convey. There are approximately 100 items

grouped into seven notional categories. The following examples in Table 3 provide three items under each class, to serve as illustrations:

Table 4: Examples of logico-grammatical items (Strevens, 1973)

Categories	**Examples**		
Linking and logical sequence of ideas	in addition to	furthermore	thus
Paraphrase and apposition	as if	similarly	like
Opposition or contrast	in spite of	nevertheless	however
Causality	as a result of	therefore	because
Restriction	only if	except	unless
Hypothesis	Conclude	suppose	refute
Enquiry	with what purpose?	to what extent?	

Strevens (1973) points out that these logico-grammatical items are prominent in scientific and technological texts without exemplifying what the specific sentence patterns might be.

The verb forms used in academic writing have also being analysed by many researchers. One study conducted by Barber (1962) consists in the analysis of three chapters of science textbooks used by an American university, with each chapter being taken from three different textbooks of astronomy, electronics and biochemistry respectively. This analysis of verbal tenses was carried out in order to have a clear overview of how finite verbs function in academic texts of a scientific nature. It is necessary and interesting to analyse the verb forms, especially the tenses of finite verbs, because in most cases, the choice of tense in scientific academic writing is more about the process of the research rather than sheer grammar. For example, in different sections of a research paper, the choices of tenses by the writer usually show distinctive patterns. In the Introduction section, writers tend to use present simple, while in the Literature Review section, writers tend to use both past simple and present perfect. Within the Literature Review section, the writer takes a stance when

he chooses between past simple and present perfect, informing the reader of his opinion on the previous research results. The writer chooses past simple when he only wants to state what others have done, while he uses present perfect tense to show the reader that he thinks the previous research, to some extent, has impact or implication on his own research.

The result of Barber's (1962) research shows that the total number of verb forms used in the three texts is 2903, which is about one for every 8.1 words of running text. Of these, 61% are finite verbs and 39% are non-finites (i.e. infinitives, past participles, -ing forms). As far as the finite tenses are concerned, the simple form of the verb in English can be modified by any combination of four tense-markings, which are the past, the perfect, the progressive, and the passive, giving a total of 16 potential tenses. At the same time, the future forms of 'will' and 'shall' can be modified by any combination of perfect, progressive, and passive marking, producing another 8 tenses. Adding the imperative tense to this list gives a total of 25 tenses in English. However, not all of the 25 types of tenses appear in Barber's (1962) study, who found out that twelve of the tenses did not show in the analysed texts (See Table 5), and three of them - past perfect active, past perfect passive and present progressive passive – only showed once in the three texts. After that, the finite verbs with a modal auxiliary were analyzed separately. There were 228 finite verbs with a modal auxiliary, representing 16% of all finite verbs. Two prominent auxiliaries were 'can' (110 occurrences) and 'may' (101 occurrences). Six other auxiliaries also showed in the text, with 'must' showing 46 times, 'should' 13, 'would' 10, 'could' 5, 'might' 2, and 'let' 1, Finally, Barber combined the results of finite verbs with and without auxiliary and got the following table of results:

Table 5: Tense of finite verb forms

Type of tense	Total	%
Present Simple Active	949	54
Present Simple Passive	364	21
Can- forms	110	6.2
May- forms	101	5.7
Future Simple Active	54	3.1
Must- forms	46	2.6
Present Perfect Passive	25	1.4
Present Perfect Active	21	1.3
Past Simple Active	18	1.0
Past Simple Passive	17	1.0
Should- forms	13	0.75
Future Simple Passive	10	0.57
Would- forms	10	0.57
Present Progressive Active	9	0.51
Imperative	5	0.28
Could- forms	5	0.28
Might- forms	2	0.11
Present Progressive Active	1	0.06
Past Perfect Active	1	0.06
Past Perfect Passive	1	0.06
Let- forms	1	0.06

As stated above, 39% of the verb forms are non-finites, consisting of infinitives, past participles and –ing forms.

Table 6: Classification of non-finite verb forms

Non-finite verb forms	Total	%
Infinitives	519	46
past participles	387	34
–ing forms	221	20

Although Barber's overview of the verbal tenses used in scientific academic writing is very illustrative, the data might be illusive in the sense that the corpus used is not big enough to be considered representative: only 23,400 words from three texts in three subject areas.

The question of personal versus impersonal forms in academic discourse is also a very controversial issue. Some authors, such as White (2000: 133), consider objectivity to be an essential feature of the whole academic enterprise, necessarily implying the use of the passive voice, the third person and other impersonal structures. Macmillan and Weyes (2007: 105) also share the opinion that scientific academic writing must be as objective as possible, using language techniques that generally maintain an impersonal tone.

Another author who favours the use of impersonal forms is Allison (1997:53), who instructs students to use the third person and avoid personal pronouns except in naturalist or qualitative research. Along the same lines, Oliver (1996: 5) advises the use of impersonal verbs in the third person, especially in the natural sciences. Fairbairn and Winch (1996: 131) add that the first person is acceptable in literary, theological or philosophical essays.

Bailey (2006: 106) acknowledges that academic discourse resorts to the passive tense more often than daily English, but warns that it should not be overused and that both constructions have their place, depending upon the focus of the sentence. Cottrell (2003: 177) initially recommends the use of impersonal forms, but explains that, although the scientific model of writing has influenced all academic writing, this is now changing and there are presently alternatives to the scientific model that allow a measure of subjectivity and even the use of personal experience.

When social sciences first emerged, the dominant model followed was that of the natural sciences. These latter disciplines mostly used quantitative methods, and research was written up from the perspective of an objective, impartial researcher, emotionally distant from the research. Using expressions like 'the research was conducted' or 'the analysis confirmed the hypotheses' suggested that the research had been undertaken in a rigorous manner and that what the data revealed was precise and clear. The implication is that the researcher followed defined procedures and protocols, and was able to separate personal values from the activity of researching. When less positivistic research philosophies were developed, and when it was accepted that the figure of the totally objective researcher is an ideal rather than a reality, interest moved from the numerical analysis of data to the interpretation of the meaning of the data. The continuous choices needed while undertaking research in the social sciences highlighted the more subjective nature of researching into people's behaviour as opposed to analysing natural phenomena like light or helium.

A great many other authors argue in favour of deploying the active voice. Hennessy (2002), Greetham (2001), Strong (2006), Dixon (2004) and Dunleavy (2003), to name but a few, they all firmly argue against using the passive on stylistic grounds. Others are less emphatic. Fabb and Durant (2005) do not prohibit the passive, merely warning that it should be used carefully, while Warburton (2007) points out that, though the active is generally preferable, it is conventional in science to use the passive.

Dunleavy (2003) offers a convincing argument for using the active voice as opposed to the passive, explaining that using active verbs with real subjects makes the text much livelier and warning that students should strictly avoid passive forms because they tend to create avoidable ambiguities. However, he admits that the active voice also has its own dangers, such as the lure of reification, not to mention the problem of using personal pronouns that may detract from an overall perception of objectivity. Indeed, these issues are rather controversial in this kind of discourse and Fabb and Durant (2003: 96-7) discuss the alternatives at length:

> When referring to yourself as the writer of your essay, it is possible to use a range of forms: 'I', 'we', 'one', 'the present author', etc. Traditionally, however, there are restrictions on straightforwardly saying 'I'. Nowadays, it is considered permissible occasionally (e.g. to emphasize a point you wish to show is personal rather than general). The guiding principle must be that the overall interest of your essay lies in how well its combination of observation and argument leads to more general statements, and so away from the particularity of autobiography and personal impression.

The question of using personal versus impersonal forms, or the active versus the passive constructions, is clearly a highly fraught area, reflecting the complexities of the underlying epistemic debate about the desirability, and indeed possibility, of achieving objectivity in research. As Levin (2004: 84) points out, the use of one form above another has become something of a personal choice nowadays, and it is no longer possible to make hard and fast generalizations on their issue.

2.2.2 Syntactical features

Syntax is a word from the Greek that is used by grammarians to mean those principles and rules which teach us how to put words together so as to form sentences (Cobbett, 1818). In other words, syntax refers to sentence structure, which is flexible according to who writes it and what type of text it belongs to. Therefore, a generalization of the syntactical features of any text type should never be taken as a set of principles, but rather thought of as descriptions based on experience and statistics. As to the sentence length and structure of scientific and technological academic articles, there are many divergent opinions. According to Edith (2006), a balanced style would consist of simple sentences (occasionally) for emphasis, compound sentences (occasionally) to add or link information, and complex sentences (usually) to define relationships between information (e.g. causal, sequential, and conditional).

Many authors insist that long, complicated sentences should be avoided in favor of short, direct ones with straightforward syntax (Fairbairn et al, 1996; Warburton, 2007). This may partly be an attempt to compensate for the unnecessary complexity often introduced by (inexperienced) writers trying to cultivate an authoritative erudite style.

However, other authors link it to the structural and stylistic properties of the English language itself. For example, Dunleavy (2003) points out that the inner core of an English sentence is the Subject-Verb-Object unit, and that these three components need to be closely bonded together if ambiguity is to be avoided. Thus, qualifying or subordinate clauses are always best placed at the beginning or ends of sentences, never in the middle,

which should be reserved for the core. In order to keep the SVO unit clearly visible, sentences "should not get too long and they should have the simplest feasible grammatical structure" (Dunleavy, 2003). As a guide, he suggests students should never write a sentence longer than 40 words, and that the ideal sentence length should be of around 20 words. Problems with long sentences usually reflect either the fact that the author is writing unauthentically in a pompous style or trying to do too many things with a single sentence, typically by loading in qualifying clauses beginning with 'although', 'however,' and so on. In his opinion, a sentence should express a single thought or proposition, not multiple ones.

Northedge (2005), for his part, analyses the sentence lengths in a model academic article, and concludes that these vary considerably, from 1 to 54 words, although the distribution of different lengths was quite even as seen in Table 7 below:

Table 7: Sentence length of English Academic articles according to Northedge

Sentence length	**No. of words**	**%**
Very short	1-10	22
Shortish	11-15	21
Middling	16-20	19
A bit longer	21-25	18
Long	Over 26	21

He also found that different sentence lengths were performing different jobs within the paragraph. The longer sentences were generally used to present information (such as evidence from research) or to explain arguments, while shorter ones tended to appear at the start or the end of paragraphs or texts (or even on either side of long sentences) to set up the theme and summarize it afterwards.

The controversy regarding sentence length in academic writing is somehow settled by Dixon (2004:148-149), when he concludes that:

> Academics disagree amongst themselves about sentences. Some favour short ones. Others are quite happy, indeed enthusiastic, about the idea that students should, in the course of their studies, cultivate the art of the long sentence; being able to retain control of one's ideas and language while constructing a complex and involved sentence, making judicious use of commas and semi-colons, they say, is an important academic skill. I prefer brevity. There is no need to adopt a hard and fast rule about this though. Sometimes a long and involved sentence might be appropriate and attractive.

What is particularly interesting, though, is the extent to which the question of sentence length and its complexity appears to be unrelated to discipline. While it might be expected that scientists prefer short, simple sentences, and those working in the humanities and social sciences would prefer a greater degree of elaboration, this is not necessarily the case. Redman (2006), discussing writing for social sciences, and Pirie (1985), in the case of literature, all insist upon the use of simple, straightforward sentences, in contrast to Fabb and Durant (2005) who advocate resorting to a greater variety of sentence lengths.

In the particular instance of scientific texts, Strevens (1973: 224) states that these type of "texts tend to be written in complex sentence structures with two or more clauses". He points out some features of the clauses that are prominent in scientific-technological texts within the parameters of:

> numbers of clauses contained in sentences; type of clauses within a sentence; sequence of clauses within a sentence; relative frequency of main and subordinate clauses; number of adjuncts (adverbial and prepositional phrases) and their location initially or finally in the clause; relative frequency of

particular verb-forms (e.g. passive or active, tense, aspect, etc.); and reference forward or backward in the text. (ibid: 224-225)

However, in a previous study carried out by Barber (1962: 24), the number of main and subordinate clauses used, as shown in the following table, seem to contradict the above findings:

Table 8: Number of Clauses per Sentence in scientific texts

Subordinate Clauses		0	1	2	3	4	5	Total
Main Clause	1	144	57	36	9	4	0	250
	2	41	23	14	8	1	1	88
	3	5	4	0	0	0	0	9
	4	0	2	0	0	0	0	2
Total		190	86	50	17	5	1	349

This table reveals the degree of simplicity found on research articles in terms of clause structure, which can be seen from the density of the figures in the top left-hand corner. There are six common sentence patterns: (1) one main clause with no subordinate clauses, (2) one main clause with one subordinate clause, (3) one main clause with two subordinate clauses, (4) two main clauses with no subordinate clauses, (5) two main clauses with one subordinate clause, and (6) two main clauses with two subordinate clauses. The most common type of sentence is that with one main clause and no subordinate clauses (144 occurrences), which accounts for 41% of the total 349 items. They are traditionally known as ‘simple sentences’, but not all of them are simple in the ordinary sense. Instead, some are quite long and can involve the use of complicated structures, such as non-finite verbs. There

are 250 sentences that have only one main clause (71%), whereas 88 sentences have two main clauses (25%). There are fewer cases in which there are more than two main or subordinate clauses.

Another feature of scientific and technological texts is the prominent use of nominalizations. Grefenstette & Teufel (1998) define nominalization as a process that transforms a verbal phrase into a nominal form. The resulting nominal can take the form of a gerundive or a de-verbal noun and it is usually accompanied by a highly-unpredictable, semantically-emptied verb that links the nominalization with the rest of the sentence. Apposition structures and 'there be' structures are also common in scientific texts. According to Woodford (1986), another salient feature of this genre is the frequent use of specific sentence-patterns, usually the postulatory, the argumentative and the formulative patterns.

2.2.3 Lexical features

A number of authors, such as Bailey (2006), Jordan (1997) and Smith (1994), argue that English academic writing is by nature formal and technical and they insist on the need for a register that avoids the use of colloquialisms, slang, abbreviations and most phrasal verbs. Fabb and Durant (2005), without specifically using the word 'formal', also insist that academic prose requires a standardized written variety of the language. As regards terminology, Barrass (2002), writing for science students, insists on the need for correct nomenclature. Redman (2006), in the field of the social sciences, also advises to use the specialized or jargon language of the discipline. Dunleavy (2003) claims that the use of

academic jargon is unavoidable as it has more precise meaning and allows the exposition to quickly reach targeted subjects, which would be harder to grasp or cumbersome to define in other ways.

Many other authors, however, urge the avoidance of jargon and pretentious or pompous register in favour of short everyday words. Strong (2006), who proposes rules of academic writing in the field of law, an area notorious for its archaic and specialized diction, specifically distinguishes between legal jargon, which is something to be avoided, and terms of art. Legal jargon refers to the type of overused legalisms that really add nothing to the discussion. In his opinion, referring to 'the aforementioned' or 'the res in question' is pompous and unnecessary, and the inclusion of unnecessary Latin phrases such as 'qua', 'ex ante' or 'de novo', may also put the reader off. The difference between legal jargon and a proper term of art is whether the word or phrase carries a specific legal meaning or is simply part of a single legal text. If the term has acquired this type of official legal value, then it is usually a term of art.

Strong (ibid.) goes on to urge the case for simple language, pointing out that although some people think that unusual, literary or polysyllabic words impress readers and demonstrate greater erudition and knowledge, the reality is different. Instead, big words often slow the pace or confuse the meaning and he discourages the use of a long word if a short one will do.

A similar idea is expressed by Dixon (2004), who criticises the fact that some university academics during the course of the twentieth century have developed an unreadable prose.

In his opinion, the lively yet precise prose of the great eighteenth and nineteenth century essayists, historians and philosophers has been supplanted by a jargonistic, pedestrian and impenetrable sort of specialist discourse. However, perhaps out of fear of reprisal, he hastily adds that most academics these days write extremely well and it is only a minority who produce obscure, jargonistic, pompous, excessively abstract or pretentious prose. This accusation of bad prose is a recurrent theme amongst many authors, who repeatedly urge to avoid circumlocution and verbosity, by choosing precise terms and using concrete terms over abstract ones (Hennessy,2002; Dunleavy, 2003), despite acknowledging that academic jargon is unavoidable.

In the same way as total homonymy does not exist in a language, any apparent correspondences or equivalence in vocabulary between different languages can only be partial. Every expression in a given language has a number of possible meanings, of which only one may come into play in a particular context. However, according to Strevens (1973), within the scientific context, words tend to have only one meaning because they are constructed on agreed principles, and built up logically from simple lexical elements, usually from Greek or Latin. Because of this comparatively one-fold characteristic, terminology studies tend to be highly successful in the field of scientific-technological translation.

The phrase structures that are usually discussed in terminology consist mostly of noun phrases containing adjectives, nouns, and occasionally prepositions; rarely do terms contain verbs, adverbs, or conjunctions. Besides specific terms, scientific-technological texts also reveal a frequent occurrence of epistemic resources, hedges and modal verbs (Hyland 1998). Examples are: modal verbs (may, suggest, could); epistemic grammatical categories (predict,

suggest, possibility, relativity, likely, presumably); and hedges both as expressions that limit conditions ('we have not been able to determine…') and as expressions that admit lack of knowledge ('nothing is known about…').

As to the translation of terminology, the study of specific terms and concepts seems to have become much easier as terminology management tools are widely used nowadays. These computerized tools accumulate terms based on the translator's previous usage rather than conducting a structural analysis of the terms, and given their importance in the field of scientific and technological translation, they are further discussed in Chapter Three of this current study. In addition, a discussion is also conducted in the same chapter on how translators deal with new creations or coinages of terms and on which equivalent terms they choose to store in the terminology management tools.

As Beeston (1970) states, the need for a large vocabulary dealing with technological and scientific matters is, however, the least interesting feature of the new lexical developments; more fascinating, though more elusive, is the evolution of new words for intellectual concepts. The major problem facing translators at present is terminology standardization and dissemination in the sphere of science and technology. Therefore, it is important for translators to have access to and be familiar with new terms in their specialized field, to verify the validity and usability of these terms, and finally find a relatively equivalent term in their target language.

Terminology is indeed an important issue as regard to the study of academic journal articles on science and technology, but it must also be acknowledged that the study of the lexis

used in academic articles means more than terminology. As no individual has the capacity to learn the whole terminology of a given field, what they tend to acquire are some of the terms for adequate understanding of the subject area. Therefore, it seems more interesting that the study of terminology focuses more on the management of terminology rather than on the acquisition of a large number of scientific and technological terms.

Nevertheless, there is a certain type of vocabulary which is generally useful to students, writers and readers of all subject areas in science and technology as these words occur frequently in scientific and technological literature. To find some of these words, Barber's (1962) uses a method of filtering them from several research articles by applying three rules. The first rule is that the words must occur frequently in different articles in different subject areas. The second rule is that the words cannot be scientific or technological terms, but rather of a more general nature though still very recurrent in this type of texts. The third rule is that the words should not be part of a General Service List (GSL) of English words. GSL words are words used daily, not specifically related to science or technology and that all high school graduates are presumed to know, no matter what subjects they are studying. In his study, Barber (1962) concluded with the following list of words: accurate, alter, approach, assume, capable, completely, considerably, consist, constant, crystal, definite, equation, final, indicate, intensity, method, obtain, occur, optical, phenomenon, positive, principle, process, readily, require, reserve, secondary, series, shift, similar, sufficient, suitable, vary, visible. However, he only lists these words as examples. Given that the data used by Barber cannot be considered representative enough, it is rather difficult to ascertain whether this list contains the general vocabulary useful to students of all subject areas in science and technology.

2.2.4 Linguistic features based on the function of scientific-technological texts

Scientific-technological texts usually fulfil two objectives. Firstly, it should accurately describe the procedures that were followed and the results that were obtained. Secondly, it should place these results in perspective by relating them to the existing state of knowledge and by interpreting their significance for future study. According to Alley (1996), to fulfil these objectives, scientific papers usually follow five procedures: (i) trace the scientific origins of the research problem, (ii) summarize the state of knowledge on the subject, (iii) state the critical hypothesis being tested in the research project, (iv) interpret the results of the study in relation to these hypotheses and to the general state of knowledge, and (v) identify the scientific questions and procedural weaknesses that need to be addressed in the future.

From a translational point of view, the translation of a scientific-technological text has to achieve a similar function to that of the original text. According to Bühler (1965/1990), language has three major functions, namely, expressive, informative, and vocative. Of these, the informative function is the main function of scientific-technological texts, which means that their translation tends to focus much more on accuracy and clarity than on loyalty to the ST form and style.

Ilyas (1989: 109) describes the nature of scientific texts as follows: “In scientific works, subject-matter takes priority over the style of the linguistic medium which aims at expressing facts, experiments, hypothesis, etc.” Readers of such scientific works do not read it for any sensuous pleasure, which a reader of literary work usually seeks, but they are after the information it contains. What is required is verbal accuracy and lucidity of expression, characteristics that are also applicable to the translator’s style. The register used in scientific texts differs from the one used in ordinary communication and in literary works since it does not accumulate emotional associations and implications. This explains why the translation of a scientific work is supposed to be more direct, freer from alternatives, and less artistic than other kinds of prose. As mentioned in previous sections, the register of scientific and technological language is characterized by impersonal style, simple syntax, use of acronyms, and clarity of expression.

Usually, authors of scientific texts mean what they say and say what they mean. Moreover, as foregrounded by Newmark (1988), scientific-technological language is usually free from emotive language, sound effects and original metaphors, so the problem of dealing with connotations and implications, which are relatively common in literary translation, rarely exist in a scientific-technological translation, and the scientific papers in particular. This is the reason why terminology tends to be more approved of and favoured by technical and scientific-technological translators than by literary translators. Indeed, computer assisted tools are indispensable in scientific-technological translation, in an industry pursuing high quality, efficiency and cost effectiveness.

2.2.5 Linguistic features based on the genre of scientific-technological texts

Scientific language is also identified by its formal style as it is frequently used in research papers and in the exposition of hypotheses and theories. The style of scientific-technological texts, or what Trosborg (1997) calls 'genre', is what I would like to comment on.

The concept of genre, borrowed from text and language for specific purposes (LSP) studies, is a vaguely-defined concept which can be interpreted in several directions. The one commonly adopted by translation scholars is that genre is a class of texts which is recognized as such by the receiver as all the texts in that group show recognizable conventions regarding their structure and other linguistic elements and are produced in similar communicative situations (Trosborg,1997).

Dolník and Bajzíková (1998), based on the criterion of the 'global area of activity', identify five broad genres of texts: journalistic, economic, political, legal and scientific texts. Their empirically based text classification, firmly rooted in the structural-functional theory of text, integrates the criteria of communicative function, context and strategy.

According to Woodford (1986), the genre of scientific papers is characterized by a standard format with the following sections: title, abstract, introduction, materials and methods, results, and discussion. References and figures are usually included after the discussion.

A scientific work tends to have a concise but descriptive title which reflects exactly what the author has done in the study. The abstract summarizes the paper in one short paragraph,

stating the object of the study, methods employed, and summarizing results and primary conclusions. The introductory part of a scientific paper explains the research objectives of the study and why it is worthwhile and meaningful. Authors usually first present a description or an observation of a phenomenon, and then refer to information from the literature to trace the development of the problem and its current state, looking for gaps within the extant research on this issue, and finally propose their own hypotheses. In the materials and methods section of a scientific paper, authors describe exactly what they have done so that other researchers interested in their study can follow suit. The results section presents a description of the results of the experiment or investigation along with a summary of representative data in tables and figures.

Although text is always preferred when presenting data in scientific papers, figures and tables are also appropriate, particularly in cases where the presentation of data is lengthy or ambiguous. Figures include graphs, maps, photos and technical diagrams. Presentation of data in graphs is generally more desirable than in tables because they aid the reader in visualizing trends in the data. There are many different types of graphs but, as pointed out by Day (1983), the most common graphs used in scientific writing are scatter plots (Figure 1), line graphs (Figure 2), and vertical bar graphs (Figure 3):

Figure 1: Example of scatter plot

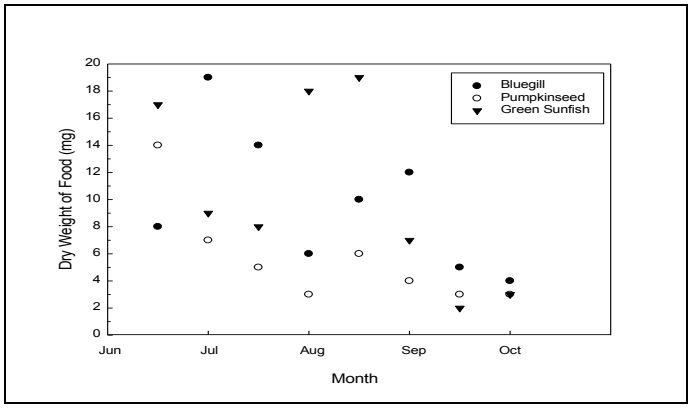


Figure 2: Example of line graph

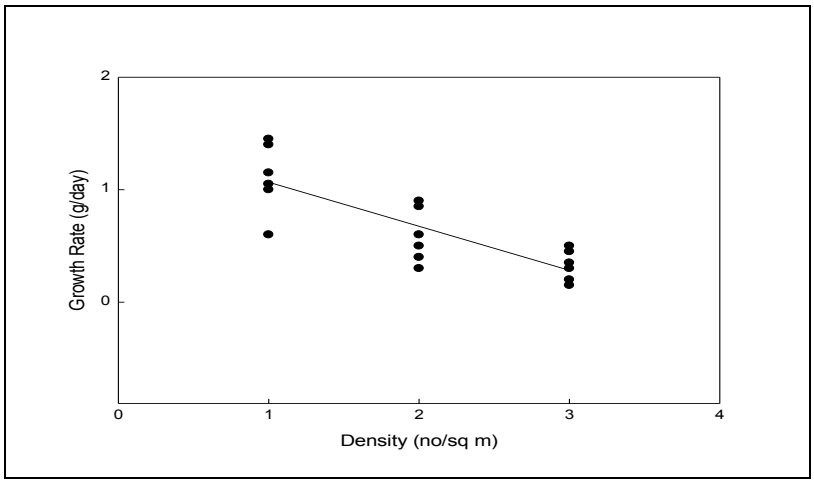
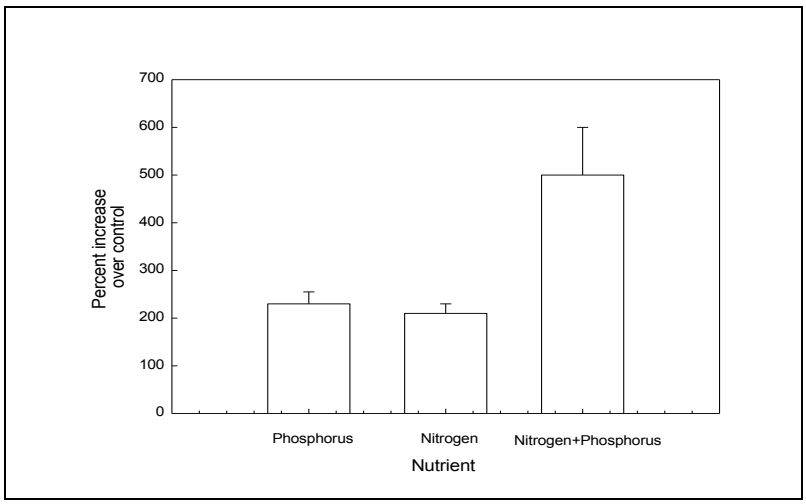


Figure 3: Example of vertical bar graph



Finally, research papers usually contain several citations and quotations from other scholars throughout the article, and a list of bibliographical references at the end of the paper, in the Literature Cited section, that acknowledges all the works that have had a bearing on the study (Gopen and Swan, 1990).

Citations are one of the most prominent features of academic writing through which authors both exhibit the breadth of their scholarship in a specific research area and subtly demonstrate their membership of the discipline community. Citations are important rhetorical devices that allow writers to promote their current research findings persuasively and efficiently. In addition to other rhetorical features in academic writing such as hedges (Hyland, 1998) and imperatives (Swales *et al*., 1998), citations are considered central to the social context of persuasion (Hyland, 1999: 342).

Research writers employ citations with various rhetorical functions: to position their research in the right context; to show the significance and relevance of their research; to demonstrate their competence in their research field; to exhibit the adequacy and accuracy of methodology and procedures; to prove the legitimacy of their claims; to establish their argument and justify their findings, and ultimately, to persuade readers to accept their new claims as scientific facts and thus contribute to new knowledge based on prior knowledge within the field.

In Applied Linguistics, citation analyses have mainly focused on the different types and functions of citations across various disciplines. Swales (1986) began with the textual analysis of citations and later (Swales, 1990) elaborated on and identified two major types of citations, namely, integral and non-integral citations, which are based on linguistic criteria and the syntactic position of the name of the cited author. Citations can be classified according to surface form into integral and non-integral citation (Swales, 1990). Integral citations are those performing a grammatical function within the text, for example as

subject or as object of a preposition. Non-integral citations are defined as those in parentheses or brackets.

Later studies further divided these two major types of citations into different sub-types, based on their syntactic position and their contextual functions. Drawing on their functions, Thompson and Tribble (2001) divide non-integral citations into four subtypes named as source, origin, reference and identification. Source is used to attribute a research finding, information or idea to a given author with the function of showing knowledge of the field. Origin is used to indicate the originator of a concept or product. Reference is used to introduce sources for further information, and identification is used to identify the actor or the agent in the cited sentence. Thompson and Tribble (ibid.) have also divided integral citations, mainly based on syntactic criteria, into three subtypes: verb-controlling, where the citation includes a lexical verb that might be active or passive; naming, where the citation is used as a noun phrase or part of a noun phrase; and non-citation where the year of publication does not follow the name of the cited person.

Other research studies have investigated citations based solely on their rhetorical functions. In this respect, Harwood (2009) focuses on the reason why the citation is being used as well as on the writer's intention for using a specific citation, regardless of its being integral or non-integral.

Other scholars have also documented variations in citation practices across different disciplines. These variations are prominent between hard disciplines and soft disciplines. Biglan (1973) identified three dimensions to academic disciplines: (1) the degree to which a

paradigm exists, or alternatively paradigmatic or pre-paradigmatic (hard versus soft disciplines); (2) the extent to which the subject matter is practically applied (pure versus applied); and (3) the involvement with living or organic matter (life versus nonlife science). For example, the natural and physical sciences are considered to have more clearly delineated paradigms and are hard disciplines, while those having less-developed paradigms and low consensus on knowledge bases, e.g., the social sciences and humanities are considered as soft disciplines.

Hyland (1999), in a study of 80 articles both from hard disciplines and soft disciplines, has proven that non-integral citations are used more frequently in hard disciplines to give prominence to the research and less emphasis to the role of the researchers. In contrast, the use of integral citations in soft disciplines allows writers to show their stance and make evaluations. Thompson and Tribble (2001) further studied the use of sub-types of integral, i.e., verb-controlling, naming, and non-citation and non-integral citations, i.e., source, origin, reference and identification in texts from agricultural botany and agricultural economics and found that agricultural botanists mainly used source and identification while agricultural economists preferred integral-naming citations. The findings are consistent with Hyland's conclusion, because agricultural botany is a hard discipline while agricultural economics is a soft discipline.

Harwood (2009) added to this line of studies by looking at citation functions employed by computer scientists and sociologists and revealing that computer scientists used citations more for signposting while sociologists employed citations more for engaging the readers. Other research has also focused on citation differences among genres (Thompson & Tribble,

2001), and different choices of citations between national and international journals (Hewings et al., 2010).

As far as citation functions are concerned, these constitute the main reason for which citations are used and can be identified regardless of its integral or non-integral nature. According to Mansourizadeh & Ahmad (2011), the functions of citations can be divided into the following six categories:

1. Attribution: The citation is used to provide acknowledgment for the source of information or research finding. Citations are identified as attribution if there are no other functions that could be related to them.
2. Support: The support citation is used to provide evidence for the significance of the topic; to justify the procedures and materials; to support the writer's argument or claim, and to justify the results of the study.
3. Reference: The citation is used to introduce a source for further information, allowing the author to be concise especially where there is limited space to include all the information.
4. Establishing links between sources: This type of citation is used to establish a link with sources which presented the same argument or with sources which reported similar findings or had a similar focus of study.
5. Identification: This type of citation is mainly used to identify the actor or the agent in the cited sentence where there is a reporting verb.

6. Comparison of one's own findings with other sources: This type of citation is used to compare one's own findings with previous research findings, with the aim of expressing similarities or dissimilarities.

To summarize, citations are a fundamental feature in academic writing, used by scholars to position their current research within an existing state of knowledge, as well as to lend support for claims made in their research writing.

In conclusion, section 2.1 points out the necessity of a profound study into English-Chinese scientific and technological translation within the academic register, and the translation of journal articles in particular. In section 2.2, some of the key features of English scientific-technological academic papers have been identified and discussed. Since this study is to be carried out first by initiating a comparable model of the features of English and Chinese academic writing, the following section will discuss the features of scientific-technological academic papers in Chinese.

2.3 Features of Chinese scientific and technological texts

Following the comprehensive explanation of the characteristics of English scientific-technological texts, the present section continues discussing its Chinese counterpart. It starts with a macro-perspective on Chinese academic writing on science and technology, such as its definition, components, and genre, and then is followed by a micro-analysis of its

linguistic characteristics, such as the use of classifiers, nominalizations, imperatives, and tenses.

The Chinese academic writing on science and technology dates back to the early 20th century when the Chinese Imperial Examinations System was abolished after nearly one thousand years of existence and when the introduction of scientific knowledge from the Western world took place. The important role science and technology play in strengthening national power was highly emphasized by scholars. They realized that the military defeat of China in the First Opium War from 1840 to 1842, the Second Opium War from 1856 to 1860, the First Sino-Japan war from 1894 to 1895, and the Siege of the International Legations from 1900-1901 were caused by the lack of both scientific and technological knowledge as well as social and political systematic knowledge. Yan (1895) proposed the guiding principles for saving China, i.e. arousing people's physical strength, refraining from taking opium, facilitating people's intelligence and wisdom by learning science and technology, and refreshing people's values and beliefs. Thereafter, the belief of 'saving the nation though science and education' became the consensus of the Chinese elite intellectuals, such as Kang Youwei and Liang Qichao. This idea was taken as the dogma by many magazines that were published after 1902. The representative journals established during that time include *Science Bulletin*, *Geography Periodical*, *Agriculture Periodical*, and *Journal of Liji Medical School*. Until 1911, when the democratic revolution led by Sun Yat-sen started, there were around 200 periodicals. After the democratic revolution, more journals were published, adding up to 900 till the establishment of the People's Republic of China by the Communist party led by Mao Zedong in 1949. Taking advantage of this political change, China started putting more effort in the development of science and technology as the nation entered in a

comparatively speaking more stable and independent era. To date, there are more than 6,000 Chinese journals in science and technology and social sciences, among which 50 journals are indexed by Science Citation Index. Some of the most illustrative examples in the field of science and technology are: *Chinese Science Bulletin*, *Communications in Theoretical Physics*, *High Energy Physics and Nuclear Physics*, *Journal of Computational Mathematics*, and *Journal of Materials Science & Technology*.

The great influence of Western scientific and technological knowledge on China has resulted in Chinese journal articles being the synthetic product of the Chinese and Western ideologies. For example, Chinese journal articles have the same components such as title, abstract, key words, introduction, conclusion and references, as their Western counterparts. However, they usually do not stick to the rigid IMRD format,[2] which is followed by the majority of Western scholars carrying out research in science and technology. In spite of the similarities to Western articles, Chinese scientific and technological articles possess certain features that are peculiar to the writing style of the Chinese language. For example, English is a synthetic language which makes a comprehensive use of forms (e.g. different forms of a verb for present and past tenses), word order and functional words to express complicated ideas. Long sentences are widely used, in which plenty of information fuses together with phrases embedded in clauses that themselves imbricate in those long sentences, as an attempt to be cautious in thinking and close in organization. Chinese, on the other hand, is a typical analytic language which mainly uses word order and functional words to express complex ideas, without resorting to any formal inflections. Short sentences, clauses, and

[2] IMRD (Introduction, Methods, Research and Discussion) is a common format used for academic research papers. While used primarily in the hard sciences, like physics and biology, it is also widely used in the social sciences.

running sentences are often used and arranged according to time or logical sequence with the aim of making narration achieve an order of priority and a gradual development. English sentences have a backbone which consists of the subject and main verb accompanied by other sentence items to which they are connected by conjunctions, hence resembling a flourishing tree, whilst Chinese sentences are joint together one segment after another, like a bamboo (Pan, 1997).

From the macroscopic perspective, a qualified academic journal article in Chinese should be up to standard in terms of content, format and language. Qualified content means that the article should explain an original idea, a new invention, an improved method, a significant experimental result, or an applicable technological finding. In short, the article should be worthy of scientific communication between researchers. To guarantee an efficient and effective communication, the format should be preferably understandable and shared among researchers. Usually, an academic article on science or technology talks about a very specialized topic in a certain area and can be, therefore, quite difficult to fully understand. The unification of format, to some extent, reduces these difficulties and makes perfect sense from the English and Chinese academic writing perspectives. Nonetheless, as long as language is part of the equation, differences between the two languages regarding the use of word bundles, tenses, sentence length, clauses, discourse markers, and so on are considerable.

To ensure the comparability of these features with the characteristics argued in section 2.2, section 2.3 will follow the same structure, explaining the key features of Chinese academic

journal articles on science and technology, paying special attention to grammatical, syntactical, lexical, and functional features.

2.3.1 Grammatical features of Chinese scientific and technological texts

This section generalizes the main grammatical features of Chinese scientific-technological texts, and focuses will be put on the use of numeral classifiers, aspect markers, and passive voice. These three features were profoundly studied in this research because of their frequent occurrences and undisputable importance in scientific and technological texts. First of all, since a large amount of scientific and technological articles nowadays are of an experimental and applied nature, authors need to describe the objects used in the experiments and classifiers are always used in the description of the objects. Since English is a non-classifier language, the translation of zero-classifier nouns from English into Chinese always poses problems. The translator has to find an appropriate Chinese numeral classifier for an English noun. It is important to correctly translate these nouns with corresponding Chinese numeral classifiers in that it demonstrates the accuracy of the amount of objects used in the experiments and facilitates the Chinese readers' understanding of the article, whilst strengthening their belief in the feasibility and value of the experiments. Secondly, the choice of tenses in English academic writing is very important because they signify the process of the research and sometimes even show the writer's stances on certain arguments. In a literature review, for instance, writers take a stance when they choose between past simple and present perfect, thus informing the reader of their opinion on the

previous research results. Writers tend to choose past simple when they only want to state what others have done, while they resort to present perfect tense to show that they think the previous research has impact or implication on their own research. On the contrary, the Chinese language is not a tense language, but rather an aspect language, in which aspect markers are used to indicate the time of the event. This difference lies in the nature of English and Chinese, and therefore translators have to compare and pair the English tenses with the Chinese aspect to ensure a correct transferring of meaning. Lastly, the passive voice is widely used in English scientific and technological texts, where the agent is not needed but the process being described is of ultimate importance to convey information. Passives are frequently used to highlight the theme, transmit the information and make the text more cohesive. On the other hand, the passive voice is less commonly used in Chinese scientific-technological texts on account of the flexible syntax of the Chinese language. Therefore, it is significant to discuss the strategies of translating English passives into Chinese.

2.3.1.1 Classifiers and numeral classifiers

Classifiers

In the late 1990s, a number of proposals for a typology of noun categorization systems emerged. These typological studies on classifiers were originated because of the consensus that profound understanding and categorization of classifiers are necessary, but these studies were carried out in different perspectives and dimensions. Allan (1977) differentiated four types of classifiers, i.e., numeral classifiers, concordial classifiers,

predicate classifiers, and intra-locative classifiers. Craig proposed four main types of classifier systems based on morpho-syntactic features: noun classifiers, numeral classifiers, verbal classifiers, and genitive classifiers (1986). Croft (1994) studied the classifiers from the syntactical perspective and divided them into five categories: noun classifiers, noun class, numeral classifiers, verbal classifiers and genitive classifiers. A further research by Aikhenvald (2000) added two more categories to this list, i.e., locative classifiers and deictic classifiers. The researchers' categorization of classifiers can be generalized as follows:

Allan 1977	Craig 1992	Croft 1994	Aikhenvald 2000
numeral classifiers	noun classifiers	noun classifiers	noun classifiers
concordial classifiers	numeral classifiers	noun class	noun class
predicate classifiers	verbal classifiers	numeral classifiers	numeral classifiers
intra-locative classifiers	genitive classifiers	verbal classifiers	verbal classifiers
		genitive classifiers	genitive classifiers
			locative classifiers
			deictic classifiers

As can be seen from the above table, 'numeral classifiers' has been discussed by all of the four researchers. It shows the frequent occurrences and importance of this type of classifiers. Furthermore, many of the modern journal articles on science and technology are of an experimental and applied nature, and science authors frequently use numeral classifiers to describe objects used in the experiments. The accurate translation of these numeral classifiers help the Chinese readers understand the experiment and research, and meanwhile strengthen the credibility and receptivity of the science articles. Therefore, the following section will focus on the classification and exemplification of numeral classifiers,

and meanwhile provide advice on how to translate the non-classifier English into Chinese with numeral classifiers.

Numeral classifiers

A numeral classifier is a classification word used in some languages between a numeral and a count noun that shows a conceptual classification of the referent of the noun when it is being counted or quantified (Allan, 1977). Classifiers are used in some Asian languages like Chinese, but not in English. For example, the Chinese equivalent of 'three flasks' is '三个烧瓶/san ge shaoping/ three unit flask'. Therefore, it is suggested that languages like English are non-classifier languages, whereas those like Chinese are classifier languages.

In English, a numeral can directly modify a count noun (e.g. three apples). For many Asian languages like Mandarin Chinese, a classifier is required when numerals combine nouns. For example, the Chinese equivalent of 'three flasks' is '三个烧瓶/san ge shaoping/ three unit flask'. '个/ge/unit' is used as a classifier to quantify the flasks. The classifier is chosen according to the properties of the noun, such as its shape, size, animacy, flexibility, and functionality (Allan, 1977). For instance, 'three experiment tables' is translated into Chinese as '三张实验台/san zhang shiyantai/ three sheet experiment table'. '张/zhang/Sheet' is a shape-based classifier that is normally used to quantify flat objects. To quantify mass nouns in English, a measure word is usually required between the numeral and the noun (three cups of water). This is the same case in Chinese. For example, the Chinese version of 'three cups of water' is '三杯水/san bei shui/ three cup water'. Since the quantification of mass

nouns are similar between English and Chinese, focuses of this research are put in understanding the difference of quantification of count nouns between English and Chinese.

Many researchers suggest that there are two general types of numeral classifiers: sortal and mensural classifiers (Allan 1977; Tai 1994; Zhang 2007). Sortal classifiers indicate quantificational units for sortal nouns, i.e. nouns that name things with natural quantificational units (Cheng et al, 1998). Examples for sortal classifier and noun phrases are '三个烧瓶/san ge shaoping/ three ge flasks', '三只果蝇/san zhi guoying/ three zhi drosophila', and '三条轨道/san tiao guidao/ three tiao orbits'. Sortal classifiers belong to a closed class, and sortal nouns usually have a relatively fixed and rigid association with a particular sortal classifier; using the correct classifier often requires memorization. That is, simply knowing the meaning of a noun and the meanings of a range of sortal classifiers would not necessarily allow speakers to select the proper classifier. For example, although both '叶子/yezi /leaf' or '帖子/tiezhi /sticker' denote flat objects, the former is quantified by '片/pian/ piece', while the latter is quantified by '张/zhang/sheet'. Mensural classifiers, on the other hand, form a more temporary relationship with the nouns (Tai 1994). These classifiers are often open-class words and are typically nouns that are used as units of quantification. For instance, '杯/bei/cup' is a noun, and like any noun, it can be counted with its associated sortal classifier '个/ge/unit', e.g. '三个杯/san ge bei/ three cup'. However, '杯/bei/cup' can also be used as a classifier to indicate quantity, as in '三杯水/san bei shui/ three cup water'. In this sense, mensural classifiers are similar to the measure words in English.

The Chinese language may have dozens of noun classifiers (Zhang, 2007). It should be noted that the number of classifiers that are used in everyday informal conversation is lower. Erbaugh (1986) has claimed that about two dozen core classifiers account for most classifier use. For instance, there is a general classifier '个/ge/unit' in Chinese that may often (but not always) be used in place of other classifiers. Especially in informal and spoken language, native speakers tend to use this classifier far more than any other, even though they know that another classifier is more appropriate. The sentence 'You used five experiment tables' should be '你用了五张实验台/ni yongle wu zhang shiyantai/ you used five sheet experiment table' in Chinese, but sometimes the Chinese would say '你用了五个实验台/ni yongle wu ge shiyantai/ you used five unit experiment table'.

Classifiers are further subdivided into count and mass classifiers (Tai, 1994). The difference between them can be described as categorizing versus quantifying. Count classifiers are used for naming or counting a single count noun and have no direct translation in English. For example, '一个烧瓶/yi ge shaoping/ one CL flask' can only be translated in English as 'one flask' with the CL (classifier) being omitted. Mass classifiers do not show the inherent properties of the noun as count noun classifiers do. Instead, they just make mass nouns into countable units. Thus, one mass classifier can generally be used with multiple mass nouns. For example, the mass classifier 'he' (box) can be used to count boxes of potassium permanganate (一箱高锰酸钾/yi xiang gaomengsuanjia/one box potassium permanganate) or of beakers (一箱量杯/yi xiang liangbei/ one box beakers). While count classifiers have no direct English translation, mass classifiers often do.

Although there is not a one-to-one rule for pairing nouns and classifiers, a native speaker usually knows which classifier can be used for a particular noun. For example, flat objects generally take the classifier '张/zhang', machines '台/tai', mountains '座/zuo', animals '只/zhi'. A count noun usually has one or more correspondent classifiers, and one classifier may be used for different nouns. For instance, 羊/yang/sheep may be counted using the classifiers '只/zhi' and '头/tou'. The classifier '条/tiao' can be used to quantify any objects that are long, thin, and flexible, such as ropes, fish, ties, or ribbons. Each classifier represents a category of objects which fall into the same set of conditions (Hu, 1993). As in the former example, the classifier '条/tiao' would represent a category defined as all objects that meet the conditions of being long, thin, and flexible, and nouns using that classifier must fit all the conditions with which the category is associated.

Since the English language does not have count classifiers and the Chinese count classifiers are paired to their own category of nouns, it is usually quite difficult to translate the quantified nouns from English into Chinese with the correct classifiers. In translating science and technology from English to Chinese, the translator always has to face the problem of translating zero-classifier in English to the noun-specific classifiers in Chinese. This is particularly so as a large amount of journal articles on science and technology nowadays are of an experimental and applied nature, and authors need to describe the objects used in the experiments. The right translation of these nouns with correct Chinese classifiers facilitates the Chinese readers' understanding of the article, whilst strengthening their belief in the feasibility and value of the experiments.

Translation techniques for the numeral classifiers

As stated above, this section demonstrates the translation techniques of non-classifier English nouns into Chinese nouns with numeral classifiers. Three examples are provided as follows.

a) translate English zero-classifiers nouns into Chinese nouns with sortal classifiers

	numeral	zero-classifier	count noun
English	one	×	test-tube
Chinese translation	一	支	试管
Chinese Pinyin	yi	zhi	shiguan
Back translation	one	unit	Test-tube

b) translate English nouns with measure words into Chinese nouns with mensural classifiers

	numeral	Measure word	mass noun
English	one	Tablet of	aspirin
Chinese translation	一	片	阿司匹林
Chinese Pinyin	yi	pian	asipilin
Back translation	one	piece	aspirin

c) translate English abstract nouns with ‘a + count noun + of’ structure into Chinese nouns with sortal classifiers

	numeral	‘count noun + of’ structure	abstract noun
English	a	glimmer of	hope
Chinese translation	一	线	希望
Chinese Pinyin	yi	xian	xiwang
Back translation	one	string	hope

To summarize, on the one hand, count nouns in English do not have classifiers and they can appear immediately after a numeral. On the other hand, English mass nouns always appear together with the ‘numeral + count noun + of’ structure. On the contrary, both count and mass nouns in Chinese appear with classifiers, with sortal classifiers being used before count nouns and mensural classifiers being used before mass nouns. Therefore, the English zero-classifier count nouns can always be translated into Chinese count nouns with sortal classifiers, and the English mass nouns with the ‘numeral + count noun + of’ structure can be translated into Chinese mass nouns with mensural classifiers.

2.3.1.2 Aspect markers in Chinese

As explained in section 2.2, the choice of tenses in English academic writing is very important because they signify the process of the research and sometimes even show the writer’s stances on certain arguments. In a literature review, for instance, writers take a stance when they choose between past simple and present perfect, thus informing the

reader of their opinion on the previous research results. Writers tend to choose past simple when they only want to state what others have done, while they resort to present perfect tense to show that they think the previous research has impact or implication on their own research.

However, in Chinese there are no verbal tenses and the main difference between English and Chinese grammars is that the former is a tense language while the latter is an aspect language. As discussed in section 2.2, English speakers use tenses to indicate actions in time - past, present and future -, with corresponding rules for verb conjugation. For instance, the English verb 'go' conjugates as 'going, gone, went' depending on the time the situation occurs. On the contrary, Chinese does not have these types of tenses as verbs do not conjugate. The Chinese verb 'qu/go' is always the same, no matter what the time frame is for the situation. Instead of using tenses, Chinese speakers specify time frames with aspect by using aspect markers before or after the verbs. The aspects markers 'le' and 'zai' are used to indicate different internal temporal continuance of a situation. The following two sentences show that there are no inflections of the verbs to show the time frame of the event and, instead, certain markers are used to indicate the time of the event:

Chinese characters	我 做了 实验	我 在做 实验
Chinese Pinyin	Wo zuo 'le' shiyan.	Wo 'zai' zuo shiyan.
English translation	I did the experiment.	I am doing the experiment.
Back translation	I do 'le' experiment.	I 'zai' do experiment.

The only lexical difference between the two sentences is that they use a different aspect marker, but their meanings differs in that the former sentence show that the action has been finished while the latter indicates that the action is being progressed.

According to Comrie (1985), tense is the grammaticalized expression of the location of a situation in time, and aspect is the grammaticalized expression of internal temporal constituency of events, processes, etc. While tense relates the time of a situation to some other time, usually the time of speaking, aspect conveys other temporal information, such as duration, completion, or frequency, as it relates to the time of action. The most fundamental aspectual distinction, represented in many languages, is between perfective aspect and imperfective aspect. Essentially, the perfective aspect looks at an event as a complete action, while the imperfective aspect views an event as the process of unfolding or a repeated or habitual event, thus corresponding to the progressive or continuous aspect for events of short-term duration and to habitual aspect for longer terms (Klein, 1994).

In Chinese, the perfective aspect is indicated by the markers ‘le’ and ‘guo’, while the imperfective aspect markers are ‘zai’ and ‘zhe’. The aspect marker ‘le’ is generally considered a perfective marker, presenting a situation in its entirety, as an event bounded at the beginning and the end without reference to its internal structure (Chao, 1968). However, some researchers like Li & Thompson (1981) argue that ‘le’ does not by itself indicate a completed event or action and consider, instead, that the meaning of completion often comes from the meaning of the verb with which ‘le’ occurs. For example, when the verb encodes a situation with a clear temporal boundary, ‘le’ indicates that the situation comes to its natural endpoint, namely, its completion (Example 1); but when the verb

encodes a situation with no natural boundary, 'le' signals the termination rather than completion of a situation (Smith 1991), as can be seen in example 2:

Example 1:

Chinese characters	小白鼠	感染了	细菌
Chinese Pinyin	Xiaobaishu	ganranle	xijun
English translation	The white mouse	was infected with	bacteria
Back translation	White mouse	infected 'le'	bacteria

Example 2:

Chinese characters	粒子碰撞机	启动	了
Chinese Pinyin	Lizipengzhuangji	qidong	'le'
English translation	The particle collider	was started	
Back translation	Particle collider	start	'le'

In example 1, the activity of 'was infected with' has been completed, whereas in example 2, the action of 'was started' was terminated, because in example 1, there is a resultative endpoint indicating a result has been achieved, while in example 2, 'le' indicates that the event took place and terminated at some indefinite point.

Another perfective aspect marker, 'guo', generally considered as an 'experiential marker', indicates that an event has been experienced at some indefinite time, usually in the past. It differs from 'le' in that it involves both reference time and speech time, thus indicating more of a 'perfect' status than a 'perfective' status (Smith, 1991). The following two examples illustrate the difference:

Example 3:

Chinese characters	小白鼠	感染了	细菌
Chinese Pinyin	Xiaobaishu	ganran ‘le’	xijun
English translation	The white mouse	was infected with	bacteria
Back translation	White mouse	infected ‘le’	bacteria

Example 4:

Chinese characters	小白鼠	感染过	细菌
Chinese Pinyin	Xiaobaishu	ganran ‘guo’	xijun
English translation	The white mouse	has been infected with	bacteria
Back translation	White mouse	infected ‘guo’	bacteria

In example 3, ‘le’ indicates a completed action of ‘was infected’, and the mouse may be still infected with these bacteria. Example 4 means that the mouse was infected with bacteria at a certain time in the past, but it may have recovered and been clean of these bacteria. As can be seen, the difference between the above two sentences is the reference time of the utterance. Li and Thompson (1981) also state that ‘le’ and ‘guo’ differ in ‘definiteness’ and whereas ’le’ indicates boundedness of a specific or definite event, ‘guo’ only indicates that the event described has occurred sometime.

The particle ‘zai’ has first been recognized as a verb, then as a locative preposition, and recently as an imperfective aspect marker (Li & Bowerman, 1988). As a preposition, ‘zai’ can occur both before and after a verb, while as an aspect marker it can only occur before the verb (Zhu, 1981), to indicate that an action or event is in progress.

The particle ‘zhe’ indicates that a situation is viewed as enduring or continuing. Usually, the ‘zhe’ verb phrase is not the predicative of the sentence but only background information, and tends to appear as the V + ‘zhe’ + V constructions.

The two imperfective markers ‘zai’ and ‘zhe’ differ in the verb types to which they can be applied. ‘Zai’ can be used with dynamic verbs, whereas ‘zhe’ can be used with stative verbs. Smith (1991) also argues that ‘zai’ has a dynamic meaning, while ‘zhe’ has a static meaning, but the dynamicity or stativity depends on the verb to which the particles apply to rather than the particles themselves.[3] For example, the verb ‘chuan’ can be translated into English as either ‘put on’ or ‘wear’, depending on whether the aspect marker is ‘zai’ (‘put on’) or ‘zhe’ (‘wear’):

Example 6:

Chinese characters	小明 在穿 毛衣。
Chinese Pinyin	Xiaoming ‘zai’ chuan maoyi
English translation	Xiaoming is putting on a sweater.
Back translation	Xiaoming ‘zai’ put on sweater.

Example 7:

Chinese characters	小明 穿着 毛衣。
Chinese Pinyin	Xiaoming chuan ‘zhe’ maoyi
English translation	Xiaoming is wearing a sweater.
Back translation	Xiaoming wear ‘zhe’ sweater.

[3] Another comprehensive exposition of the Chinese aspect markers can be found in Li and Thompson (1981).

To summarize, Chinese as an aspect language has an almost complete set of markers to express different temporal perspectives, and the basic viewpoint distinction is drawn between perfective and imperfective. On the other hand, English, as a less aspectual language, only differentiates between the simplex viewpoints of progressive, perfect and simple aspect (Biber et al. 1999). When translating from English into Chinese, the translator has to decide on which Chinese aspect should be used to render the original English tense and aspect. This is especially crucial in the translation of scientific-technological English texts, where tense not only signifies the process of the research, but also shows the author's stance

2.3.1.3 Passive voice in English and Chinese scientific and technological texts

The passive voice is one of the most common syntactic constructions across many languages, including English and Chinese (Keenan and Dryer, 2007), taking a variety of forms in different languages, such as the 'be' passives in English and the 'bei' passives in Chinese. As discussed below, there are some universal features of passive constructions commonly shared by the world's languages, but there are also differences between languages upon how these constructions function.

Keenan and Dryer (2007) have analysed passive sentences based on the syntax of passive sentences, and categorized them into 'clause-level syntax' and 'verb-level syntax'. These two categories not only seem to cover all the universal features shared by the world's languages, but also sum up all different approaches to passive syntax analysis.

Clause-level syntax describes the relations between the three elements of a passive sentence, i.e. agent, patient and action. All passives can be viewed as the foregrounding or backgrounding of certain information of the sentence (Foley & Van Valin, 1985). In passive formation, foregrounding refers to the promotion of the patient phrase to the subject position, while backgrounding refers to the demotion of the agent to an oblique position or the diminishing of the agent (Foley & Van Valin, 1985; Keenan and Dryer, 2007). The foregrounding and backgrounding have a significant impact on the two semantic roles involved in the passive voice, i.e. agent and patient. In passive voice, even though the patient functions as the "syntactic subject" of the verb phrase, the agent phrase remains as the "semantic subject" of the transitive verb, (Keenan and Dryer, 2007: 332). Passive voice, in a sense, is the subject-verb relationship between the patient and the verb phrase (Wang & Li, 2007).

Verb-phrase syntax focuses on the explicit indication of the direction of action through the marking of the verb phrase. The formation of passives takes place by deriving verb phrase in certain ways (Keenan and Dryer, 2007; Huddleston et al., 2002). According to Keenan and Dryer (2007), the main verb in the passive verb phrase is usually transitive in its non-passive form, expressing an activity in which the agent is the semantic subject and the patient the semantic object. Keenan and Dryer (ibid.: 337) further argues that the only major difference between the active and the passive lies in the form of the verb. The active transitive verb takes both subject and object agreement, while passive intransitive verbs take only subject agreement. The passive verb phrase is formulated through the syntactic and morphological modifications of the transitive verbs (Keenan and Dryer, 2007). It should be noted that the auxiliary or syntactic modification mentioned here largely refers to the passive markers,

such as ‘be’ in English and ‘bei’ in Chinese. The presence of these passive markers indicates that the subject is being acted upon rather than performing the action of the main verb, making the direction of action explicit (Charrow et al., 2001).

Huddleston et al. (2002: 1427) claim that passives in English are determined by their syntactic rather than semantic properties, making it clear that they prefer the verb-level syntax as the way to distinguish passives. In English, verb-level syntax consists of the auxiliary verb and the morphological inflection (e.g. past particle) of the main verb. Syntactic properties prevail over semantic properties in the determination of voice due to the clarity in form. However, Chao (1968) claims that there is no voice distinction of Chinese verbs because the direction of action in the Chinese sentence structure is largely ambivalent. Even though the direction of action can sometimes be determined by the semantic interpretation of the relations between the topic and the main verb, it is only through passive markers such as ‘ba’ and ‘bei’ that the direction of action is explicitly specified (Chao, 1968). Chinese is not a voice language and does not function as English. Instead it expresses passives in a different way. As stated by Keenan and Dryer (2007), languages without passives have somewhat more grammaticalized means for expressing functional equivalents of basic passives. In this sense, it is true that besides the most identified ‘bei’ passives and its variations, there are many other constructions that perform the equivalent function of passives in Chinese, such as notional passives like the ‘shi…de’ constructions (Li & Thompson, 1981).

According to Keenan and Dryer (2007), there are four categories of passive markers in English: (1) the auxiliary verb of being (be, to be, been) or becoming; (2) the auxiliary verb of

reception (get, receive); (3) the auxiliary verb of motion (go, come); (4) the auxiliary verb of experience (suffer, touch). Based on the type of auxiliary verbs, English passives can be divided into three categories: (1) be-passive, (2) get-passive, and (3) bare-passive (no auxiliary verb) (Huddleston & Geoffrey, 2002).

In Chinese, the passive marker 'bei' as a passive auxiliary verb of experience can be replaced by a number of other passive markers with built-in content meanings (Keenan and Dryer, 2007). A number of alternatives are identified by many scholars (e.g. Feng, 1990; Reynolds, 1995; Ting, 1996), such as jiao/ to ask, rang/ to let, gei/ to give, ai/ to suffer, shou/ to receive, zao/ to experience bad circumstances, wei…suo/ structure without content meaning, huo/ to receive something good. Since Chinese does not have morphological inflection, passives are the result of the combination of these passive markers with main verbs. On occasions, no passive marker is used but the sentence shows passive meaning as in the case of the verb 'yuhai/experiencing harm', which usually means 'being killed'.

To summarize the different passive markers in English and Chinese, the following table is generated:

Table 9: Categorization of English and Chinese passive markers

Category of passive marker	**Passive marker of being or becoming**	**Passive marker of reception**	**Passive marker of experience**
English	be-passive	get-passive	bare-passive
Chinese	wei wei…suo	shou huo gei rang jiao	bei zao

As concluded in section 2.2, the passive voice is widely used in English scientific and technological texts, where the agent is not needed but the process being described is of ultimate importance to convey information. Passives are frequently used to highlight the theme, transmit the information and make the text more cohesive. On the other hand, the passive voice is less commonly used in Chinese scientific-technological texts on account of the flexible syntax of the Chinese language. Therefore, when dealing with English-Chinese translation, translators should avoid keeping the original English pattern, and try to convert the passive voice into a more acceptable Chinese version of either passive or active voice. The translation of passives will directly influence the readers' perception of the writers' knowledge on science and technology.

Based on the comparison of passive structures and passive markers between English and Chinese presented earlier in this chapter, it can be said that there is a discrepancy in the frequency of using passives in English and Chinese texts, with English using more passives than Chinese. Therefore, in translating from English into Chinese, the translator can choose to translate the English passives into Chinese actives or passives, either with or without passive markers. The most common methods of translating English passives into Chinese can be classified into five ways as generalized by the author and listed and exemplified as follows:

a) Translate into Chinese passives without passive markers

Sometimes, Chinese verbs can express the passive voice without using passive structure or passive markers and the subject of the original sentence will be unchanged in the Chinese version:

Example 8:

English original text	The World Health Organization estimates that 1.7 billion people are infected with mycobacterium tuberculosis.
Chinese translation (character)	世界 卫生 组织 估计 有 17 亿人 感染了 肺结核
Chinese translation (pingyin)	Shijie weisheng zuzhi guji you 17yi ren ganran le feijiehe.
Back translation	World health organization estimate 1.7 billion people infect tuberculosis.

The passive structure 'are infected with' is translated into the active voice with the verb 'ganran/infect' because the verb 'ganran' itself expresses passive meaning in its active form in Chinese.

b) Translate into Chinese passives with passive markers

In the following example, the passive marker 'huo' is used to render the passive voice of the original sentence:

Example 9:

English original text	Officials from the national aeronautics and space administration said 300 researchers in industry, government and education would be permitted to use the system.
Chinese translation (character)	美国宇航局官员说，工业，政府，和教育部门的 300 名研究人员将获准使用这个系统。
Chinese translation (pingyin)	Meiguo yuhangju guanyuan shuo, gongye, zhengfu he jiaoyu bumen de 300 ming yanjiu renyuan jiang huo zhun shiyong zhege xitong.
Back translation	National aeronautics and space administration officials said, industry, government, and education departments 300 staff will *huo* permission use the system.

c) Translate into a Chinese active: Change the original subject into object

In the following example, the subject of the English sentence is used as the object in the Chinese translation so as to make the sentence simpler and comply with the conventions of scientific texts.

Example 10：

English original text	In chemistry, symbols are used to represent elements.
Chinese translation (character)	化学用符号代表元素。
Chinese translation (pingyin)	Huaxue yong fuhao daibiao yuansu.
Back translation	Chemistry use symbols represent elements.

d) Translate into a Chinese active: Change into sentence with no subject

As illustrated in the next example, one way of translating the English passive is by means of a sentence in which no subject is used in Chinese:

Example11:

English original text	Many strange new means of transport have been developed in our century, the strangest of them being perhaps the hovercraft.
Chinese translation (character)	在我们这个世纪内研制了许多新奇的交通工具，其中最奇特的也许就是气垫船。
Chinese translation (pingyin)	Zai women zhege shijinei yanzhi le xuduo xinqi de jiaotong gongju, qizhong zui qite de yexu jiushi qidianchuan.
Back translation	In our this century, develop le many new transport tools, among strangest de perhaps is hovercraft.

e) Translate into a Chinese active: Add a generic subject

The English passive can also be rendered by adding a subject made up of a generic noun like 'renmen (people)' or a personal pronoun like 'we':

Example 12:

English original text	Gases are frequently regarded as compressible, liquid as incompressible.
Chinese translation (character)	人们通常认为气体是可以压缩的，而液体则不可以压缩。
Chinese translation (pingyin)	Renmen tongchang renwei qiti shi keyi yasuo de, er yeti ze bukeyi yasuo.
Back translation	People usually think gases are compressible *de*, but liquid not compressible.

After an detailed explanation of the grammatical features related to Chinese scientific-technological texts, syntactic features will be analysed in the following subsection.

2.3.2 Syntactic features of Chinese scientific and technological texts

The purpose of this section is to generalize the syntactic features of Chinese scientific and technological texts and make comparisons with its English counterpart. Main features to be discussed include nominalization, imperatives, and attributive clauses.

2.3.2.1 Nominalization in English and Chinese

Nominalization is any process by which either a noun or a syntactic unit functioning as a noun phrase is derived from any other lexical unit (Matthews, 1997). For example, a verb or an adjective can be used as the head of a noun phrase, with or without morphological transformation. Halliday (1994) defines nominalization as any element or group of elements made to function as a nominal group in the clause. Nominalization occurs in nearly all languages around the world, the difference being that in some languages verbs or adjectives can be simply used as a noun without any morphological change while in other languages it is necessary to make a morphological change to form a nominalization.

English recurs to both types of nominalization. The morphologically transformed nominalization is formed by adding a derivational suffix to the verbs or adjectives. The cases where the verbs or adjectives are directly used as nouns are referred as zero-derivation (Halliday, 1994). The following table gives some examples of English nominalization:

Table 10: English nominalizations

	Original	**noun**
Nominalization from verbs	confuse	confusion
	realize	realization
	develop	development
	swim	swimming
Nominalization from adjectives	stable	stability
	difficult	difficulty
	vague	vagueness
	fearless	fearlessness
Zero derivation nominalization	murder	murder
	change	change
	smile	smile
	jump	jump

The gerund form or the –ing form of a verb can always be used as a noun phrase in English, such as running, jogging, and swimming. In addition to true zero-derivation, English also has a number of words which can be used either as nouns or verbs, depending on the subtle pronunciation variant. The pronunciation change is caused by changing the stress placement, usually from the last syllable to the first syllable. For example, 'progress' can be used either as a verb (the stress is on the second syllable) or a noun (the stress is on the first syllable).

Similar to English, Chinese also has two types of nominalization, namely, zero derivation nominalization and transformed nominalization. However, unlike English, Chinese has more zero derivation nominalizations than transformed nominalizations since many verbs and adjectives can be used as noun phrases without any change (Sun & Cong, 2005). Even with the transformed nouns, there are no morphological transformations. Instead, particles such as 'de' are added to form noun phrases. 'De' is actually the most common particle attached to verbs and adjectives to form nominalization. For example, the verb '喝/he (drink)' functions as a noun, '喝的/he de (the drink that was drunk)'. There are a number of variations of the 'de' structure, including (a) genitive agent nominals, (b) possessive objects, (c) 'de' expression without verb, and (d) internal 'de' expression (Tang, 2011).

Mandarin has the adnominal usage of 'de' in genitive agent nominals. Huang (1997) identifies the genitive agent nominal as a gerundive nominal which expresses the action of doing something, as in the following example:

Example13:

Chinese characters	他 的 校长 演得 好
Chinese Pinyin	Ta de xiaozhang yan-de hao.
English translation	He acts very well as a headmaster.
Back translation	He de headmaster act well.

In this sentence, ‘ta de xiaozhang/ he de headmaster’ is a reduced form of ‘ta de dang xiaozhang/ he acts as a headmaster’. This sentence can be paraphrased as ‘talking of his acting as a headmaster, he acts very well’. Therefore, ‘acting as a headmaster’ is a gerundive construction, comparable to the English gerund functioning as a noun.

Objects in some Mandarin sentences are in possessive form. In these cases, the possessive form with ‘de’ functions as a noun phrase to work as the object of the sentence:

Example 14:

Chinese characters	他 生 我的 气。
Chinese Pinyin	Ta sheng wo de qi.
English translation	He is angry at me.
Back translation	He bear me de anger.

In this sentence, ‘wo de’ literally means ‘my’, but it should be interpreted as ‘me’ and referred to as possessive objects (Huang 1997).

In Chinese, there are sentences that do not have a verb, and 'de' is used after the subject. The meaning of the omitted verb can be figured out if rich contextual information is provided:

Example 15:

Chinese characters	谁　　的　老板
Chinese Pinyin	Shui　de　laoban?
English translation	Who works as the boss?
Back translation	Who　de　boss?

Structures showing the adnominal usage of 'de', preceded by the verb and followed by the object, are called 'internal de expressions' in Chinese. In the following example (Ono, 2001), 'baogao/report' is the head of a predicate nominal, which is modified by the attributive 'zuotian xie de/ written yesterday':

Example 16:

Chinese characters	他　昨天　　写　的　报告。
Chinese Pinyin	Ta　zuotian　　xie　de　baogao.
English translation	He wrote the report yesterday.
Back translation	He　yesterday　write de　report.

Sugimura (1999) observes an interesting fact about the 'internal de expressions', namely that these expressions are anaphoric, and thus tend to pick out an action in the preceding discourse as their antecedent:

Example 17:

Chinese characters	后来 他们 就 动了手。 谁 先 动的手？
Chinese Pinyin	Houlai tamen jiu dong-le shou. Shui xian dong de shou?
English translation	Later on, they took action. Who did it first?
Back translation	Later they then move-le hand. Who first move de hand?

In the above sentence, 'dong de shou/take action' refers to 'dong-le shou/have taken action' in the preceding sentence based on the contextual information.

Sugimura's (1999) claim is further discussed by Kimura (2003), who proposes that the function of the 'de phrase' in the 'internal de expressions' is to modify an action by defining its property. Using the above example, it can be said that 'internal de expressions' refer to an event of 'taking action' presupposed in the discourse. The 'de phrase' attributive is to restrict the domain of this presupposed event by expressing its temporal property, namely, the time the action took place.

The wide use of nominalization is a striking feature of written language with which people tend to think metaphorically rather than congruently (Matthews, 1997). Nominalization is also one of the most prominent features of scientific and technological writings, playing an important role as indicator of formality, as well as an important means to achieve clarity and other stylistic effects. Nominalization has also been regarded as the single most powerful resource for creating grammatical metaphors (Halliday, 1994). Let us consider the following sentences:

Example 18:

Prolonged exposure will result in rapid deterioration of the item.
If the item is exposed for long, it will rapidly deteriorate.

Here, it can be argued that the second way of writing seems more direct or easier to understand, while the first sentence is more formal.

Mo and Shan (1985) have made a statistic study on Chinese nouns, verbs and adjectives and their functions in the sentence and have found that these three classes of words can cover almost all grammatical functions in a clause. Their results are shown in table 3, where it can be seen that verbs and adjectives are more likely to be nominalized as objects (8.89%) than as subjects (2.63%):

Table 11: Nouns, verbs, adjectives and their functions in the sentence (%)

%	Subject	Predicate	Object	Attribute	Adjunct	Complement
Nouns	21.2	0.18	49.04	20.9	6.5	0
Verbs	0.91	76.7	2.86	6.52	7.15	5.86
Adjectives	1.72	26.2	6.03	42.0	19.1	4.8

Sun & Cong (2005) conducted a comparative study on nominalization in English and Chinese scientific texts. They studied 100 sample clauses extracted from scientific texts in the fields of computer science, physics and military science and concluded that nominalizations fall into two categories: nominalized clauses and non-finite verbal clauses. Based on the

function of the nominalizations in the sentence, they concluded the results into the following table.

Table 12: Nominalization in English and Chinese scientific texts

	Subject		Object	
	English	**Chinese**	**English**	**Chinese**
Computer science	3	5	1	0
Physics	2	4	2	3
Military science	5	11	4	4
TOTAL	10	20	7	7

From the above table, it can be concluded that both English and Chinese are nominalized languages, and that nominalized forms tend to function more as a subject than an object in both English and Chinese. However, more Chinese sentences have nominalized forms functioning as subjects. Another conclusion for this section is that, there are more morphologically transformed nominalizations than zero derivation nominalizations in English; whereas, Chinese has more zero derivation nominalizations and less transformed nominalizations which is formed not by morphological change but by adding certain particles.

2.3.2.2 Comparison of imperatives in English and Chinese

Authors use imperatives for various strategic purposes such as engaging the reader, achieving text economy, or manifesting personal style (Swales et al., 1998). According to

Brown and Levinson (1987), imperatives may commonly be found in instruction manuals and textbooks, but they seem to appear less frequently in scholarly works. The reality is that there is a notable absence of specific studies on the use of imperatives in scholarly papers, perhaps partly due by the popular belief that imperatives are uncommon in formal academic prose. This notion started to change a few decades ago, when Myers (1989) pointed out that in scientific articles writers can use imperatives in the method section without imposing any kind of threat, on the assumption that readers are interested in learning the announced techniques and procedures of the experiments. However, according to later research done by Swales et al. (1998), imperatives are used by many academic writers not only in the method section but in other sections as well.

Swales et al. (ibid.) designed a study to explore the role of imperatives, their syntactic and rhetoric functions, in academic articles. They argue that imperatives should be seen as textual signals by which academic writers manipulate various rhetoric strategies. They think imperatives are a tricky but effective persuasive device for academic writers. This study offers only a short and somewhat speculative acknowledgement that this area is under researched. Neither the APA Publication Manual (1994) nor the MLA Style Manual (Achert and Gibaldi 1985) seem to acknowledge the use of imperatives as a possible grammatical structure for the scholarly writer.

Swales et al. (1998) conducted a corpus study on the imperatives used in 50 academic journal articles across ten disciplines, totalling 365,000 tokens. They first proposed an operational definition of imperatives which would be explicit enough so as to allow a consistent judgement among the members of the research team who were in charge of

different fields, and could also lead them to an efficient survey of imperative occurrences in as many disciplines as possible. Given these considerations, a definition based mainly on the syntactic form was put forward, drawing on existing studies such as Quirk et al. (1985). Following these authors, an imperative sentence is defined as a sentence which has no surface subject but has either a main verb or emphatic 'do' in the base form and without any modals. Under this definition, all instances of the verb 'let' were taken to be imperatives in both first-person contexts and in third-person ones.

They concluded with three tables of quantitative results of imperatives use in the 50 academic articles. Table 13 shows the occurrences of imperatives in the main texts for each discipline, whilst Table 14 gives the ratio between imperative verbs and all words for each discipline. Finally, Table 15 shows the most frequently used lexico-syntactic patterns of imperatives in all the articles from all the ten disciplines.

Table 13: Occurrences of imperatives in main text of each discipline (Swales et al, 1995)

Discipline	**Occurrences of imperatives**
Statistics	141
Linguistics	103
Experimental geology	51
Philosophy	40
History	12
Chemical engineering	10
Art history	5
Literary criticism	3
Political science	0
Communication studies	0

Table 14: Ratio of imperative verbs to total number of words (Swales et al, 1995)

Discipline	Ratio
Statistics	1: 298
Linguistics	1: 457
Experimental geology	1:844
Philosophy	1: 1567
History	1:3120
Chemical engineering	1:3676
Art history	1:3800
Literary criticism	1:4700
Political science	0
Communication studies	0

Table 15: Most frequently used lexico-syntactic patterns for imperatives (Swales et al, 1995)

Imperative patterns	Occurrences
See	87
Consider	71
Note (that)	38
Suppose	25
Let A verb B	23
Let us	9
Recall	6
Define, Let me (verb)	4
Classify, Insert, Assume	3
Contrast, Calculate, Notice, Imagine, Denote, Use, Integrate, Set	2

These figures show great variation from one field to another. As can be seen from Table 13, there was an average of 28 imperatives per article in statistics, but none in political science and communication studies. The authors conclude that the more 'social sciences' the topic is, the less use of imperatives, whereas the more 'scientific' the topic is meant to be, the more imperatives are used. It is also shown in Table 14 that the three top fields are all those which tend to produce texts that not only consist of paragraphs, but also contain mathematical, experimental, or illustrative elements, and which, in consequence, may require rather more specific forms of reader-text management. As listed in Table 15, six

types of imperative patterns are most frequently used: ‘see’, ‘consider’, ‘note’, ‘suppose’, ‘let A+Verb+B’, and ‘let us’.

The use of imperatives can come from a variety of reasons, such as the writing tradition, the need for word economy, stylistic variation, and a desire to capture the reader's attention at certain key focus. The use of imperatives in English is also presumably connected with other contemporary academic writing trends, namely, trends towards increasing informality in scholarly writing (Van Maanen, 1995).

In Chinese, the term ‘imperative’ is used to refer to the type of syntactic construction which is marked by an implicit or explicit second person subject, and which expresses a direct command (Zhang, 1990). The imperative in Chinese is a complex, embedded sentence in the deep structure, consisting of a matrix sentence with a second person pronoun as subject, the verb ‘yao’, ‘yong’, ‘zhun’, etc. as the imperative main verb, and a complement sentence with a second person pronoun subject as well. The verb phrase which appears in the surface structure is derived from the complement sentence in the deep structure. The subject of this complement sentence is obligatorily deleted in the surface structure.

In the surface structure, that is, the structure manifested in the speech form, the imperative construction in Chinese is seemly simple, and can appear in the form of a single verb or verb phrase, as in:

Example 19

Single verb	**Verb phrase**
来	去打球
Lai.	Qu daqiu.
Come.	Go play basketball.
Come.	Go to play basketball.

Or in the form of a single noun or noun phrase, as in:

Example 20

Single noun	**Noun phrase**
水	一杯热水
Shui.	Yibei reshui.
Water.	A cup hot water.
Give me water.	Give me a cup of hot water.

Typically, the context for such a command, as noted by Chao (1968), is one in which the noun phrase represents the thing or things desired by the speaker. To soften a command, one of the verbs 'qing/please', 'laojia/trouble you' or 'mafa/to trouble' is often used at the beginning of the sentence. For example:

Example 21

'qing/please'	'laojia/trouble you'	'mafa/to trouble'
请用茶	劳驾递一下盐	麻烦你换一下位置
Qing yongcan	Laojia di yixia yan.	Mafan ni huan yixia weizhi.
Please eat.	Trouble you pass a little salt.	To trouble you change a little seat.
Please help yourself.	Please pass me the salt.	Please change a seat.

‘Qing’ is more appropriate in written language than ‘laojia’ or ‘mafan’ and, therefore, may be used in texts of instruction, where ‘laojia’ or ‘mafan’ are never used.

Negative forms of imperative constructions are usually referred to as prohibitions (van der Auwera, 2006). Negative commands in the form of verb phrases differ from alternative commands only because of the presence of the negative marker ‘bie’, which is used exclusively for the imperative:

Example 22

Chinese characters	明天 别 跟 姐姐一起来。
Chinese Pinyin	Mingtian bie gen jiejie yiqi lai.
English translation	Don’t come with your elder sister tomorrow.
Back translation	Tomorrow not with elder sister together come.

Commands in the form of noun phrases cannot be directly negated by ‘bie’, because no noun in Chinese can be negated directly. Consequently, the negative counterparts must take the form of negated verb phrases, as illustrated in the following example:

Example 23

Positive form	Negative form	Wrong negative form
水	别给我水	别水
Shui.	Bie gei wo shui.	Bie shui.
Water.	Not give me water.	Not water.
Give me water.	Don’t give me water.	

Concerning the negative form of the imperative construction, the word ‘bie’ has often been described as the contracted or abbreviated form of ‘buyao’ (Xiao & McEnery, 2005). The crucial question, from a translational perspective, is whether these two forms are semantic alternatives. ‘Bie’ and ‘buyao’ may not occur under the same pragmatic situation, and some speakers feel that the use of ‘bie’ may invoke a stronger and more abrupt demand while the use of ‘buyao’ gives a much softer tone. In other words, the impressions invoked by these two expressions are not quite the same.

Other negative forms of imperative are ‘buyong/not use’ and ‘bubi/ not necessary’, which are different in meaning from ‘bie’ and ‘buyao’. The latter items, i.e., ‘bie’ and ‘buyao’, only function as negative imperative particles, while the former are compounds composed of the negative particle ‘bu/not’ and either the verb ‘yong/use’ or the adjective ‘bi/necessary’, thus carrying the negative meaning of ‘don’t need to /don’t have to’:

Example 24

Chinese characters	不用来。
Chinese Pinyin	Buyong lai.
English translation	Don’t need to come
Back translation	Not use come.

Chinese is also different from English in that it allows for double negative imperatives, although they are less frequently used than other types of imperatives:

Example 25

别不去	别不听他的话
Bie bu qu.	Bie bu ting ta-de hua.
Don't not go.	Don't not listen his words.
You should go.	Do listen to him.

Another interesting characteristic of Chinese imperatives is that a subject noun phrase can appear in the surface structure. That is to say, the imperative sentence can start with a second person pronoun, such as 'ni/you' or 'nimen/you', which may be added to all of the imperatives, except for the ones formed by a single noun phrase:

Example 26

Right sentence	Wrong sentence
来 = 你来	水 ≠ 你水
Lai. = Ni lai.	Shui. ≠ Ni Shui
Come. = You come.	Water ≠ You water

Some imperative sentences in Chinese use the sentence final particle 'ba' to effect soliciting agreement:

Example 27

Chinese characters	我们起来吧。
Chinese Pinyin	Women qi lai ba.
English translation	Let's get up.
Back translation	We up come ba.

This final particle ‘ba’ may also optionally occur in an ordinary second person command, to soften the imperative force:

Example 28

Chinese characters	你睡觉吧。
Chinese Pinyin	Ni shuijiao ba.
English translation	Go to sleep. OK?
Back translation	You sleep ba.

To summarize, Chinese imperatives can take the form of a single verb or verb phrase and a single noun or noun phrase. Imperative negative forms are formed with the particles ‘bie’, ‘buyao’, ‘buyong’, or ‘bubi’, and double negative imperatives are possible in Chinese. In certain cases, a subject noun phrase can appear in the surface structure of the imperative sentence. Finally, some imperative sentences use the sentence final particle ‘ba’ to effect soliciting agreement. If ‘ba’ is used in first person plural commands, it conveys the idea of ‘let’s’.

After a complex explanation of the difference between English and Chinese imperatives, the following section is going to analyse the function of imperatives in academic writing, and also probe into the techniques for translating English imperatives into Chinese.

Imperatives are usually thought to have the function of commanding, suggestion, warning, threatening, citing, and inviting. For the imperatives in academic writing, Hyland (1994)

stated that imperatives were mainly used for five purposes: citation, suggestion, notification, description, and invitation.

a) citation

In academic writing, citation takes up a large proportion of an article. The most frequently used verb in citation is 'see', as in

'see Smith, 1990', 'see section---', 'see example ---'.

b) suggestion

Authors of scientific articles use imperatives to suggest on further discussion of certain arguments or discussions. The verb 'consider' is frequently used for this function, as in the following example:

To further illustrate the transmission medium for the Ebola virus, consider the following data from ---.

The verb 'consider' can also be used in imperatives to introduce a new discussion, as exemplified in the following sentence:

Next consider the effect of antibiotics in treating Ebola virus.

c) notification

In scientific academic articles, some important details that the author thinks can be easily skipped or ignored by the readers are always emphasized or notified by the author using imperatives with the verb 'note', as can be seen in the following example:

Note that bacteria A and B have different level of resistance to the antibiotics.

d) description

In English academic writing, some condition clauses are substituted by imperatives with verbs, such as 'suppose, assume, imagine', to describe a condition for a hypothesis.

Suppose a block rests upon inclined place.

e) invitation

Authors usually use imperatives with invitation to attract the readers' attention and promote the receptivity of their opinions. The structure 'let us + V' is usually used, as exemplified below:

Here let us further divide the cells into ---

Through the above-mentioned functions of imperatives, authors of academic articles try to achieve two goals, i.e. communication with readers and simplification of wording（Hyland, 1994; Swales et al, 1998）. To ensure the Chinese translations of imperatives achieve the same functions and goals of the original texts, translators are suggested to follow the techniques listed below.

a) direct translation of English imperatives into Chinese imperatives

Example 29

English imperatives	Work out the amount of air required for complete combustion of the fuel.
Chinese translation	计算出燃料完全燃烧所需要的空气量.
Chinese Pinyin	Jisuan chu yanliao wanquan ranshao suo xuyao de kongqi liang
Back translation	Calculate fuel complete combustion need air amount.

b) translate English imperatives into Chinese condition clauses

Example 30

English imperatives	Place a clean iron part in the solution of copper sulphate, and the part will be coated with red copper.
Chinese translation	如果把一个干净的铁制件放在硫酸铜溶液中，它就会涂上一层紫铜。
Chinese Pinyin	Ruguo ba yige ganjing de tiezhijian fangzai liusuantong rongye zhong, ta jiuhui tushang yiceng zitong.
Back translation	If put a clean iron part in the solution of copper sulphate, it will be coated with red copper.

c) translate the English imperatives into Chinese sentence with '我们/women/we' as subject

Example 31

English imperatives	Carry out a visual examination to ensure that equipment for fire fighters are of correct size and type.
Chinese translation	我们必须对灭火设备进行外观检查，以确保尺寸和型号准确无误。
Chinese Pinyin	women bixu dui miehuo shebei jinxing waiguan jiancha, yi quebao chicun he xinghao zhunque wuwu.
Back translation	We must have a visual examine of the fire equipment, to ensure the size and type are correct.

In conclusion, this section discusses the differences between English and Chinese imperatives. The author addresses this issue in details because the 'fringe phenomenon' of imperatives in scholarly articles has not been examined thoroughly as stated by Swales et al. (1998) and the translation of imperatives has seldom been researched. The functions of

imperatives were also studied and translation strategies were suggested for translating English imperatives into Chinese.

2.3.2.3 Comparison of attributive clauses in English and Chinese

Attributive clauses, also known as “adjective clauses”, are the most common and complicated subordinate clauses in English (Chen & Ke, 2008). They are always introduced by relatives, such as “who”, “whose”, “that”, “which”, “as”, “when”, “where”, and “why”. The function of the attributive clause is to modify, describe and add meaning to the headword. In English, attributive clauses always come after the word they modify and, according to Lu (1980), are likely to be very long since the reader already knows what is being talked about and the sentence may then be followed, theoretically, by an unlimited number of attributive clauses following the word being modified. English attributive clauses are classified into restrictive and non-restrictive (Chen & Ke, 2008). The former are closely related to the nouns or pronouns they modify, and thus no comma is added between the main and the subordinate clauses. The meaning of the complex sentence would be incomplete if the restrictive attributive clauses are omitted. On the other hand, non-restrictive attributive clauses have a comparatively loose connection with the nouns or pronouns they modify and they only function as supplement to the main clause. Thus, if non-restrictive clauses are omitted, the complex sentence still makes sense. A comma is usually used between the main and the non-restrictive attributive clauses.

On the contrary, attributive clauses in Chinese are always placed ahead of the word they modify, and thus they cannot be too long. If the attributive clauses are too long, the reader would have to wait till the sentence finishes to find out the noun or pronoun being modified. This violates the typical English theme-rheme rules and will cause confusion to the reader. This disparity in the way attributive clauses are structured in both languages is a clear challenge for English-to-Chinese translators.

Based on the comparison between English and Chinese attributive clauses, it can be concluded that two of the main differences are the length and position of the attributive clauses. In view of these differences, Lian (2006) proposes several methods of dealing with the translation of attributive clauses from English to Chinese, namely, (1) combining attributive clauses with the particle 'de', (2) dividing complex sentences into simple sentences, (3) mixing main clauses and attributive clauses, and (4) changing an attributive into an adverbial clause. These methods are explained in further detail in the following subsections. The examples were taken from scientific-technological texts.

1) Combining attributive clauses with 'de'

This is the most common method, in which the attributive is embedded in the Chinese sentence and placed before the noun or pronoun with 'de' being used as a connection word between them. This way, the complex English sentence gets converted into a simple Chinese sentence:

Example 32

English original text	Pollution is a pressing problem which we must deal with before the 2008 Olympic Games.
Chinese translation (character)	污染是在 2008 奥运会之前我们必须解决的紧急问题。
Chinese translation (pinyin)	Wuran shi zai 2008aoyunhun zhiqian women bixu jiejue de jinji wenti.
Back translation	Pollution is 2008 Olympic Games before we deal de pressing problem.

In the following example, the attributive clause 'which are small in size' is translated into a 'de' phrase and placed before the noun 'transistors':

Example 33

English original text	Transistors, which are small in size, can make previously large and bulky radios light and small.
Chinese translation (character)	体积很小的晶体管可以使以前体积庞大的收音机变得轻便小巧。
Chinese translation (pinyin)	Tiji henxiao de jingtiguan keyi shi yiqian tijipangda de shouyinji biande qingbian xiaoqiao.
Back translation	Size small de transistors can shi previoudly large and bulky de radios make light small.

2) Dividing a complex sentence into simple sentences

English is a hypotactic language within which sentences appear to be long and complicated since various modifiers are used to qualify a word; whereas Chinese is characterized by paratactic structures, which usually contribute to a short and brief sentence structure (Hsiao & Gibson, 2003). Taking these differences into consideration, English complex sentences

with attributive clauses can be broken into simple sentences when translating them in Chinese, as in the following example:

Example 34

English original text	The lightest element is hydrogen, the atom of which consists of nucleus of only one proton, round which revolves only one electron.
Chinese translation (character)	最轻的元素是氢。氢原子是由一个氢核构成。这个氢核中只有一个质子。而绕氢核旋转的只有一个电子。
Chinese translation (pinyin)	Zuiqing de yuansu shi qing. qingyuanzi shi you yige qingke goucheng. zhege qinghe zhong zhiyou yige zhizi. er rao qinghe xuanzhuan de zhiyou yige dianzi.
Back translation	Lightest de element is hydrogen. the atom of hydrogen is from one nucleus Composed. this nucleus in only have one proton. but round nucleus revolve de only have one electron.

This example illustrates how an English complex sentence can be broken into four Chinese simple sentences. In the process, some of the nouns in the original sentence are repeated twice or more in the four simple sentences to make them all comply with Chinese grammar.

3) Mixing main clauses and attributive clauses

When confronted with a complex English sentence, the translator can break up the attributive structure and mix the main clause and the attributive clause to form one sentence in Chinese. This translation method is especially adopted to translate 'there-be' sentences:

Example 35

English original text	There are many functions which can not be integrated.
Chinese translation (character)	有许多函数是不能积分的。
Chinese translation (pinyin)	You xuduo hanshu shi buneng jifeng de.
Back translation	Have many functions is can not integrate de.

In cases like the example above, the attributive clause becomes the main clause in the Chinese translation, while the original main clause becomes a prepositional or adverbial phrase that modifies the verb.

4) Changing into adverbial clauses

In English scientific and technological texts, some attributive clauses actually function as adverbials indicating result, cause, concession, condition and etc. (Ma, Zhang & Liu, 2011). These clauses are normally translated into separate simple units which also show the logical relations they have in the original complex sentence, but in a more overt way:

Example 36

English original text	The molecules of a body are separated by small spaces, within which they move rapidly around.
Chinese translation (character)	物体的分子之间存在小的空间，所以它们能够在其中迅速地移动。
Chinese translation (pinyin)	Wuti de fenzhi zhijian cunzai xiaode kongjian, suoyi tamen nenggou zai qizhong xunsu de yidong
Back translation	Body de molecules between have small space, therefore they can being around rapidly de move.

In the above example, the attributive clause ‘within which they move rapidly around’ is translated into a separate simple sentence in Chinese to show overtly the result of ‘the molecules of a body being separated by small spaces’.

To conclude, English is a language rich in attributive clauses, whose structure varies. English-to-Chinese translators have to analyse the syntactic structure of the original text first and then choose the right translation method to produce an acceptable Chinese version.

2.3.3 Lexical features of English and Chinese scientific and technological texts

This section analyses the lexical bundles that exist in English and Chinese academic writing. As argued by Biber et al (1999), academic prose presents distinctive distribution patterns of lexical bundles. These bundles are familiar to writers and readers who regularly participate in academic circles. Conversely, the absence of such bundles might reveal that the writer lacks fluency as a writer of that community. It is extremely beneficial to identify these bundles in an attempt to help translators understand the register of a particular academic community. On the other hand, a match of the English lexical bundles with their correspondent Chinese versions can alleviate the workload of the translator.

2.3.3.1 Lexical bundles in English and Chinese scientific and technological texts

Lexical bundles can be regarded as extended collocations, namely, sequences of three or more words that show a statistical tendency to co-occur in a register (Biber et al., 1999), e.g. 'do you want me to', 'I said to him', and 'in the case of the'. As a recently introduced category of word combinations, lexical bundles have been labelled by Biber et al. (1999) as the most frequently recurring lexical sequence in a register, regardless of their idiomaticity, and regardless of their structural status. As such, they do not necessarily correspond to complete structural units or to the combinations that could be identified as idiomatic expressions. That is to say, they are usually not complete structural units, nor fixed expressions.

Lexical bundles can be identified empirically and statistically, the latter meaning that frequency of occurrence is the defining characteristic for lexical bundles. According to Biber et al. (1999), for a word combination to count as a bundle, it must occur at least twenty times in a corpus made of one million words with the additional requirement that this rate of occurrence be realized in at least five different texts.

Lexical bundles also have other properties, such as fixedness in form and non-idiomatic meaning. Lexical bundles are fixed in the sense that the computer program that yields these word combinations calculates the frequency of the occurrence of the bundle only based on forms. For example, the computer program may generate frequencies for both the phrases

of ‘from the point of view’, and ‘the point of view’ from the sentence ‘The trade union leader thinks the issue from the point of view of an underpaid worker’. However, this fixedness is different from that of other word combinations, because it is determined by frequency of occurrence in a database rather than the phrase structure. Most lexical bundles are not idiomatic either. Instead, their meaning is transparent, fully retrievable from the meaning of the individual words that make up the bundle. This is the case of bundles such as ‘in the presence of’, ‘as a result of’, ‘I want you to’, and ‘what do you mean?’, for instance.

Lexical bundles should be distinguished from both idioms and collocations. Idioms are relatively invariable expressions with meanings that cannot be predicted from the meanings of the parts (Biber et al, 1999). They are usually structurally complete units and many function as verb phrases that can be replaced by a single lexical verb, such as ‘kick the bucket’ for ‘die’, and ‘bear in mind’ for ’remember’ (Chen & Baker, 2010). In addition, whereas idioms are not necessarily common expressions, lexical bundles are the sequences of words that most commonly co-occur in a register. Collocations are associations between two words, so that the words co-occur more frequently than expected by chance. In this sense, when considered out of context, the adjectives ‘little’ and ‘small’ are similar in meaning but they co-occur with quite different sets of nouns.

The study of lexical bundles used in academic register was first initiated by Biber and his colleagues, who, in a series studies on lexical bundles, found that academic prose presents distinctive distribution patterns of lexical bundles (; Biber et al., 1999; Biber & Barbieri, 2007; Biber & Conrad, 1999; Biber, Conrad, & Cortes, 2003, 2004). For example, most bundles

used in academic prose are phrasal, e.g. ‘on the condition that’, ‘as analysed in the above section’ and ‘in the sense that’. In these studies, it is also proposed that the presence of certain lexical bundles like ‘as a result of’, ‘it should be noted that’, and ‘as can be seen’ identify a text as belonging to the academic register. These bundles are familiar to writers and readers who regularly participate in academic circles, and signal the writers’ competent participation in the academic community. Conversely, the absence of such bundles might reveal that the writer lacks fluency as a writer of that community.

To gain control of a specific register within a language requires sensitivity to expert users’ preferences for certain linguistic sequences. In this sense, it is extremely beneficial to identify these bundles in an attempt to help translators understand the specific rhetorical practices of a particular academic community. On the other hand, the extensive use of such pre-fabricated sequences in academic written genres helps to signal the text register to readers and to reduce processing time by using familiar patterns to link elements of new information. Text receivers are therefore able to sort out what is natural from what is merely grammatical and judge whether a particular bundle sounds right in a given context.

Based on the work carried out by Hyland (2008) with a corpus of 3.5 million words, the table below offers a compilation of the most frequent lexical bundles found in the academic register:

Table 16: Most frequent lexical bundles in academic register (Hyland 2008)

3-Word bundles	Occurrence	4-Word bundles	Occurrence	5-Word bundles	Occurrence
in order to	1629	on the other hand	726	on the other hand the	153
in terms of	1203	at the same time	337	at the end of the	138
one of the	1092	in the case of	334	it should be noted that	109
the use of	1081	the end of the	258	it can be seen that	102
as well as	1044	as well as the	253	due to the fact that	99
the number of	992	at the end of	252	at the beginning of the	98
due to the	886	in terms of the	251	may be due to the	64
on the other	810	on the basis of	247	it was found that the	57
based on the	801	in the present study	225	to the fact that the	52
the other hand	730	is one of the	209	there are a number of	51
in this study	712	in the form of	191	in the case of the	50
a number of	690	the nature of the	191	as a result of the	48
the fact that	630	the results of the	189	at the same time the	41
most of the	605	the fact that the	177	is one of the most	37
there is a	575	as a result of	175	it is possible that the	36
according to the	562	in relation to the	163	one of the most important	36
the present study	549	at the beginning of	158	play an important role in	36
part of the	514	with respect to the	156	can be seen as a	35
the end of	501	the other hand the	154	the results of this study	35
the relationship between	487	the relationship between the	152	from the point of view	34
in the following	478	in the context of	150	the point of view of	34
the role of	478	can be used to	148	it can be observed that	33
some of the	474	to the fact that	143	this may be due to	32
as a result	472	as shown in figure	136	an important role in the	31
it can be	468	it was found that	133	in the form of a	31

The bundles that frequently appear in academic register can be classified based on either their structure or function. Biber et al.'s (1999) structural classification is used for the grouping of bundles, while Hyland's (2008) classification is adopted for the functional categorization of bundles, as can be seen in the tables below:

Table 17: Most common patterns of four-word bundles in academic writing (Biber et al, 1999)

Structure	**Examples**
Noun phrase + of	the end of the, the nature of the, the beginning of the, a large number of
Other noun phrases	the fact that the, one of the most, the extent to which
Prepositional phrase + of	at the end of, as a result of, on the basis of, in the context of
Other prepositional phrases	on the other hand, at the same time, in the present study, with respect to the
Passive + prep phrase fragment	is shown in figure, is based on the, is defined as the, can be found in
Anticipatory it + verb/ adjective	it is important to, it is possible that, it was found that, it should be noted
Be + noun/ adjective phrase	is the same as, is a matter of, is due to the, be the result of
Others	as shown in figure, should be noted that, is likely to be, as well as the

Table 18: Functional classification of lexical bundles in academic writing (Hyland, 2008)

Major functions	Sub-categories	Examples
Research-oriented: help writers to structure their activities and experiences of the real world includes:	Location – indicating time/place	at the beginning of, at the same time, in the present study
	Procedure	the use of the, the role of the, the purpose of the, the operation of the
	Quantification	the magnitude of the, a wide range of, one of the most
	Description	the structure of the, the size of the, the surface of the
	Topic – related to the field of research	in the Hong Kong, the currency board system
Text-oriented – concerned with the organization of the text and its meaning as a message or argument includes:	Transition signals – establishing additive or contrastive links between elements	on the other hand, in addition to the, in contrast to the
	Resultative signals – mark inferential or causative relations between elements	as a result of, it was found that, these results suggest that
	Structuring signals – text-reflexive markers which organize stretches of discourse or direct reader elsewhere in text	in the present study, in the next section, as shown in figure
	Framing signals – situate arguments by specifying limiting conditions	in the case of, with respect to the, on the basis of, in the presence of, with the exception of
Participant-oriented – these are focused on the writer or reader of the text	Stance features – convey the writer's attitudes and evaluations	are likely to be, may be due to, it is possible that
	Engagement features – address readers directly	it should be noted that, as can be seen

2.3.3.2 The translation of scientific and technological terms from English to Chinese

The use of clear and consistent terminology is of vital importance for all effective scientific and technological communication. In the case of translation, this is true for both the source language text and the target language version. When translating neologisms, the translator

always faces the question of how to best deal with their transfer. It is generally agreed that the ideal scenario is that a brief Chinese term that can fully express the meaning of the original term should be found, and this approach is generally preferred by Chinese scholars (Lou, 1992). In other cases, it is better to simply transfer the pronunciation of the English term rather than use a long or awkward term, or one that does not transfer the concept accurately. Chinese researchers in translation studies refer to the former approach as 'yiyi / transferring meaning' and to the latter as 'yinyi / transferring pronunciation' (Zhang, 1982).

There are other more complicated classifications of the ways in which Chinese translators deal with English scientific terms. Lou (1992) highlights three techniques for translating English technological terms in Chinese, namely, (1) adopting the English term directly, (2) phonetic transcription, and (3) adopting Japanese translations.

As regards the first method, in the published Chinese translations of English academic works, many original English terms, mostly abbreviations, are directly used in the translated version, such as CD-ROM, MOS, DNA, UFO, and BASIC to name but a few. This translation method is adopted because the translator is aware that the readers also have a scientific background and are familiar with the terms.

The method of phonetic transcription is resorted to when translating an entity or object that does not exist in China. For example, in the 1960s, the new term 'laser' came into being in English, but the Chinese language did not have it. The term made eventually its way into Chinese through translation as 'lei she', which is a close pronunciation rendering of the English 'laser'. However, with more people becomeing familiar to and being specialized in

new technology, phonetic transcriptions tend to be superseded by meaningful Chinese terms. In the case of 'laser', a new term has been coined in Chinese, 'jiguang', which bears the meaning of 'amplified light by emission of radiation'.

Chinese translators may also make use of the Japanese translations of certain English terms, mainly because Japanese and Chinese share some characters, although they differ greatly in pronunciation and grammar. This technique can be traced back to the last years of the Qing Dynasty, e.g. 1900s. For example, 'integrated circuit' is translated as 'jichengdianlu', a term used by the Japanese. One of the main reasons for this state of affairs is the fact that Japan had access to new technology quicker and easier in those old times and, accordingly, the translations came into being earlier. Another reason is that, during the Qing dynasty, many Chinese scientists and technicians studied in Japan and it was reasonably easy for them to adopt the Japanese translation of the term and to bring it to China at a later stage.

The abovementioned methods are still used by Chinese translators to deal with new terminology. The ways of forming new terminology differ greatly between English and Chinese. New terminology in English can take the form of complete new words, acronyms, or loan words from the language of the country where the term was originally invented (Pérez Iglesias, 2004). For example, penicillin is a totally new word created to name the medicine and it derives from the Latin word for mould. Examples of acronyms are PC/Personal Computer, and AIDS/Acquired Immune Deficiency Syndrome, and loan words such as 'sputnik' and 'kalashnikov' are taken from Russian.

Chinese new terms, on the other hand, are formed rather differently. Chinese translators, for instance, invent words which somehow retain the meaning of the original but do not keep the sound of the original as in the cases of 'film', translated as 'dianying/electric photo', 'protein' as 'danbaizhi/ egg white substance' or 'petroleum' as 'shiyou/rock oil'. On other occasions, the translation borrows part of the pronunciation of the original word but uses characters which usually do not carry any meaning. For example, 'lymph' is translated as 'linba', within which neither the character 'lin' nor 'ba' carries meaning. In certain cases, the translation keeps part of the meaning as well as part of the pronunciation of the original as is the case with the word 'vitamin', translated as 'weitaming', within which 'wei' means 'protect' and 'ming' means 'life'. Finally, unlike the English frequent use of acronyms, Chinese prefers to resort to abbreviations. So, Chinese translators would tend to use more 'shimaozuzhi' than WTO, 'shimao' being the abbreviation for 'shijie maoyi zuzhi/ world trade organization'.

All the above mentioned techniques are normally used when new words or phrases need to be translated into Chinese, although translators would have to make sure that they use the Chinese versions for the English terms that have been previously translated by others. For this reason, translators need to be aware of all the resources available to them when carrying out terminology searches, such as hard copy specialized dictionaries, online dictionaries and glossaries, encyclopaedias, and other online reference material. In this respect, the web is an excellent tool for finding information about the origin, use and frequency of words and for assessing their correctness in a given context.

When encountering new terms, translators often refer to paper or online dictionaries and glossaries. When these fail to provide a translation, monolingual web pages can be used in more or less the same way as a monolingual dictionary in order to gain an interpretation of the original term in the original language so as to fully understand the original term. Translators can also search bilingual websites to locate the original term and find its Chinese counterpart. In any case, translators will always need to verify whether a given translation is authoritative by searching the original and target terms as a pair in the web to verify their usage. If the web sources showing the pairs can be considered authoritative - government bodies, educational institutions, or well-known companies - translators can then guarantee to some extent that the term used is somehow acceptable by the target readership.

With an ever increasing number of Chinese webpages coming into being, including numerous sites devoted to scientific and technological issues as well as to academic publishing, translators have more resources than ever to resort to in their search for documentation.

To summarize, section 2.3 has discussed some of the main features of Chinese scientific and technological academic writing, establishing comparisons with the English language when needed. Some translation techniques have been mentioned to illustrate what translators usually do when faced by certain challenges caused by systemic differences between English and Chinese. In the next chapter, the translation technology and resources to be used in this study are introduced. Special emphasis is put on how to use CAT tools to tackle the translation of the specific features mentioned in Chapter Two.

Chapter Three

Translation Technology and Resources

The term 'translation technology' is naturally associated with translation and computers. Researches in how computers can be used for translation began as early as the middle 20th century. The very early term for the use of computer to do translation is 'machine translation'. Machine translation programs automatically output a target text from a source text. As realized by researches, machine translation is only capable of providing a 'draft translation', which is up to the end user to decide what to do with the document. The purpose of the machine translation is to provide a so-called indicative text for the translator to do the final editing and produce the final translation with good quality（Zanettin, 2001）. Although machine translation systems continue to develop, the human translators will continue to play the most important part in translation.

Whereas traditional research in Machines Translation (MT) aims at designing machine translation systems that can replace human translators, recent trends emphasise the shift towards providing human translators with tools specifically geared to help the translation process. The latter approach aiming at designing programs that assist translators during the translation process is called computer-aided or computer-assisted translation tools (CAT tools). The major distinction between MT and CAT lies in who is primarily responsible for the actual task of translation. In MT, the computer translates the text, though the output

may later be edited by a human translator. In CAT, human translators are responsible for doing the translation, but they may make use of a variety of computerised tools to help them complete the task and increase their productivity (Bowker, 2002).

The researches on CAT tools have been developing since the 1990s and it substitutes Machine Translation, becoming the most widely used computerized tools for translation. Therefore, in this research, the CAT tools are the main topic under discussion in terms of translation technology used in translator training.

Along with the increasing research interests in CAT tools, there comes the major development of corpus-linguistics and substantial use of electronic corpora in computerized tools for translation. Corpus linguistics relies on the possibility of storing large amounts of natural language in electronic format and of retrieving linguistic data from such corpora. In corpus-aided activities the computer is treated as a source of information, and it is left to the user to decide how to exploit the potential translation candidates which a bilingual concordance can provide, in the form of previously translated instances (as in the case of translation memories and other parallel bilingual corpora), or of similar textual environments retrieved from comparable collections of texts composed independently in the languages involved (Zanettin, 2001).

The approach based on parallel bilingual corpora only need to reuse the knowledge and ability of human translators by combining parts of existing translations through statistical methods. Another way to make bilingual corpora is to retrieve source text and their translation from the internet, and align these texts to form bilingual corpora.

A variety of resources is available to translators through the Internet, ranging from monolingual and multilingual specialised dictionaries, term-banks, electronic text archives and on-line newspapers. The World Wide Web is rapidly becoming not only the most easily accessible source to which translators can turn for documentary information, but also a resource for exchanging information in real-time within the international translation community. Therefore, the electronic corpora and online materials are important resources for translators, and will be discussed in detail in the following section.

3.1 Computer Assisted Translation (CAT) tools

Bowker (2002) listed six types of CAT tools, namely, data-capture tools, corpus- analysis tools, terminology-management systems, translation memories, localization and web-page translation tools, and diagnostic tools. She excluded from CAT tools some computer tools, such as word processors, spelling and grammar checkers, electronic resources and internet, because she thought these tools were rapidly becoming part of the general knowledge, and they were used by people in many professions, not just translators. In this research targeting the translation of scientific and technological texts, the author will focus on the application of Translation Memory (TM) and terminology management tools.

Historically, TM tools have been one of the most popular CAT technologies (Bowker, 2002; Somers, 2003). TM tools have a wide range of functions, including term candidate extraction; terminology research; automatic terminology lookup; terminology consistency check and non-allowed terminology check; new text segmentation, previous source target text alignment and indexing; translation memory lookup; missing segment detection and format

and grammar checks (Melby, 1998). Using TM tools like SDL Trados studio and Déjà Vu greatly increases translators' efficiency and understanding of the process of translation. At the same time, translators become more aware of solving ambiguities and updating terminology and dictionaries. In using CAT tools, trainee translators learn translation at the level of language features, such as terminology, grammar, collocations, and idioms.

Translation Memories are databases that store translated texts together with the corresponding original texts (Zanettin, 2001). However, texts are not stored as wholes. They are stored in translation units or segments instead and, in most cases, a translation unit corresponds to a sentence (Austermühl, 2001). TMs can increase translation productivity mainly because of two reasons, the internal and external repetition. On the one hand, in terms of internal repetition, the translator can refer to the segements translated earlier in the same project, especially considering that research shows that 50 percent or more of the elements in a text can be repeated in the same text, which is especially true in scientific-technological texts (Webb, 1998). In the process of translating, the TM system continuously updates the database so that the task might be sped up as more units are accumulated and can be reused. On the other hand, in terms of external repetition, the translator can refer to texts previously translated in former projects, because documents of the same text type usually contain numerous repetitive elements, which is especially true in scientific-technological texts.

TMs are usually built by two means. One of them is to create your own translation memory from scratch (Zanettin, 2001). That is, when the translator is translating, the source and target units are automatically saved as pairs. With increasing translations being done, the

database becomes bigger and therefore the probability of being able to reuse previous translations increases. Another way to create a TM is to align existing source texts and their corresponding translations by alignment tools that examine the source and target texts to determine which units (usually sentences) belong together. The translator can modify the aligned pairs in case of errors. Translators can also import existing TM files downloaded online to enrich their TM.

TMs work by the rationale that they provide previously translated segments for the translator either to reuse them or modify them. The previously translated segments are usually shown in the following choices: perfect or exact match, full match, and fuzzy match (Austermühl, 2001). A perfect or exact match is the translation unit found in the database which corresponds exactly to the new source text segment. Full match is the translation unit found in the database that is identical to the new source text unit except for variable elements such as dates, numbers, time or measurements (Austermühl, 2001). Fuzzy match is all other translations units found in the database that do not match the new source text exactly but are still within the range of the minimum match value, e.g. 80 percent, which is defined by the translator.

The use of TMs can bring along great potential in terms of improving the quantity and quality of translation. Webb (1998) has done a study illustrating the benefits of using TMs, including the increase of the translator's income, the elimination of repetitive translation tasks, and the guarantee of consistency. He also indicates some drawbacks of using translation memories, such as, the post-editing can only be done within the TM, higher

tendency for a translator to create only one or two drafts and thus affecting the quality of the final translation. However, these disadvantages can be remedies with solutions.

It is difficult to state that a TM tool is more effective than another, because they are just different in terms of what file types they can process. Some tools have better performance on certain file types than others, but none of them is jack-of-all-trades. They also differ in other aspects, such as price, online or offline access, popularity among translation agencies, compatibility, etc. For this current study, SDL Trados studio 2011 and Wordfast Anywhere have been selected as the TM tools to be used because of the file types they can process and their availability for the control group.

3.2 Electronic corpora

Ever since Baker (1993: 243) predicted that the availability of large corpora of both original and translated texts would introduce the development of a corpus-driven methodology in the research conducted in translation studies, a growing number of scholars begun to seriously consider the corpus-based approach as a viable and fruitful perspective within which translation and translating could be studied in a novel and systematic way (Bowker, 2003a; Kenny, 2007; Bernardini, 2006; Beeby et al., 2009). The corpus-based approach to TS works at both a descriptive and a practical level. Since the 1997 *Symposium on Corpus Use and Learning to Translate* (CULT) that took place in Bertinoro, Italy, the use of corpora to investigate translation teaching has become increasingly popular and fertile. Zanettin (2012) indicates that the most widely used corpora in translation teaching are (i) monolingual

corpora (whether general or specialized, usually in the target language), (ii) comparable bilingual corpora (originals in two languages, selected according to analogous criteria such as topic and text type), and (iii) parallel corpora (originals in one language and their translations in another).

Monolingual corpora can provide information about typical units of meaning in the source or target language or in a specialized subset of any of the two (Zanettin, 1998). They can thus help future translators opt for natural, native-like turns of phrase, appropriate to the communicative situation in which the TT will be operating. For example, when describing a mathematical graph, the researchers will use the term 'climb and descent indicator', rather than 'raising and falling indicator' or any other synonyms as it is a universally-accepted convention to use these two words, climb and descent, as a set collocation in this combination and context. These advantages of monolingual corpora in teaching translation are similar to those put forward for the use of monolingual corpora in second language learning (Zanettin, 2009).

Comparable bilingual corpora can provide translators with a better understanding not only of target but also of source texts, allowing them to compare terminology, phraseology and textual conventions within original and translated texts and across languages (Zanettin, 1998).

Parallel corpora offer learners the possibility to observe what strategies translators appear to privilege, for instance, how situationally-constrained expressions are typically translated or how lexical creativity is dealt with in translation (Zanettin, 2009).

From a translation training perspective, Bowker (2003a) proposes the use of corpora by establishing a Student Translation Archive (STA) which is an electronic collection of student translations. Once this corpus has been compiled, a corpus management tool, known as the Student Translation Tracking System (STTS), will be used to extract information from the STA according to specific criteria, which are a set of predefined attributes regarding the students' translations, such as ST reference, native language, foreign language, translation conditions and so on. These extracted corpora are called translation learner corpora. Examples of such corpora include text-specific corpora, subject-specific corpora, multiple subject field corpora, cross-linguistic/same subject field corpora, and longitudinal corpora. Baker (1995), Laviosa (1998), and Bowker (2003b) have already demonstrated that this type of corpora can be useful for (i) identifying areas of difficulty, (ii) studying the nature of professionally translated texts, (iii) finding translation problems specific to a particular subject field, (iv) examining the impact of source language interference, and (v) charting the progress of individual students.

Although the software and procedure suggested by Bowker (2003a) can be useful to some extent, improvements can be made to optimize its performance. For instance, the STA and STTS separate the process of archive collection and corpora extraction in two different stages, when it could be possible to integrate them both into just one system. Another improvement can be made with regard to the criteria by which the corpora are extracted. In STA, the criteria used are too marginal and, accordingly, the corpora extracted are not typical. Therefore, it requires more effort and time on the part of the trainer to read and analyze. Some specific sub-categories can be added to each of the five categories of learner

corpora proposed by Bowker (2003a). For example, as to the category of subject-field specific corpora, we can extract subordinate categories by applying criteria like collocation patterns, sentence structures, noun compounds and so on. Sub-categorization of the criteria makes the corpora extracted to be more self-evident and characteristic, and thus it is easier for trainers to analyse (Bowker & Pearson, 2002).

3.3 World Wide Web

The World Wide Web is an omniscient and seemingly omnipresent encyclopaedia which translators can resort to at any time anywhere. It significantly affects how translators work today, both in the way they deal with translation commissions and in the way they search for linguistic and encyclopaedic information. Web pages tend to present language as it is used, and the data retrieved from the web can be useful in dealing with some translation issues, such as the translation of new coinages, borrowed words, culturally-specific concepts, and so on. For this reason, the web should be seen and studied as any other computationally available linguistic resource. In other words, the web can act as a supplementary tool to help solve problems encountered when using CAT tools and other types of translation technology. The ability to exploit the wealth of information available on the web is an indispensable part of modern translation competence. In addition, the web can be used as an aid for translation teaching and its potential can be seen in the following areas: detection and compilation of neologisms, proper nouns, culturally-specific concepts, typical collocations, and any other data unavailable in TM or corpora.

How to use effectively the World Wide Web in the translating process is a topic worthy of discussion. As the translating process can be divided into three phases, namely, the reception, transfer and formulation phases as proposed by Bell (1991), different World Wide Web functions can be applied to the three phases of the process respectively, as described by Austermuhl (2001: 13-15).

During the reception phase, i.e. the phase of understanding the source text, the online encyclopaedias and dictionaries can help the translator to retrieve background information of the subject area of the texts to be translated and to understand words of difficulty or concepts that have different meanings in the source and target language. For example, not understanding the concept of 'axiomatic quantum theory' in Physics, when translating a sentence relating to this concept, may have negative consequences on the target text. One thing that can be done, though, is to search online to find the definition of the concept either in online encyclopaedias or dictionaries.

In the formulation phase, the translator can use online archives of newspapers or magazines and parallel texts, mostly to check whether certain terms or phrases can be used in the target language, especially when the translator is translating into a foreign language. Let us suppose a situation of translating a text into English in which the translator is not a native speaker of English. If the translator wants to use the phrase 'to implement the policy' but is not sure whether it is right in English, s/he can verify the validity of the term on a news or magazine website by simply searching the phrase in the query box of the website and seeing whether some identical phrases show up. Or, the translator can refer to monolingual corpora such as the BNC. If similar phrases show up, the translator can check the context in

which the phrase is used and decide whether its usage in the translation being undertaken is right. There are some authoritative news and magazines websites in terms of language use, including Newsweek, The Guardian, VOA, BBC, ABC, etc.

Since the current research is about scientific-technological translation, specialized online encyclopaedias and dictionaries worth a touch here. Specialized online encyclopaedias and dictionaries are most useful in translating because they usually cover a range of subject matters and display the search results by category, e.g. economics, medicine, biotechnology, information technology, etc.

Finally, as the current research is concerned with the training of translators, the electronic bibliographical databases turn out to be a very useful source for trainee translators to look for books and articles related to their specialized areas. Some of the commonly referred electronic bibliographical databases are online libraries (e.g. The Library of the US Congrass or the British Library) and online bookstores (e.g. Amazon), as well as scholarly databases such as Google books.

To summarize, the World Wide Web can be very effective in the process of translating and translator training. Its main potential lies in the use of online encyclopaedias and dictionaries, online archives of newspapers or magazines, specialized online encyclopaedias and dictionaries, and electronic bibliographical databases.

3.4 The application of computerized language tools to translator training

Based on the language features and function of scientific-technological texts and their translation, and on the ways in which the above-mentioned types of computer tools can be applied in translating, I proceed to discuss why and how specific functions of CAT tools, corpora and the web can be used in the teaching of scientific-technological translation. Special attention will be paid to the potential of these tools at different stages of the translation process and at different linguistic levels (e.g. word, phrase, clause, sentence and text).

This study argues that a translation task designed for the training of would-be translators can be divided into three main processes: transferring language, transferring function and supplementing. By transferring language, I mean processing the source text at the word, phrase, clause and sentence level, while transferring function means that trainee translators should try to achieve with their translation the same or similar function as the source text has in the source culture. Supplementing means that trainee translators should be able to generalize the problems and doubts encountered when translating and find solutions to these problems.

The purpose of training is to help trainee translators learn certain skills and improve their cognitive abilities in performing the three processes. Computerized Language Tools like CAT tools, corpora and the web can facilitate students' learning and at the same time help evaluate their progress. A single type of CLT would not certainly suit the learning of all three processes and that is the reason why, instead, some tools may be more suitable for learning

the process of transferring language whilst others would be more productive in the teaching and learning of how to transfer the function. In this sense, the author would like to argue that CAT tools can best aid the process of understanding the source text because the TM provides optional target text that helps the translator understand the gist of the source text. It also turns out to be easy to operate. Comparable corpora and learner translation corpora can be used in the process of transferring function in order to evaluate whether student translations manage to achieve the same function as the ST in terms of standards at the text level, i.e. format, informativity, relevance, cohesion and coherence, etc. In the final process of supplementing, the web can be well exploited because of its encyclopedic and omniscient nature.

3.4.1 Application of CAT tools based on the linguistic features of scientific and technological texts

As mentioned above, CAT tools can be optimally used in teaching trainee translators to deal with lower language level features of scientific-technological translation, including terminology, passive tense, nominalizations, third person use, empty verbs and present tense. Therefore my research will include experiments dealing with the use of CAT tools to teach the linguistic features of scientific-technological texts included in Table 19 below.

Table 19: Object of study as regards the application of CAT tools in the translation of scientific-technological texts

The application of CAT tools to teaching	Terminology	In scientific-technological translation
	passives	
	nominalizations	
	modals	
	empty verbs	
	collocations	
	logico-grammatical items	

3.4.2 Application of CAT tools based on typical features of CAT tools

As mentioned in section 2.2, computer-assisted translation technology covers a wide range of tools that have different functions and offer manifold possibilities, from the simple ones such as grammar checkers, to more complex ones like indexers. Some of the functions can be more productive in translator training than others. In this research, it is suggested that the application of the following features of CAT in translator training: Translation Memory Systems (segmentation, matching and alignment); Terminology Management Systems (storage and retrieval); Text Analysis Tools (word-frequency list, concordancer, and collocation generator); Language Search Engines (indexer); Project Management Software (translators' workstation), and Diagnostic Tools (cost/benefit estimator).

The above CAT tools are recommended for the training of scientific-technological translation for several reasons. Translation Memory is recommended because repetition is a typical characteristic of scientific-technological translation. Hence, when using TM, trainee translators are constantly exposed to repeated or similar collocations or sentence patterns

and their translations, and accordingly may become familiarized with these features of scientific-technological texts.

Table 20: Application of CAT in teaching scientific-technological translation (based on specific features of CAT tools)

The application of	Translation Memory Systems	to teaching scientific-technological translation
	Terminology Management Systems	
	Text Analysis Tools	
	Language Search Engines	
	Project Management Software	
	Diagnostic Tools	

3.4.3 Application of Corpora to enhancing students' translating competence

The use of corpora helps the trainee translators identify the distinctive features of the language of translation and understand the specific constraints, pressures, and motivations that may influence the act of translating. As long as the trainee translators are aware of such factors, they can handle them more rationally and effectively.

Comparable bilingual corpora consist of texts written by native speakers in both the source and the target languages in the same specialized field, which means that the trainee translators can become acquainted with the wholesale linguistic and rhetorical features as well as the style of specialized texts in both languages. Trainees can also gain knowledge of the appropriate conceptual and linguistic information of a specialized subject field as documented by experts in that field in their native language.

Parallel corpora are appropriate for comparing how the same or similar ideas and concepts are represented differently or similarly in the two languages. Because differences and similarities exist between languages, a given equivalence, or to be more precise, a match of segments is representative of the relationship between the utterances produced in the ST and their translation into the TT. The use of parallel corpora does not mean the imposition of concepts like equivalence, but rather a way to show students how to express the same idea and transfer the same information from one language into a different one.

Based on the above argument, the application of corpora to enhancing students' translating competence can be shown in the following diagram:

Table 21: Application of corpora to enhancing students' competence

The application of	monolingual corpora of translated texts	to enhancing students' translating competence
	comparable bilingual corpora	
	parallel corpora	

3.4.4 Application of Corpora in evaluating students' translation

A corpus-based approach can be adopted to detect whether students' translations have the same communicative function as the source text and it can also help tutors make an evaluation of the students' work.

Comparable bilingual corpora are used to discover typical ways of expressing ideas in a particular language, in a particular text type, and in a particular subject field. Lecturer will use comparable corpora in much the same way as students when preparing their translation classes, and they may also use comparable bilingual corpora as an aid to evaluating students' work (Bowker, 1999; Pearson, 1998). Access to comparable bilingual corpora allows teachers to validate their own intuitions, and to use the corpus evidence as a basis for their explanation to students.

Another valuable approach can be the establishment of a corpus made up of student translations, and then compare different translations of the same text done by different students in the same class in order to try to identify common areas of difficulty, or compare several pieces of work done by the same student in order to gauge that particular student's progress over an academic term or semester. Building on the learner language corpora designed by Granger (1998), Bowker (2001) proposes the establishment of a learner translation corpus to compile an electronic collection of student translations. However, the problem is that the learner translation corpus is accessible only on a single computer, leading to intensive labour of the part of the trainer who is responsible for collecting and inputting these translations. Another weakness of this tool is that trainee translators cannot access the data, which may help them recognize and improve their ways and styles of translating.

Table 22: Application of corpora to evaluating students' translations

The application of	comparable bilingual corpora	to evaluating student translations of scientific-technological texts
	web-based learner translation corpora	

3.4.5 Application of web resources

As a supplementary resource in scientific-technological translation, the web can be of great help in subject areas that change very quickly and in which neologisms are very common. Some web-based tools are used for the semiautomatic detection of neologisms in electronic corpora. With the use of such web-based corpus research tools, it becomes possible to establish with a certain degree of rigor which words are new, by comparing the new terms (and texts) to the collection of all the compiled texts in the reference corpus. This makes it possible to find not just words that are completely newly created and feel new, but also words from the potential lexicon that have recently become actualized. Thereafter, a corpus of neologisms and/or revamped terms can be established for its use in translation. Malmkjaer (2003) states that the creation of a corpus of neologisms can be disadvantageous in translator education because offering past linguistic behaviour as a model for the future goes against the nature of language and stifle creativity. However, I would like to argue that it is significant to create a corpus of new terminology based on the principle that standardized or universally recognized terminology can help knowledge exchange and avoid misunderstanding and misconception. The same as in the case of neologisms, a comparable corpus of proper nouns which form the majority of terminology can also be developed in the same way. The diagram for my research in this area is illustrated in Table 23 below:

Table 23: Application of web-based tools to teaching scientific-technological translation

The application of web-based tools to	creating a corpus of neologisms	of scientific-technological translation
	creating a corpus of proper noun	

Chapter Four

Experiment Methodology and Test Materials

4.1 Introduction

To test empirically the main hypothesis that the application of computer-assisted translation tools to translator training may have a positive effect on students' acquisition of translation skills in scientific and technological translation, the author designed a controlled experiment that was then carried out on two groups of Master's students of Translation. Of these two groups, the experimental one (Group A) had been trained on translation with access to CAT tools while the control group (Group B) had not been exposed to this technology.

Before any of the students had been trained using CAT tools, a translation test was given to all students from both groups so as to ascertain their initial level of translation ability. Afterwards, the experimental group, based in London, was trained with access to CAT tools for a period of four months, whereas the control group, based in Beijing, was trained on translation issues but without using CAT tools.

In this particular experiment, Wordfast Anywhere and SDL Trados studio 2011 were used with the experimental group, given their availability at Imperial College London and their

wide acceptance among translation companies and professional translators. After the four month training period, the author administered yet another test to both groups of students which was of approximately the same difficulty as the first test. The data collected in these various tests was then used to analyse how and to what extent experience of computer-assisted translation software may have affected students' acquisition of translation skills, when working from English into Chinese.

4.2 Subjects and experiment methodology

As previously mentioned, the experiment involved two groups of MSc students of Translation, from Imperial College London and Beijing University of Aeronautics and Astronautics, who are hereafter referred to as Group A and Group B (abbreviated as Ga and Gb) respectively. All students were native speakers of Chinese.

The experimental group was made up of 20 of the then current Master's students taking the MSc in Scientific, Technical and Medical Translation with Translation Technology (academic year 2012-13) at the Translation Group of Imperial College London. The control group consisted of 20 of the then first year Master's students doing the Master's of Interpretation and Translation at the Translation Unit of the Beijing University of Aeronautics and Astronautics, during the same academic year 2012-13. In the case of the control group it was imperative that students had to be in their first year of studies because the Master's Degree of Translation takes two years full-time to complete in China versus only one year in the UK.

To protect students' privacy, they are named from No. 1 to No. 20 (abbreviated as N1, N2, N3, and so on), instead of using their real names. For ease of reference, students can then be identified as GaN1, GaN15, GbN2, GbN19, and so on. In starting the experiment, and as previously mentioned, Ga and Gb were given a general translation test to determine their translation ability level. This test was seated on the 20th of December 2012, both in London and Beijing, and hereafter is abbreviated as Ta. Four months after Ta, both groups sat the second test (hereafter referred as Tb) on the 20th of Mar 2013, in the two different cities. These two tests generated a total of 80 test results, which are named in the form of G_N_T_. For example, GaN2Ta is assigned to the test result from the experimental Group A (i.e. the group in London) that was done by student No. 2 on completion of Test A.

During the four months' period of study between the two tests, students in Ga were trained with access to some computer-assisted translation software, such as SDL Trados 2011 and Wordfast, while Gb were not. Except for this variable, Ga and Gb shared a similar level of knowledge and experience during their training. They were all Chinese native speakers who had just finished their undergraduate studies and had started their Master's programme of study, in which they were being exposed to similar modules. Therefore, what can be compared between these two groups is whether there is any difference of improvement made by students in Ga and Gb.

The initial hypothesis is that, after four month's training, students in Ga will have improved their general translation skills more than Gb, because they had been trained with access to computer-assisted software. The difference of improvement between the two groups is

shown by the score difference found in the students' results obtained in Ta and Tb. It is very likely that the scores of Tb will be higher than the scores of Ta for both Ga and Gb, because they may have improved in terms of translation ability after four months' study, irrespective of whether they learned with computer-assisted translation software or not. A standard improvement should be evident when the scores obtained in Tb are contrasted with those reached in the previous Ta. Here the hypothesis is that all students will get a higher score in Tb than in Ta, primarily because the difficulties encountered in translating Tb are very similar to those encountered when translating Ta, and all the students from the two groups have had four months' training. However, the important difference lies in finding out how much they have improved after four months' training when contrasted. The improvement is shown by the score difference between Ta and Tb, namely, Tb-Ta. The hypothesis is that Ga has improved more than Gb because the students have been trained with access to CAT tools while students in Gb have not. If we put this hypothesis in the form of numeral scores, it would mean that the score of Ga(Tb-Ta) should be higher than that of Gb(Tb-Ta).

4.3 Test materials

The rationale followed in order to choose the textual materials to be used for the two tests mimics the format of the tests used for the qualification of The Diploma in Translation (DipTrans) issued by the British Chartered Institute of Linguists (CIoL, www.iol.org.uk). This examination was introduced back in 1989 as a benchmark of professional standards and has since then being used in an attempt to meet the needs for a high level professional translating qualification. It is a postgraduate level equivalent qualification intended to test the ability of those who wish to progress into careers as freelance translators or work for

corporations worldwide, and to perform at a professional level (www.iol.org.uk/qualifications/exams_diptrans.asp).

The DipTrans consists of three units of examinations, namely, a general translation test and two semi-specialised tests for which options are provided for examinees. Most of the tests are from English into other languages, though the possibility exists for candidates who want to translate from other languages into English. Options for the first semi-specialised test include Technology, Business and Literature, while the second semi-specialised test offers candidates choices from the areas of Science, Social Science and Law. The DipTrans website also provides examinees with sample papers for each type of the tests. Thus, there are sample papers for English General, English Technology, English Business, English Literature, English Science, English Social Science, and English Law.

Since the current research is about the training of translators in the fields of science and technology, the material for the experiment tests has been selected bearing in mind the sample papers of English Science (see Appendix 1) and English Technology (see Appendix 2) used in the past by the CIoL. According to the DipTrans test standards, each test is of approximately 450 words and candidates are given a maximum of 2 hours to translate one of them. To adhere to similar standards, the translation tests conducted in the current study consist of two texts of approximately 230 words each and students are also given 2 hours to complete their translation.

The test materials that have been used are the abstracts of various articles taken from the *Journal of Industrial Ecology* (www.yale.edu/jie). The material has been chosen from this

journal for two main reasons. First of all, this is an authoritative science and technology journal that has been published by Yale University since 1997. Secondly, a Chinese translation of the abstracts is also published in each issue and this Chinese translation can be used as prototype when dealing with assessing the students' tests. These published Chinese translations of the abstracts are free of mistakes and of professional standard, because they are translated by specialized professional translators and proofread by experts and lecturers of ecology. What's more, several tutors at Imperial College scrutinized and reviewed these Chinese translations to ensure they were correct and legitimate for the marking process.

Four abstracts were chosen in total, two of which were used for the first Test A and the other two for the second Test B. The four English abstracts that were finally used as the test materials for the current study were meticulously chosen in the sense that they reflect some of the main characteristics of scientific and technological texts, as reviewed in Chapter Two. At the same time, to ensure that the texts were up to date, abstracts from some of the issues published in 2012 were chosen. Several measures were taken to make sure that students could not find the Chinese translations of the abstracts on the web. First, the name of the journal was not provided in the instructions of the tests. Secondly, the author searched all the sentences and key phrases of the four abstracts on Google.com to confirm that the website of the journal never came out as a hit. Finally, students were discreetly overseen during the tests to make sure that they were not accessing the journal's website.

The following are the two texts used in experiment Ta:

(For information only, not to be translated: the following two passages are taken from a well-known American Journal published earlier this year.)

Test A

Passage One

There is a strong need for methods within life cycle assessment (LCA) that enable the inclusion of all complex aspects related to land use and land use change (LULUC). This article presents a case study of the use of one hectare (ha) of forest managed for the production of wood for bioenergy production. Both permanent and temporary changes in above-ground biomass are assessed together with the impact on biodiversity caused by LULUC as a result of forestry activities. The impact is measured as a product of time and area requirements, as well as by changes in carbon pools and impacts on biodiversity as a consequence of different management options. To elaborate the usefulness of the method as well as its dependency on assumptions, a range of scenarios are introduced in the study. The results show that the impact on climate change from LULUC dominates the results compared to the impact from forestry operations. This clearly demonstrates the need to include LULUC in LCA of forestry products. For both impacts on climate change and biodiversity, the results show large variability based on what assumptions are made; and impacts can be either positive or negative. A mere measure of land used does not, consequently, give any meaning in LCA, as it is not possible to know whether this contributes a positive or negative impact.

(222 words)

Test A

Passage Two

By ‘working with the willing’, the National Industrial Symbiosis Programme (NISP) has successfully facilitated industrial symbiosis throughout the UK and, in the process, delivered significant economic and environmental benefits for both Programme members and the country as a whole. One of the keys to NISP’s success is that, unlike failed attempts to plan and construct eco-industrial systems from scratch, the Programme works largely with existing companies who have already settled in, developed, and successfully operate within a given locale. This article argues that existing and mature industrial systems provide the best prospects for identifying opportunities for, and ultimately facilitating, industrial symbiosis. Due to levels of diversification and operational fundamental niches that, in the fullness of time, develop within all industrial systems, industrially mature areas are deemed to be industrial symbiosis ‘conducive environments’. Building on the conservation biology concept of a habitat suitability index, the article presents a methodology for comparing a potential site for eco-industrial development to a known baseline industrial ‘habitat’ already identified as being highly conducive to industrial symbiosis. The suitability index methodology is further developed and applied to a multi-criteria-evaluation geographic information system to produce a ‘habitat’ suitability map that allows practitioners to quickly identify potential industrial symbiosis hotspots (the methodology is illustrated for England). The article concludes by providing options for the development of symbiosis suitability indices and how they can be used to support the facilitation of industrial symbiosis and regional resource efficiency.

(238 words)

These are the two texts that were used in the second test Tb:

(For information only, not to be translated: The following two passages are taken from a well-known Journal published earlier this year.)

Test B

Passage One

Urban policy makers and researchers consistently recognise the challenge of more effectively reshaping the linkages between cities, urban infrastructure, eco-system services and natural resources. The aim of this article is to consider the potential value of developing connections between two currently disconnected approaches to resource use and cities – Material Flow Accounting (MFA) and Transitions Analysis (TA). This article attempts to address this deficit and looks critically at resource flows through cities and the infrastructures that have been – or could be – reconfigured to more effectively manage these flows from the perspectives of MFA and TA. This is an issue that has not been addressed with the result that inadequate attention has been paid to the reconfiguring of urban infrastructures, whose construction and maintenance are, in turn, often the largest expenditures at city government level. Insufficient attention has been given to the fact that the design, construction and operation of infrastructures (specifically energy, waste, water, sanitation, and transport infrastructures) create a socio-technical environment that plays an important role in shaping, and potentially reshaping, how resources are procured, used and disposed by the city. The challenge, of course, is how such a transition takes place, who leads it and what social and governance processes are best suited to facilitate such city transitions. This article assesses the role of MFA and TA in understanding these resource flows and urban infrastructures, making it possible to begin to tackle this challenge in practical transformative ways.

(239 words)

Test B Passage Two
Urban metabolism is an important technique for understanding the relationship between cities and the wider environment. Such analyses are typically performed at the scale of the whole city using annual average data, a feature that is driven largely by restrictions in data availability. However in order to assess the resource implications of policy interventions and to design and operate efficient urban infrastructures such as energy systems, greater spatial and temporal resolutions are required in the underlying resource demand data. As this information is rarely available, we propose that these demand profiles might be simulated using activity-based modelling. This is a micro-simulation approach that calculates the activity schedules of individuals within the city and then converts this information into resource demands. The method is demonstrated by simulating electricity and natural gas demands in London and by examining how these non-transport energy demands might change in response to a shift in commuting patterns, for example, in response to a congestion charge or similar policy. The article concludes by discussing the strengths and weaknesses of the approach, as well as highlighting future research directions. Key challenges include the simulation of in-home activities, assessing the transferability of the complex data sets and models supporting such analyses, and determining which aspects of urban metabolism would benefit most from this technique. (215 words)

4.4 Marking criteria

The DipTrans also provides the examination candidates with a handbook that includes detailed information about the examination format, the marking criteria, the topic areas of

the test (i.e. as mentioned above, whether the test falls into the category of English Technology, English Business, English Literature, English Science, English Social Science, or English Law), the administrative rules (i.e. the rules of administrating the tests) and regulations as well as general information (see Appendix 3). As the material to be used in the tests has already been discussed, the present section focuses on the assessment and the marking criteria that have been used to evaluate the students' work. According to DipTrans assessment criteria, three aspects of the candidates' performance are to be assessed, as listed below:

1. Comprehension, accuracy and register.
2. Grammar (morphology, syntax, etc.), cohesion, coherence and organisation of work.
3. Technical aspects: punctuation, spelling, accentuation, transfer of names, dates, figures, etc.

To mark these three dimensions, a total score of 100 points are allocated to the three aspects in the proportion of 50-35-15, as seen in Table 24 below. The criteria also provide detailed guidance on marking each aspect of the candidates' performance and a marksheet is provided to be used as the following table shows:

Table 24: CIoL's marking guidance for the three aspects of candidates' performance

	Grade	Band	Mark
Aspect of Performance 1: *Comprehension, accuracy and register* - the correct transfer of information and evidence of complete comprehension and appropriateness of rendering and lexis	Distinction	The translation shows an excellent command of the subject matter with faultlessly accurate transfer of information and evidence of complete comprehension throughout. The choice of language and register are entirely appropriate to the subject matter and to the spirit and intention of the original.	40-50
	Merit	The translation shows a good command of the subject matter, although at times there may be some under or over translation or a slight lack of clarity. The vocabulary, terminology and idioms and register are faithful to those of the source text.	35-39
	Pass	The translation shows an adequate command of the subject matter. There are no serious errors or omissions in the transfer of information. Any inaccuracies or omissions are minor and will not give false or misleading information to the reader.	30-34
	Fail	The translation shows an inadequate grasp of the informational content. There are a number of clumsy or inappropriate renderings, both major and minor inaccuracies, which distort or impair the message at several points. There may also be serious omissions, some incorrect choice of register and terminology, and/or unidiomatic use of language.	0-29
Aspect of Performance 2: *Grammar (morphology, syntax, etc.), cohesion, coherence and organisation of work*	Distinction	The translation reads like a piece originally written in the target language. The sentence structures, grammar, idioms, linkages and discourse are all entirely appropriate to the target language.	28-35
	Merit	The translation is well organised, with good sentence structures and overall coherence. Whilst not perfect, the translation is written with appropriate reorganisation of the information contained in the source text where necessary.	24-27
	Pass	The sentence structure is sound, though with some awkwardness, and lapses in grammar. Nothing too serious.	21-23
	Fail	The translation does not read like an original piece of writing. It may be stilted and incoherent. There may be too much adherence to the sentence structure of the source text, with little effort to modify the sentences. There may also be paraphrasing or over-elaboration.	0-20
Aspect of Performance 3: *Technical points relating to spelling, accentuation, punctuation and the transfer of dates, names, figures, etc.*	Distinction	The spelling, accentuation, punctuation, and transfer of dates, names and figures in the translation range from excellent to faultless.	12-15
	Merit	There are only minor technical lapses.	10-11
	Pass	The translation is correct in all major technical elements but with one or two minor lapses of spelling and with some errors in punctuation.	9
	Fail	A considerable number of technical faults are present, which would render even an otherwise good translation unacceptable in professional terms.	0-8

In addition to the comprehensive marking criteria set by the DipTrans, for the purpose of this study, the participants' performance was also assessed based on their way of dealing with the specific characteristics of English and Chinese scientific and technological texts, as discussed and illustrated in Chapter Two and Chapter Three. The table below offers a simplified version of the main typical features that characterise English and Chinese scientific and technological texts:

Table 25: Typical features of English and Chinese scientific and technological texts

Typical features of English sci-tech texts	Typical features of Chinese sci-tech texts
Empty verbs (such as have, make, give, and take)	Aspect markers
Passive voice	Passive voice
Logico-grammatical items (such as in addition to, furthermore, in spite of, to what extent?)	Lexical bundles
Personal versus impersonal forms	Statement of opinion or belief
Adverbial clauses	Attributive clauses
Nominalizations	Nominalizations
Complex sentence with more than two clauses	Abbreviations
'There be' structures	Noun classifiers
Terminology	Terminology
Recurrent words in scientific and technological texts which are not technical terms	
Infinitive verb form	
Gerund form	
Past Participle form	
Compound words linked by '–'	

The table above shows that there are many specific features for both English and Chinese sci-tech texts. Therefore, to make this experiment manageable, the author has decided to focus on the most salient features of this textual genre in English as pointed out by former researches in order to investigate how they have been translated into Chinese, namely, passive voice, terminology, logico-grammatical items, personal versus impersonal forms, nominalizations, infinitive verb form, gerund form and past participle form. These features have been named from F1 to F8, as can be seen in Table 26 below:

Table 26: Features of English sci-tech text tested in the current study

Feature No.	**Typical features of English sci-tech text**	**no. of occurrences in Ta**	**no. of occurrences in Tb**
F1	Passive voice	8	11
F2	Terminology	25	20
F3	Logico-grammatical items (such as in addition to, furthermore, in spite of)	8	10
F4	Personal versus impersonal forms	8	7
F5	Nominalizations	8	7
F6	Infinitive verb form	7	7
F7	Gerund form	9	18
F8	Past Participle form	9	1

To mark the students' way of dealing with these features when translating the texts from English into Chinese, a list of all these features occurring in the original text needs to be compiled. Most of these features occur more than once in the source text and have been named based on the sequential order in which they appear in the text. For example, there are eight F1 features in Ta, passage one and two, and they are named as F1-1, F1-2, and so on until F1-8. As for Tb, the features have been numbered in a consecutive manner, following the sequential numbers used for Ta. For example, there are 11 F1 features in Tb,

and they have been numbered starting with F1-9, F1-10, until F19. In the case of the terminology (F2) used in both tests, there are 25 F2 features in Ta and 20 in Tb. The numbering for the F2 features in Ta are F2-1, F2-2 until F25, while the numbering for the F2 features in Tb are F2-26, F2-27 until F2-45. The purpose of this way of numbering the various instances analysed is to facilitate and simplify the input of these features and the corresponding students' translations in one unique Excel table, which contains all the features of the original English tests, their official Chinese translation as published in the journal, and all the students' translations.

To indicate where these special scientific-technological features occur in the original English text, and in an attempt to simplify the marking process, a marked-up version of the English test and its Chinese counterpart is provided below. These Chinese translations are the official Chinese versions of the abstracts as published in the journal, which, as mentioned before (see section 4.3), have been used as reference translation when marking the students' translations:

Test A **Passage One**	
Original English Text	**Published Translation**
There is a strong need for methods within life cycle assessment (LCA) (F2-1) that enable the inclusion (F5-1) of all complex aspects related (F8-1) to land use and land use change (LULUC) (F2-2).	生命周期评价（LCA）亟需一组分析方法，以研究土地使用及其变化（LULUC）的所有复杂影响。
This article presents (F4-1) a case study of	本文以一公顷（ha）森林为研究基准，其

the use of one hectare (ha) of forest managed (F8-2) for the production (F5-2) of wood for bioenergy production (F2-3).	所产木材全部用于生产生物能源。
Both permanent and temporary changes in above-ground biomass (F2-4) are assessed (F1-1) together with the impact on biodiversity (F2-5) caused (F8-3) by LULUC as a result of (F3-1) forestry activities.	研究考虑了林业活动产生的土地利用及变化以及林地生物质数量的长短期改变对生物多样性的影响。
The impact is measured (F1-2) as a product of time and area requirements, as well as (F3-2) by changes in carbon pools (F2-6) and impacts on biodiversity (F2-7) as a consequence of (F3-3) different management options.	我们评测了以下影响变量，包括时间与面积的乘积以及不同管理方法下的碳库变化和生物多样性影响。
To elaborate (F6-1) the usefulness (F5-3) of the method as well as (F3-4) its dependency (F5-4) on assumptions, a range of scenarios are introduced (F1-3) in the study.	研究引入了一系列情境，用来验证方法的实用性及其所依赖的各种假设条件。
The results show that (F4-2) the impact on climate change from LULUC dominates the results compared to (F8-4) the impact from forestry operations. This clearly demonstrates (F4-3) the need to include (F6-2) LULUC in LCA of forestry products.	结果显示与林业经营活动相比，LULUC 是影响气候变化的主要因素，为此必须把 LULUC 包括在森林产品的 LCA 之中。
For both impacts on climate change and biodiversity (F2-8), the results show (F4-4) large variability (F5-5) based on (F8-5) what assumptions are made (F1-4); and impacts can be either positive or negative.	气候变化及生物多样性的影响评价结果很大程度上取决于的假设条件，其影响可正可负。

A mere measure of land used (F8-6) does not, consequently (F3-5), give any meaning in LCA, as it is not possible to know (F6-3) whether this contributes a positive or negative impact.	LCA 中仅评测所用的土地没有意义，因为无法确定其影响是正是负。

Test A **Passage Two**	
Original English Text	**Published Translation**
By 'working with the willing' (F7-1), the National Industrial Symbiosis Programme (NISP) (F2-9) has successfully facilitated industrial symbiosis (F2-10) throughout the UK and, in the process, delivered significant economic and environmental benefits for both Programme members and the country as a whole (F3-6).	在"有心"工作之下，国家产业共生项目组（NISP）已成功地在英国推动了产业共生，为项目成员乃至整个国家创造了可观的经济和环境效益。
One of the keys to NISP's success is that, unlike failed (F8-7) attempts to plan and construct (F6-4) eco-industrial systems (F2-11) from scratch, the Programme works (F4-5) largely with existing (F7-2) companies who have already settled in, developed, and successfully operate within a given (F8-8) locale.	与以往从无到有规划建设生态产业系统的失败经历不同，NISP 与特定区域内已经落地生根、成功运营的企业合作，这是其成功的关键之一。
This article argues that (F4-6) existing (F7-3) and mature industrial systems provide the best prospects for identifying (F7-4) opportunities for, and ultimately facilitating	本文认为已有成熟的产业体系为产业共生的发展实现提供了最佳视角。

(F7-5), industrial symbiosis (F2-12).	
Due to (F3-7) levels of diversification (F5-6) and operational fundamental niches that, in the fullness of time (F3-8), develop within all industrial systems, industrially mature areas are deemed (F1-5) to be industrial symbiosis 'conducive environments' (F2-13).	产业系统的多样化程度与基础运行条件经年既久、全方面高度发展，从而在产业成熟地区建立起了产业共生的"有益环境"。
Building on (F7-6) the conservation biology (F2-14) concept of a habitat suitability index (F2-15), the article presents (F4-7) a methodology for comparing (F7-7) a potential site for eco-industrial development (F2-16) to a known baseline industrial 'habitat' (F2-17) already identified (F8-9) as being (F7-8) highly conducive to industrial symbiosis (F2-18).	基于保护生物学栖息地适宜指数的概念，本文提出一套方法比较了可能的生态产业发展选址与公认的产业共生适宜"栖息地"。
The suitability index methodology (F2-19) is further developed and applied (F1-6) to a multi-criteria-evaluation geographic information system (F2-20) to produce (F6-5) a 'habitat' suitability map (F2-21) that allows practitioners to quickly identify (F6-6) potential industrial symbiosis (F2-22) hotspots (the methodology is illustrated (F1-7) for England).	我们进一步结合适宜指数方法与多目标的地理信息评价系统，绘制了适宜栖息地图，以便实践者能迅速发现产业共生的适宜地点；该方法以英国为例进行了验证。
The article concludes (F4-8) by providing (F7-9) options for the development (F5-7) of symbiosis suitability indices (F2-23) and how they can be used (F1-8) to support (F6-7) the facilitation (F5-8) of industrial symbiosis (F2-24) and regional resource efficiency (F2-25).	本文最后总结了共生适宜指数的不同设计方案，并指出如何用其来助推产业共生，提高区域资源利用效率。

Test B Passage One	
Original English Text	**Published Translation**
Urban policy makers and researchers consistently recognise (F4-9) the challenge of more effectively reshaping (F7-10) the linkages (F5-9) between cities, urban infrastructure, eco-system services (F2-26) and natural resources.	城市政策制定者和研究者一直面临着一项挑战：如何有效重整城市、市政设施、生态系统服务功能和自然资源之间的联系。
The aim of this article is (F4-10) to consider (F6-8) the potential value of developing (F7-11) connections between two currently disconnected (F8-10) approaches to resource use and cities –Material Flow Accounting (MFA) (F2-27) and Transitions Analysis (TA) (F2-28).	本文旨在探讨在两种脱节的资源和城市研究方法，物质流分析（MFA）和转换分析（TA）之间建立联系的潜在价值。
This article attempts (F4-11) to address (F6-9) this deficit and looks critically at resource flows (F2-29) through cities and the infrastructures that have been – or could be – reconfigured (F1-9) to more effectively manage (F6-10) these flows from the perspectives of (F3-9) MFA (F2-30) and TA(F2-31).	作者试图解决这种脱节带来的缺陷并从 MFA 和 TA 两种视角严格审视城市的资源流动和为有效管理资源流动而已经重整（或可以重整）的市政设施。

This is an issue (F4-12) that has not been addressed (F1-10) with the result that (F3-10) inadequate attention has been paid (F1-11) to the reconfiguring (F7-12) of urban infrastructures, whose construction and maintenance are, in turn (F3-11), often the largest expenditures (F5-10) at city government level.	这个问题一直未得到妥善的解决，以致于市政实施重整并没有得到足够的重视，而市政设施的建设和维护往往正是城市政府最大的开销。
Insufficient attention has been given (F1-12) to the fact that the design, construction and operation of infrastructures (specifically energy, waste, water, sanitation, and transport infrastructures) create a socio-technical environment (F2-32) that plays an important role in shaping (F7-13), and potentially reshaping (F7-14), how resources are procured, used and disposed (F1-13) by the city.	市政实施的设计、建设和运营（特别是能源、废物、水、环卫和运输基础实施）所构成的社会技术环境在塑造和重整城市资源的搜集、消费和终端处置方面起到了重要的作用，这种作用并未得到足够的重视。
The challenge, of course (F3-12), is how such a transition takes place, who leads it and what social and governance processes are best suited (F1-14) to facilitate (F6-11) such city transitions.	面前的挑战就是如何促成意识方法的转换，由谁来领导，以及那些社会和政治流程最适合促成这种转换。
This article assesses (F4-13) the role of MFA (F2-33) and TA (F2-34) in understanding (F7-15) these resource flows (F2-35) and urban infrastructures, making (F7-16) it possible to begin to tackle (F6-12) this challenge in practical transformative ways.	本文评估了 MFA 和 TA 对理解资源流动和市政设施的作用，帮助城市管理者用切合实际的改革方法面临这项挑战。

Test B Passage Two	
Original English Text	**Published Translation**
Urban metabolism (F2-36) is an important technique for understanding (F7-17) the relationship between cities and the wider environment.	城市代谢是认识城市与其外在环境之关系的重要工具。
Such analyses are typically performed (F1-15) at the scale of the whole city using (F7-18) annual average data, a feature that is driven (F1-16) largely by restrictions in data availability (F5-11).	由于数据有限，有关研究多侧重于整个城市尺度上的年均数据分析。
However in order (F3-13) to assess (F6-13) the resource implications (F5-12) of policy interventions (F5-13) and to design and operate (F6-14) efficient urban infrastructures such as (F3-14) energy systems, greater spatial and temporal resolutions are required (F1-17) in the underlying (F7-19) resource demand data (F2-37).	为了评价政策干预的资源影响，同时有效地设计运营包括能源系统在内的城市基础设施，城市的资源需求数据需要有更高的时空分辨率。
As this information is rarely available, we propose that (F4-14) these demand profiles	这方面信息虽然十分缺乏，但我们认为可

might be simulated (F1-18) using (F7-20) activity-based modelling (F2-38).	通过基于行为的模型模拟获得。
This is a micro-simulation approach (F2-39) that calculates the activity schedules of individuals within the city and then converts this information into resource demands (F2-40).	这一微观模拟方法计算城市内个体的行动日程，并将其转化为资源需求数据。
The method is demonstrated (F1-19) by simulating (F7-21) electricity and natural gas demands in London and by examining (F7-22) how these non-transport energy demands (F2-41) might change in response to (F3-15) a shift in commuting patterns (F2-42), for example (F3-16), in response to (F3-17) a congestion charge (F2-43) or similar policy.	本文以伦敦的电力与天然气需求为例验证了上述方法，同时说明了拥堵费等影响交通模式的政策会如何改变电力、天然气等非交通能源需求。
The article concludes (F4-15) by discussing (F7-23) the strengths and weaknesses of the approach, as well as (F3-18) highlighting (F7-24) future research directions.	文章讨论总结了方法的优缺点以及未来的研究方向。
Key challenges include the simulation (F5-14) of in-home activities (F2-44), assessing (F7-25) the transferability (F5-15) of the complex data sets and models supporting (F7-26) such analyses, and determining (F7-27) which aspects of urban metabolism (F2-45) would benefit most from this technique.	关键的挑战包括模拟户内行为、评价分析所需复杂数据与模型间的可转换性、并确定该方法对城市代谢的哪些方面最为有益。

Table 27 below shows the total number of occurrences of each of the 8 features found in Ta, whereas Table 28 shows the occurrences of each of the 8 features that have been found in Tb:

Table 27: Occurrences of each of the 8 features found in Ta

Feature No.	**Typical features of English sci-tech text**	**Total occurrences**
F1	Passive voice	8 (F1-1 to F1-8)
F2	Terminology	25 (F2-1 to F2-25)
F3	Logico-grammatical items (such as in addition to, furthermore, in spite of)	8 (F3-1 to F3-8)
F4	Personal versus impersonal forms	8 (F4-1 to F4-8)
F5	Nominalizations	8 (F5-1 to F5-8)
F6	Infinitive verb form	7 (F6-1 to F6-7)
F7	Gerund form	9 (F7-1 to F7-9)
F8	Past Participle form	9 (F8-1 to F8-9)
	Total number of features	82

Table 28: Occurrences of each of the 8 features found in Tb

Feature No.	Typical features of sci-tech text	Total occurrences
F1	Passive voice	11 (F1-9 to F1-19)
F2	Terminology	20 (F2-26 to F2-45)
F3	Logico-grammatical items (such as in addition to, furthermore, in spite of)	10 (F3-9 to F3-18)
F4	Personal versus impersonal forms	7 (F4-9 to F4-15)
F5	Nominalizations	7 (F5-9 to F5-15)
F6	Infinitive verb form	7 (F6-8 to F6-14)
F7	Gerund form	18 (F7-10 to F7-27)
F8	Past Participle form	1 (F8-10)
	Total number of features	81

The final score given to students for dealing with the various features can be calculated based on the proportion of the features translated appropriately to the total occurrences of features. From Table 27 above, we can see that there are 82 features in total in Ta. If a student has translated 60 features right, her/his score for dealing with them would be calculated as follows:

$$\frac{60}{82}\times 100=73$$

Similarly, from the above Table 28, we see there are 81 features in total in Tb, in which case if a student has translated 60 features right, her/his score for dealing with the specialist features would be:

$$\frac{60}{81}\times 100=74$$

Basically, the student's translation is awarded marks twice, one component is based on the DipTrans marking criteria (see Table 24), and the other is based on the way in which the student has dealt with the various features. In each of the two marking processes, the student has been given a score out of a potential 100. Therefore, the final score awarded to students in any given test is the mean value of the two scores.

Table 29 below illustrates the corresponding marksheet used for the evaluation of the current test:

Table 29: Marksheet used for marking the experiment tests

Participant	Group: Number: Test:				
This section must be completed using the Marking Guidelines in Table 1. Fill in the boxes with the number of marks allocated for each Aspect of Performance.	Aspects of Performance	Assessment Criteria	Maximum marks available	Minimum pass mark (60%)	Marks obtained by Candidate,Score Part 1 (sp1)
	1.Comprehension, Accuracy and Register	How well has the candidate understood the source text? How accurately has the message been conveyed? Are there any serious errors likely to impede comprehension? Are the choices of language and register entirely appropriate to the subject matter and to the spirit and intention of the original?	50	30	sp1-1 =
	2. Grammar (morphology, syntax, etc), Coherence, Cohesion and Organisation of work	What is the quality of the candidate's writing in the target language? Has the candidate produced a text which is grammatically accurate, coherent, cohesive and well-organized?	35	21	sp 1-2 =
	3. Technical Aspects: spelling, punctuation, accentuation, transfer of names, figures, dates, legibility, etc.	How has the candidate dealt with technical aspects? Has the candidate produced a text that is correctly spelt, punctuated, paragraphed and legible? Have names, figures and dates been correctly transferred?	15	9	sp 1-3 =
Participant's score Part 1 (sp1)			(sp1-1 + sp1-2 +sp1-3) /2		
This section must be completed using the Marking Guidelines in Table 3. Fill in the boxes with the number of marks allocated for each Aspect of Performance.	Feature No.	Typical features of sci-tech texts	Poorly translated	Well translated	Marks for dealing with features, Score Part 2 (sp2)
	F1	Passive voice			sp2-1 =
	F2	Terminology			sp2-2 =
	F3	Logico-grammatical items (such as in addition to, furthermore, in spite of)			sp2-3 =
	F4	Personal versus impersonal forms			sp2-4 =
	F5	Nominalizations			sp2-5 =
	F6	Infinitive verb form			sp2-6 =
	F7	Gerund form			sp2-7 =
	F8	Past Participle form			sp2-8 =
Participant's score Part 2 (sp2)			(sp2-1+ sp2-2+ sp2-3+ sp2-4+ sp2-5+ sp2-6+ sp2-7+ sp2-8) ÷(sp2 total)×100/2		
Participant's final score (fs)			sp1 + sp2		

The student's final score for each of the two tests is the sum of the results obtained in each of the two parts being evaluated. On the one hand, students are assessed according to the way they have dealt with the three general aspects of performance suggested by the CIoL (comprehension, grammar and technical aspects). On the other hand, the second part of the evaluation (shaded in grey in the form) awards marks to students according to the way they have reacted when dealing with the eight main specific features of sci-tech texts.

The results awarded for the general performance are called Score Part 1 and are abbreviated as sp1, whereas the score for dealing with the specific features of sci-tech texts is called Score Part 2 and has been abbreviated as sp2.

As can be seen from the above form, the score for each spect under sp1 has been named sp1-1, sp1-2, and sp1-3. The score that students can be awarded for any of the subsections (sp1-1, sp1-2, and sp1-3) is relatively straightforward, as they are given a numerical value up to the maximum value of each of the subsections (50, 35, and 15). For instance, for subsection sp1-1, a student can be awarded a score up to the maximum value of 50 points. The final score for sp1 is to be obtained with the formula: sp1-1 + sp1-2 + sp1-3, with a potential maximum of 100 points (50 + 35 + 15) that can be awarded. Therefore:

$$sp1 = \frac{sp1-1 + sp1-2 + sp1-3}{2}$$

The calculation of the Score Part 2 (sp2) is somewhat more complicated. The formula is as follows:

$$sp2 = \frac{sp2-1+\ sp2-2+\ sp2-3+\ sp2-4+\ sp2-5+\ sp2-6+\ sp2-7+\ sp2-8}{sp2\ total} \ x\ \frac{100}{2}$$

Sp2-1 sp2-2 --- sp2-8 refer to the right translations achieved for each of the eight specialist features. Sp2 total is the total number of the features that occur in the test, which is 82 in Ta and 81 in Tb, and the formula is based on the proportion of correct translations of features to the total number of features in the test. For example, in the case of a student in Ta who has come up with the right translation of 6 F1, 20 F2, 5 F3, 5 F4, 4 F5, 4 F6, 5 F7, and 5 F8, the total score will result from adding all these numbers, namely 54 (6+20+5+5+4+4+5+5). As the total number of occurrences of specialist features in Ta is 82, the sp2 for this student would be:

$$\frac{54}{82}\ x\ \frac{100}{2} = 32.93$$

The final mark is rounded up to integers, i.e. 33, as lecturers normally will not award students a score with decimals. As there are 81 specialist features in total in Tb, using the very same results would make the sp2 to be 33:

$$\frac{54}{81}\ x\ \frac{100}{2} = 33.33$$

4.5 Questionnaires in Ta and Tb

To have an understanding of the students' translation and language background before embarking on their MSc in Translation and to be able to later follow on any changes in the circumstances of the students, two questionnaires were designed in English and administered immediately after each of the two tests. The two questionnaires were used for both groups. The questionnaires were attached to the end of each test, and the students answered the questionnaire straight after the two hour test. They could spend as much time as deemed necessary to complete the questionnaires.

The questionnaires were made up of nine open questions rather than closed questions because the purpose was to get as much and as detailed information as possible to understand the students' background. Through open questions, students could provide any information they thought pertinent and, as a result, a relatively vast amount of information could be collected. Another important aim of the questionnaire was to be able to collect further information that could be used to explain some potentially unanticipated results. For instance, in the case of a student achieving a much lower score in Tb than in Ta, the questionnaire could be used to try and find the reasons for such an unexpected outcome. Also, some students may have already been familiar with CAT tools before taking Ta, meaning that the four months' training will not have made any difference in their performance in Tb. These are just some of the hypothetical scenarios that were considered before administering the tests and that justify the reason for using the questionnaires. The real incidents are discussed in detail in Chapter Five. Table 30 below displays all the questions asked in the two questionnaires:

Table 30: Questionnaires used after Ta and Tb

Questionnaire used after Ta	Questionnaire used after Tb
1. How long did it take for you to finish the test?	1. How long did it take for you to finish the test?
2. Please list the resources you used during the test (such as paper / online dictionaries, online automatic translation interface, computer-assisted translation software…).	2. Please list the resources you used during the test (such as paper / online dictionaries, online automatic translation interface, computer-assisted translation software…).
3. Please list the main difficulties you found when translating the test.	3. Please list the main difficulties you found when translating the test.
4. Have you ever received systematic training on translating scientific and technological texts? If yes, please specify for how long.	4. Have you ever received systematic training on translating scientific and technological texts? If yes, please specify for how long.
5. What type of texts would you like to translate in your future career (literary, scientific and technological, audiovisual…)?	5. What type of texts would you like to translate in your future career (literary, scientific and technological, audiovisual…)?
6. Do you think that learning how to use computer-assisted translation software will be of benefit in your future career as a professional translator? If yes, in what way do you think it will benefit you?	6. Do you think that learning how to use computer-assisted translation software will be of benefit in your future career as a professional translator? If yes, in what way do you think it will benefit you?
7. Have you ever used any computer-assisted translation software (such as SDL Trados, Déjà Vu, Wordfast…) before starting your MSc course? If yes, please list them and give an indication of how long you have been using them.	7. Have you ever been systematically trained on using computer-assisted translation software (such as SDL Trados, Déjà Vu, Wordfast…)? If yes, please list them and specify how long you have been trained on using them.
8. What subject(s) did you study for your Bachelor's degree	8. What courses have you attended so far for your MSc degree?
9. Have you ever stayed in an English speaking country before starting your Master's course? If yes, please specify when, where and how long you stayed there.	9. If you have been systematically trained on using computer-assisted translation software, do you think you have enhanced your competence as a professional translator? If yes, in what way do you think you have improved?

As can be seen in Table 30, questions 1 to 6 were exactly the same in both questionnaires, while questions 7, 8, and 9 were different. Questions 1 to 3 focused on the logistics of the actual test, such as the time the students had spent on the test, the resources and tools they had used for translating, and the difficulties they had found when translating the test. Questions 4 to 6 address their academic background and personal ideas, such as the text types that they would like to work with in the future and their opinion about the usefulness of computer-assisted translation software when translating.

Question 7 in Ta asks the students whether they have used any computer-assisted translation tools before the experiment, which may potentially justify any results that do not seem to support the initial hypothesis, i.e. that their second test would be noticeably better than the first one. In this respect, students in the experimental Ga who had already used CAT tools before sitting Ta could be expected to obtain a high score in both Ta and Tb, making a comparison between the scores obtained in both tests hardly relevant. However, the author's guess may not stand, and it is possible that the student with prior knowledge of CAT tools before embarking on the MSc does indeed obtain a much higher score in Tb than in Ta. Such a significant improvement may have been caused not so much by the use of CAT tools but rather by other factors like systematic training and familiarity on dealing with scientific texts. Having information in this respect will help us to reach conclusions more attuned with the real background of the students

Although at the time of the second test we knew for sure that the students of the experimental Ga had been trained in the use of CAT tools for 4 months, question 7 in Tb, asking students whether they had been systematically trained on using CAT tools, was deemed important because the possibility could not be ruled out that some students in the control Gb could have also learned CAT tools through various means.

Question 8 in Ta tries to find out the students' academic background before they start postgraduate studies. The answer to this question may well interfere in a rather negative manner with the experiment results. For instance, if a student's bachelor's degree has been done in science and technology, we might logically assume that this student will get a higher score when it comes to translating scientific and technological texts than students who

graduated as Bachelors of Humanities. However, this is just the author's supposition and a firm conclusion cannot be reached unless further evidence from the data collected is fully analysed. Another outcome that may enter into conflict with the results is the fact that some students may have studied a BA in Translation, during the course of which they may have already been exposed to the use of CAT tools.

Question 8 in Tb, instead, asks students about the MSc modules that they have already attended during the four months between both tests, so that the researcher can get a more objective idea of what the potential factors affecting their translational performance may be.

Question 9 in Ta asks the students whether they have spent a long term stay in an English speaking country before starting their Master's study. This question intends to find out whether there is a positive correlation between the students' experience of a long time stay in an English speaking country and their translation ability. In this sense, we may well suppose that students' language skills will have improved considerably if they have lived in a country where English is spoken and we may also assume that their ability in terms of general translation has improved too. However, it would be highly risky to conclude that a period of stay in an English speaking country has improved the students' translation ability when it comes to the translation of scientific and technological texts, as the language of science and technology is very different from daily language, and will not necessarily have improved by residing in the country.

Question 9 in Tb asks students whether they think that learning CAT tools has in effect helped them improve their translation ability. At this stage in the experiment students from

the experimental Ga had indeed been trained in the use of CAT tools for four months and the intention is to gather their subjective feedback, since their opinion on these matters may not actually match the results obtained. This very same question is also posed to the students from the control Gb just in case some of them may have learned CAT tools on their own accord.

To summarise, Chapter 4 has first introduced the subjects that have taken part in the current study, namely, the students of the experimental group and of the control group. In order to reach meaningful conclusions, the results obtained from the first test – i.e. when none of the two groups had been trained on the use of CAT tools – will be compared with the results from the second test, administered after only the experimental Ga had been trained using CAT tools. An effort has been made when selecting the test materials used for both tests so that they share similar level of difficulty and embody the specific linguistic features that characterise scientific and technological texts. The marking criteria used for the tests are based on the DipTrans marking standards as well as on the students' performance in dealing with features of scientific and technological texts. Finally, a questionnaire has been designed and administered to all subjects after both the first and the second tests, to provide value added information that will help the researcher determine some of the factors behind the students' performance.

In the following chapter, the results from the students' tests are discussed, the subsequent data is presented in a statistical manageable format, the statistical results are generated, and the results and factors that may have influenced them are also investigated.

Chapter Five

Data Collection and Analysis

5.1 Introduction

The experiment, finished as designed and scheduled, produced 80 test results, which were generated by 20 students from the experimental Group A and 20 students from the control Group B, both groups having finished Test A and Test B.

The author first marked the 80 test results based on the DipTrans criteria, awarded a score - i.e., the sp1 - for each performance and then collated the value of all sp1 results in the marking sheets. Afterwards, the author grouped the Chinese translation of all the specialised features appearing in each of the students' translations and input them in the Excel table displaying the sci-tech specialised features of the original English texts, their standard Chinese translation, and the students' translations. In the excel table, the author highlighted the students' wrong translations in red and kept the right translations in black, so that when computing the results it would be easy to spot how many features were translated right, and how many wrong. Based on the proportion of the right translated features to the actual total occurrences of said features, the author awarded the sp2, which was also input into each of the individual marking sheets. Lastly, the final score (fs) was

calculated by adding sp1 and sp2. These three scores (sp1, sp2 and fs) are the main figures used in this analysis. The author also entered in the marking sheets the three subcategory scores within sp1 (sp1-1, sp1-2, sp1-3) and the eight subcategory scores within sp2 (sp2-1, sp2-2, sp2-3, sp2-4, sp2-5, sp2-6, sp2-7, and sp2-8). This detailed information has been included because the analysis of the subcategory scores has the potential of illustrating which specific aspects the students were good at and in which aspects they did not perform so well.

Thereafter, the author grouped the scores that were contained in the 80 individual marking sheets into four tables named as GaTa, GaTb, GbTa, and GbTb, based on the group the students belonged to and the test the students had taken. Before starting Test A, the students were given a randomly numbered ID, which meant that the scores displayed in the order of their ID numbers in these four tables also looked random and did not show any patterns. To solve this shortcoming, the author decided to rearrange GaTa and GbTa in the ascending order of the students' final score, with the weakest result at the top. To make sure that the scores of the first and the second tests were easily comparable, the author rearranged table GaTb in the same order as GaTa, and table GbTb in the same order of GbTa (see section 5.2.4), after which the data collection process was completed and the actual analysis could be initiated.

The data obtained has been analysed from a horizontal as well as a longitudinal dimension. The horizontal analysis has been used to compare the two groups' performance of the same test that was seated at the same time, that is, the comparison of GaTa and GbTa, and the comparison of GaTb and GbTb. At this point in the study, the author also refers to the

student's answers to the questionnaires, so as to decide on the possible factors that may have impacted on the individual student's score. The longitudinal analysis, on the other hand, compared the results of the first and the second tests taken by the same students, with the goal of gauging any potential improvement in the students' performance: GaTa versus GaTb and GbTa versus GbTb. The data is later analysed in an attempt to find any meaningful correlation between the factors and the scores. Ultimately, the purpose of the analysis is to address the prime hypothesis, i.e., that the application of CAT tools in translator training enhances students' translation skills as indicated by a better performance after the training. Furthermore, this improvement attained because of using CAT tools is significant enough from a statistical point of view, when the results are compared to the improvement made by students who had not received any training in CAT tools. It is hoped that these results will foreground the necessity and effectiveness of including CAT tools in translator training from an early stage, particularly in the training of scientific and technological translators.

Before discussing the data in detail, the following list of abbreviations and their meaning is provided in Table 31 in order to facilitate the reading of the chapters to come:

Table 31: List of abbreviations

Ga	Group A, the experimental group, Master's students from Imperial College London
Gb	Group B, the control group, Master's students from Beijing University of Aeronautics and Astronautics
Ta	Test A, the first test taken by both Group A and Group B
Tb	Test B, the second test taken by both Group A and Group B
N	Numbers assigned to the students as their ID
fs	Final score: the overall score for a test, maximum score 100
sp1	Score part one: the score given to students based on the DipTrans marking standards, maximum score 50
sp1-1, sp1-2, sp1-3	Scores given to the three aspects considered within the DipTrans marking standards
sp2	Score part two: the score given to students based on how they deal with the eight main specific features of scientific and technological texts, maximum score 50
sp2-1, sp2-2, till sp2-8	Scores given to the eight features considered specific of scientific and technological texts
Tb-Ta	Tb minus Ta
En	English
Zh	Chinese
sci-tech	scientific and technological

5.2 Data collection process

The data collection was completed following five steps, namely:

(1) inputting students' parallel En-Zh texts with the specific features in an Excel table;

(2) marking the students' test performance;

(3) entering the resulting scores into the marking sheets;

(4) collating all students' scores shown in the marking sheets (including sp1, sp2, fs and the subcategory scores sp1-1, sp1-2, sp1-3, as well as sp2-1, sp2-2, sp2-3, sp2-4, sp2-5, sp2-6, sp2-7, and sp2-8) into four tables that show separately the scores of each of the tests taken by the various students; and finally

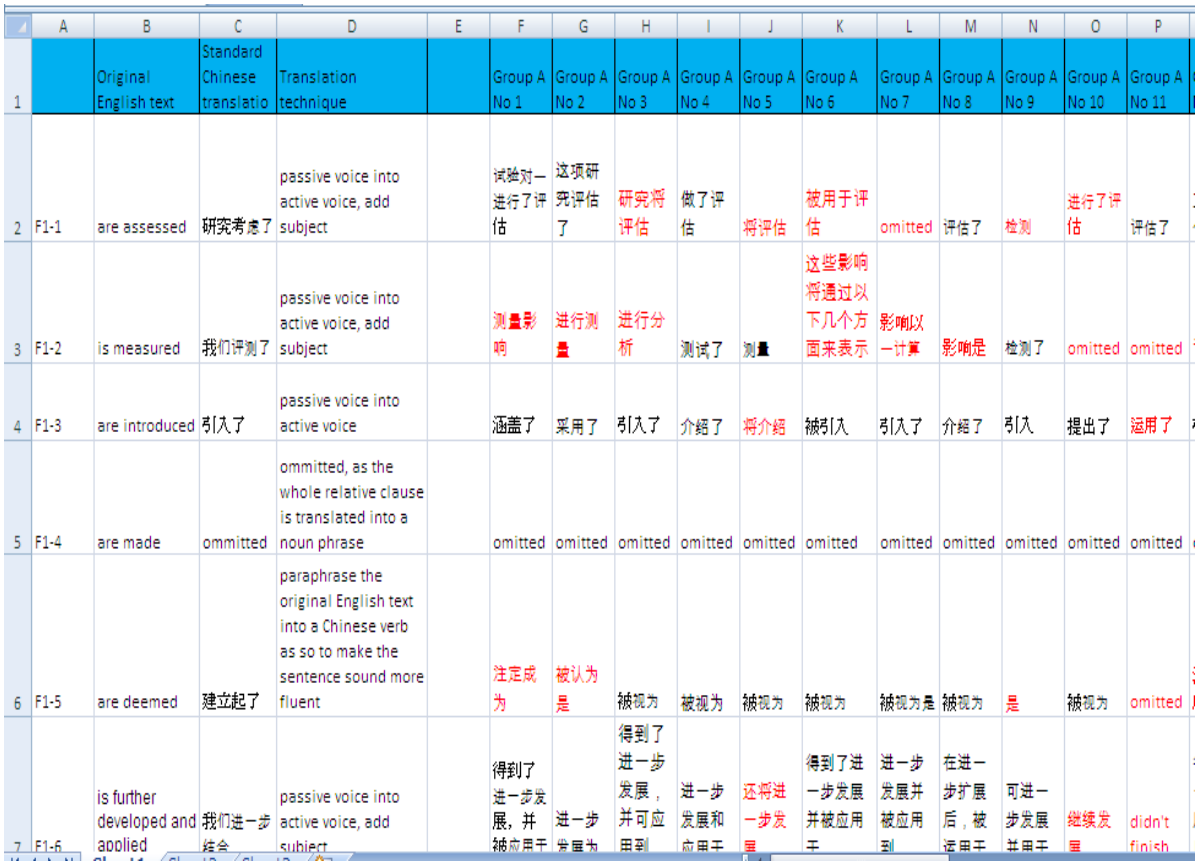
(5) rearranging the order of the scores in ascending order depending on the fs of their first test (Ta). These four reordered tables contained the data used in the analysis.

5.2.1 Inputting all the students' parallel En-Zh texts with the specific features in an Excel spreadsheet

For each test, students were given three scores: sp1, sp2 and fs. Sp1 focuses on the following three aspects: (1) comprehension, accuracy and register, sp1-1; (2) cohesion, coherence and organisation of work, sp1-2; and (3) punctuation, spelling, accentuation, transfer of names, dates, and figures, sp1-3.

The sp2 reflects how the student has dealt with the transfer of the eight main specific features typical of scientific and technological texts (see section 4.4). As already discussed, there are 82 occurrences of specific features in Ta and 81 in Tb. With 40 students finishing both tests, the total number of occurrences is (82+81) × 40 = 6,520. The original En text has been entered into an Excel spreadsheet, aligned with both the standard Zh translation and the student's translation of each of the features. If the feature is well translated, the student's translation is in black, and it is in red if the translation is wrong. Each student's sp2 is based on the proportion of right translations to the total features of a test. Appendix 4 contains the excel table of these features and their corresponding translations by all the 40 students. The following screenshot (Figure 4) shows how the excel table looks like:

Figure 4: Screenshot of the excel table recording all the features and their translations



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		Original English text	Standard Chinese translatio	Translation technique		Group A No 1	Group A No 2	Group A No 3	Group A No 4	Group A No 5	Group A No 6	Group A No 7	Group A No 8	Group A No 9	Group A No 10	Group A No 11
2	F1-1	are assessed	研究考虑了	passive voice into active voice, add subject		试验对一进行了评估	这项研究评估了	研究将评估	做了评估	将评估	被用于评估	omitted	评估了	检测	进行了评估	评估了
3	F1-2	is measured	我们评测了	passive voice into active voice, add subject		测量影响	进行测量	进行分析	测试了	测量	这些影响将通过以下几个方面来表示	影响以一计算	影响是	检测了	omitted	omitted
4	F1-3	are introduced	引入了	passive voice into active voice		涵盖了	采用了	引入了	介绍了	将介绍	被引入	引入了	介绍了	引入	提出了	运用了
5	F1-4	are made	ommitted	ommitted, as the whole relative clause is translated into a noun phrase		omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
6	F1-5	are deemed	建立起了	paraphrase the original English text into a Chinese verb as so to make the sentence sound more fluent		注定成为	被认为是	被视为	被视为	被视为	被视为	被视为是	被视为	是	被视为	omitted
7	F1-6	is further developed and applied	我们进一步结合	passive voice into active voice, add subject		得到了进一步发展，并被应用于	进一步发展为	得到了进一步发展，并可应用到	进一步发展和应用于	还将进一步发展	得到了进一步发展并被应用于	进一步发展并被应用到	在进一步扩展后，被运用于	可进一步发展并用于	继续发展	didn't finish

5.2.2 Marking and collating the results

A total of 80 individual marking sheets have been produced in order to record all students' scores in the two tests. As an example, the marking sheet used to compile the results of Test A, done by candidate number 1, belonging to Group A, is offered in Table 32 below:

Table 32: GaN1Ta marking sheet

Participant	Group: A Number: 1 Test: A	GaN1Ta			
This section must be completed using the Marking Guidelines in Table 1. Fill in the boxes with the number of marks allocated for each Aspect of Performance.	Aspects of Performance	Assessment Criteria	Maximum marks available	Minimum pass mark (60%)	Marks obtained by Candidate,Score Part 1 (sp1)
	1.Comprehension, Accuracy and Register	How well has the candidate understood the source text? How accurately has the message been conveyed? Are there any serious errors likely to impede comprehension? Are the choices of language and register entirely appropriate to the subject matter and to the spirit and intention of the original?	50	30	sp1-1 = 44
	2. Grammar (morphology, syntax, etc), Coherence, Cohesion and Organisation of work	What is the quality of the candidate's writing in the target language? Has the candidate produced a text which is grammatically accurate, coherent, cohesive and well-organized?	35	21	sp 1-2 = 30
	3. Technical Aspects: spelling, punctuation, accentuation, transfer of names, figures, dates, legibility, etc.	How has the candidate dealt with technical aspects? Has the candidate produced a text that is correctly spelt, punctuated, paragraphed and legible? Have names, figures and dates been correctly transferred?	15	9	sp 1-3 = 12
Participant's score Part 1 (sp1)			**(sp1-1 + sp1-2 +sp1-3) /2**		**43.00**
This section must be completed using the Marking Guidelines in Table 3. Fill in the boxes with the number of marks allocated for each Aspect of Performance.	Feature No.	Typical features of sci-tech texts	Poorly translated	Well translated	Marks for dealing with features, Score Part 2 (sp2)
	F1	Passive voice			sp2-1 = 6
	F2	Terminology			sp2-2 =21
	F3	Logico-grammatical items (such as in addition to, furthermore, in spite of)			sp2-3 =5
	F4	Personal versus impersonal forms			sp2-4 =7
	F5	Nominalizations			sp2-5 =6
	F6	Infinitive verb form			sp2-6 =7
	F7	Gerund form			sp2-7 =8
	F8	Past Participle form			sp2-8 =7
Participant's score Part 2 (sp2)			**(sp2-1+ sp2-2+ sp2-3+ sp2-4+ sp2-5+ sp2-6+ sp2-7+ sp2-8) ÷(sp2 total)×100/2**		**40.85**
Participant's final score (fs)			**sp1 + sp2**		**83.85**

After having completed all the individual marking sheets, the scores were then collated into four tables based on the group the students belonged to (Ga and Gb) and the test the

students had taken (Ta and Tb), in an attempt to facilitate the visualisation of each student's scores and to expedite the comparison between students' scores. Within each table, the results are arranged in the sequence of the students' ID numbers. The following Table 33 contains the scores achieved in Ta by students in Ga. The first left column of the table shows that the scores are arranged in the order of the students' ID sequences, and the columns with the blue digits offer the partial (sp1 and sp2) and final (fs) results of each student:

Table 33: Scores for GaTa in the order of students' ID sequences

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GaN1Ta	44	30	12	43	6	21	5	7	6	7	8	7	41	84
GaN2Ta	38	23	7	34	5	11	6	5	5	5	6	8	32	66
GaN3Ta	41	24	7	36	7	12	7	7	6	5	8	8	37	73
GaN4Ta	40	24	9	37	8	12	6	8	5	7	6	7	36	72
GaN5Ta	35	21	7	32	4	10	7	8	4	5	7	9	33	64
GaN6Ta	39	23	8	35	5	13	7	7	5	5	8	8	35	70
GaN7Ta	42	24	10	38	5	13	4	6	5	5	7	7	32	70
GaN8Ta	42	28	11	41	6	15	8	8	7	7	5	9	40	80
GaN9Ta	38	23	7	34	5	9	7	7	7	5	6	6	32	66
GaN10Ta	38	23	7	34	4	8	5	7	4	4	6	7	27	61
GaN11Ta	29	20	7	28	2	9	6	4	4	3	7	7	26	54
GaN12Ta	43	28	10	41	5	18	7	7	7	5	8	7	39	80
GaN13Ta	40	25	9	37	5	14	6	7	8	6	6	8	37	74
GaN14Ta	39	23	8	35	6	10	6	8	4	4	6	9	26	61
GaN15Ta	29	22	6	29	3	6	6	6	7	4	5	8	27	56
GaN16Ta	40	24	8	34	5	10	6	6	7	6	6	8	33	67
GaN17Ta	40	24	7	36	6	12	8	6	8	6	8	8	38	73
GaN18Ta	30	16	8	27	6	9	8	5	4	5	8	7	32	59
GaN19Ta	38	22	8	34	4	12	7	7	6	5	6	7	33	67
GaN20Ta	35	20	8	32	4	9	4	5	6	5	4	6	27	58

Tables 34, 35 and 36 offer the results scored by students in GaTb, GbTa, and GbTb and they are also organised in accordance with the students' ID numbers:

Table 34: Scores for GaTb in the order of students' ID sequences

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GaN1Tb	46	30	11	44	9	17	10	6	7	6	15	0	44	87
GaN2Tb	42	24	10	38	10	20	9	7	5	6	17	1	46	84
GaN3Tb	44	27	11	41	10	17	9	7	5	6	15	0	43	84
GaN4Tb	44	26	10	40	10	18	9	6	6	6	17	1	45	85
GaN5Tb	41	25	10	38	10	20	9	7	5	7	17	1	47	85
GaN6Tb	41	25	9	38	10	19	9	6	6	6	15	0	44	81
GaN7Tb	44	27	11	41	9	19	10	6	7	6	15	1	45	86
GaN8Tb	45	28	11	42	11	20	9	7	6	7	17	1	48	90
GaN9Tb	39	24	9	36	10	18	8	6	6	7	11	1	41	77
GaN10Tb	38	24	9	36	8	13	9	7	3	5	16	0	38	73
GaN11Tb	30	20	8	29	7	15	9	5	7	5	12	1	38	67
GaN12Tb	45	29	12	43	10	19	9	7	5	5	16	1	44	87
GaN13Tb	44	28	10	41	9	19	9	6	7	6	16	1	45	86
GaN14Tb	44	27	9	40	9	19	10	7	6	5	16	0	44	84
GaN15Tb	35	20	9	32	9	18	9	5	5	3	13	1	39	71
GaN16Tb	44	28	10	41	9	20	9	6	7	6	16	1	46	87
GaN17Tb	44	28	9	41	10	19	9	5	6	6	16	1	44	85
GaN18Tb	29	17	8	27	9	16	10	5	4	5	17	0	41	68
GaN19Tb	41	23	8	36	7	12	9	7	5	7	15	1	39	75
GaN20Tb	36	21	9	33	6	16	6	4	6	4	16	0	36	69

Table 35: Scores for GbTa in the order of students' ID sequences

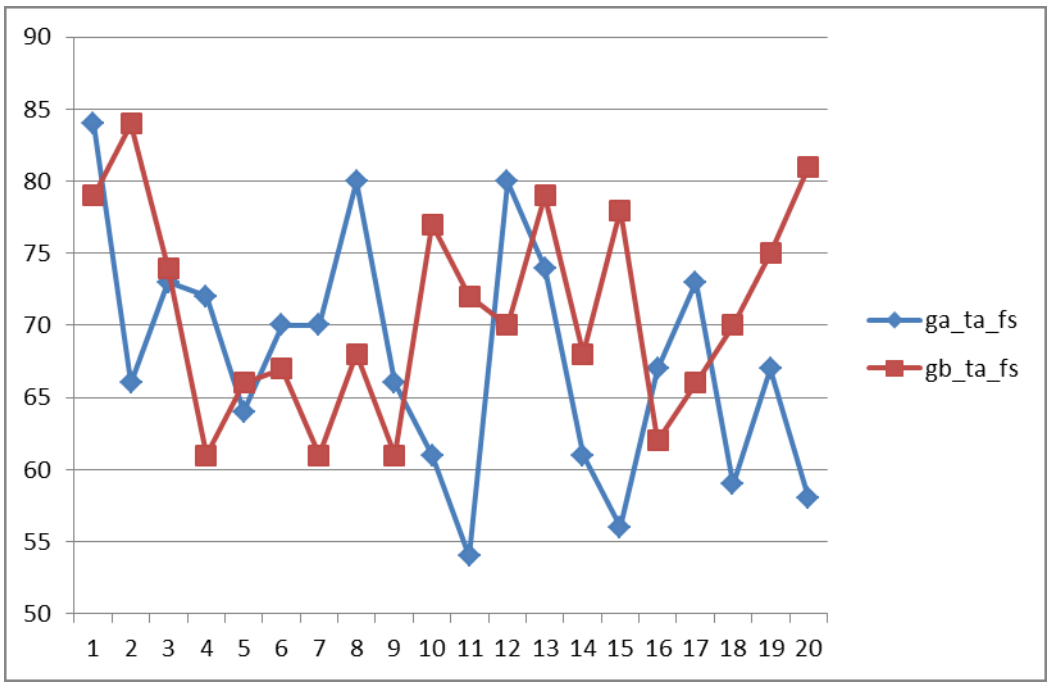
Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GbN1Ta	42	28	9	40	6	11	5	6	7	7	6	6	39	79
GbN2Ta	44	29	13	43	5	19	6	8	7	6	8	8	41	84
GbN3Ta	42	27	9	39	6	13	6	6	8	6	6	7	35	74
GbN4Ta	37	22	7	33	3	6	5	6	7	5	7	7	28	61
GbN5Ta	37	24	7	34	4	11	6	7	5	6	6	7	32	66
GbN6Ta	40	24	8	36	6	8	5	5	7	7	5	8	31	67
GbN7Ta	34	21	8	32	3	6	7	6	7	5	6	8	29	61
GbN8Ta	40	24	8	36	5	5	6	8	6	6	7	9	32	68
GbN9Ta	33	22	7	31	2	11	6	6	5	5	5	9	30	61
GbN10Ta	44	28	8	40	5	14	6	8	7	7	6	8	37	77
GbN11Ta	40	23	8	36	5	12	5	8	7	7	8	8	37	72
GbN12Ta	42	25	7	37	5	12	5	8	8	6	4	6	33	70
GbN13Ta	43	29	8	40	6	13	7	8	8	6	7	9	39	79
GbN14Ta	37	23	8	34	5	9	7	5	7	7	6	9	34	68
GbN15Ta	44	28	8	40	6	13	6	7	8	7	8	8	38	78
GbN16Ta	39	22	6	34	3	5	6	6	6	6	6	8	29	62
GbN17Ta	37	23	8	34	6	8	5	7	6	6	7	8	32	66
GbN18Ta	40	24	8	36	5	10	6	8	7	6	5	8	34	70
GbN19Ta	41	24	8	37	4	14	7	7	8	6	8	9	38	75
GbN20Ta	44	28	9	41	6	18	7	8	6	6	8	8	41	81

Table 36: Scores for GbTb in the order of students' ID sequences

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	Fs
GbN1Tb	46	30	10	43	9	20	9	7	6	6	16	1	46	89
GbN2Tb	47	30	14	46	10	20	10	6	7	4	17	1	46	92
GbN3Tb	43	26	10	40	11	19	9	7	6	6	16	0	46	86
GbN4Tb	38	22	10	35	9	18	10	7	5	6	13	0	42	77
GbN5Tb	43	26	9	39	10	17	10	5	6	5	14	0	41	80
GbN6Tb	41	24	10	38	10	20	9	5	7	4	15	0	43	81
GbN7Tb	37	21	8	33	7	12	8	6	2	3	16	0	34	67
GbN8Tb	42	25	9	38	10	17	9	7	7	5	15	0	44	82
GbN9Tb	37	22	8	34	7	14	8	5	4	4	10	1	33	66
GbN10Tb	44	28	9	41	10	18	9	6	6	6	13	1	43	83
GbN11Tb	45	27	9	41	11	17	9	6	5	7	16	0	44	84
GbN12Tb	44	27	9	40	8	14	10	5	5	4	15	1	38	78
GbN13Tb	46	31	9	43	9	19	9	6	4	5	16	1	43	86
GbN14Tb	39	24	8	36	8	14	8	6	4	5	15	0	37	73
GbN15Tb	44	29	9	41	10	15	10	6	6	5	16	1	43	84
GbN16Tb	44	27	9	40	8	18	10	7	7	5	15	0	43	83
GbN17Tb	39	23	9	35	10	17	10	7	5	4	15	1	43	78
GbN18Tb	42	25	11	39	11	17	9	6	6	7	17	1	46	85
GbN19Tb	41	24	9	37	10	18	9	6	5	7	17	0	44	81
GbN20Tb	45	27	9	41	9	12	8	5	5	5	17	0	38	78

As explained in section 5.1, the numbers 1 to 20 were randomly assigned to the 20 students in each group as their personalised ID before they took Ta, and they kept the same ID number in Tb so as to facilitate the pairing of the results obtained by the same student in the first and second tests. It is obvious that a figure of the fs values of the above four tables that represent the students' overall translation ability will not show certain patterns, or any trends, because the students have not been categorized based on their translation competence in starting the experiment, i.e., the time of Test A. For example, if we use Table 33 and Table 34 above to compare the fs values of the students of Ga and Gb who have finished Ta, the figure generated would be as follows:

Figure 5: Comparison of fs values of GaTa and GbTa based on the tables in the order of students' ID sequences



As no pattern or trend can be discerned by adopting such an approach, the decision was taken that, in order to facilitate the comparison, the data obtained be arranged in the ascending order of the fs values of Ta (column in blue), indicating in this manner the poorest results first and the best results at the end, as illustrated in Table 37 below:

Table 37: GaTa results ordered by final scores, in ascending order

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GaN11Ta	29	20	7	28	2	9	6	4	4	3	7	7	26	54
GaN15Ta	29	22	6	29	3	6	6	6	7	4	5	8	27	56
GaN20Ta	35	20	8	32	4	9	4	5	6	5	4	6	27	58
GaN18Ta	30	16	8	27	6	9	8	5	4	5	8	7	32	59
GaN10Ta	38	23	7	34	4	8	5	7	4	4	6	7	27	61
GaN14Ta	39	23	8	35	6	10	6	8	4	4	6	9	26	61
GaN5Ta	35	21	7	32	4	10	7	8	4	5	7	9	33	64
GaN2Ta	38	23	7	34	5	11	6	5	5	5	6	8	32	66
GaN9Ta	38	23	7	34	5	9	7	7	7	5	6	6	32	66
GaN16Ta	40	24	8	34	5	10	6	6	7	6	6	8	33	67
GaN19Ta	38	22	8	34	4	12	7	7	6	5	6	7	33	67
GaN6Ta	39	23	8	35	5	13	7	7	5	5	8	8	35	70
GaN7Ta	42	24	10	38	5	13	4	6	5	5	7	7	32	70
GaN4Ta	40	24	9	37	8	12	6	8	5	7	6	7	36	72
GaN3Ta	41	24	7	36	7	12	7	7	6	5	8	8	37	73
GaN17Ta	40	24	7	36	6	12	8	6	8	6	8	8	38	73
GaN13Ta	40	25	9	37	5	14	6	7	8	6	6	8	37	74
GaN8Ta	42	28	11	41	6	15	8	8	7	7	5	9	40	80
GaN12Ta	43	28	10	41	5	18	7	7	7	5	8	7	39	80
GaN1Ta	44	30	12	43	6	21	5	7	6	7	8	7	41	84

As the ultimate goal of these experiments is to monitor the students' learning process and to evaluate any potential improvement in their translation performance, the results of the second test (Tb) have been rearranged following the order dictated by Table 37. Consequently, the information contained in Table 38 below is presented in accordance with the new order of ID numbers (column in blue) as in the previous Table 37, rather than the fs results of Tb:

Table 38: GaTb results

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GaN11Tb	30	20	8	29	7	15	9	5	7	5	12	1	38	67
GaN15Tb	35	20	9	32	9	18	9	5	5	3	13	1	39	71
GaN20Tb	36	21	9	33	6	16	6	4	6	4	16	0	36	69
GaN18Tb	29	17	8	27	9	16	10	5	4	5	17	0	41	68
GaN10Tb	38	24	9	36	8	13	9	7	3	5	16	0	38	73
GaN14Tb	44	27	9	40	9	19	10	7	6	5	16	0	44	84
GaN5Tb	41	25	10	38	10	20	9	7	5	7	17	1	47	85
GaN2Tb	42	24	10	38	10	20	9	7	5	6	17	1	46	84
GaN9Tb	39	24	9	36	10	18	8	6	6	7	11	1	41	77
GaN16Tb	44	28	10	41	9	20	9	6	7	6	16	1	46	87
GaN19Tb	41	23	8	36	7	12	9	7	5	7	15	1	39	75
GaN6Tb	41	25	9	38	10	19	9	6	6	6	15	0	44	81
GaN7Tb	44	27	11	41	9	19	10	6	7	6	15	1	45	86
GaN4Tb	44	26	10	40	10	18	9	6	6	6	17	1	45	85
GaN3Tb	44	27	11	41	10	17	9	7	5	6	15	0	43	84
GaN17Tb	44	28	9	41	10	19	9	5	6	6	16	1	44	85
GaN13Tb	44	28	10	41	9	19	9	6	7	6	16	1	45	86
GaN8Tb	45	28	11	42	11	20	9	7	6	7	17	1	48	90
GaN12Tb	45	29	12	43	10	19	9	7	5	5	16	1	44	87
GaN1Tb	46	30	11	44	9	17	10	6	7	6	15	0	44	87

On the basis of the same rationale of rearranging the order of GaTa, the scores obtained in Test A by students in Group B, namely, GbTa, have also been arranged in the ascending order of the fs values of Ta (column in blue), as shown in Table 39 below:

Table 39: GbTa results ordered by final scores, in ascending order

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GbN4Ta	37	22	7	33	3	6	5	6	7	5	7	7	28	61
GbN7Ta	34	21	8	32	3	6	7	6	7	5	6	8	29	61
GbN9Ta	33	22	7	31	2	11	6	6	5	5	5	9	30	61
GbN16Ta	39	22	6	34	3	5	6	6	6	6	6	8	29	62
GbN5Ta	37	24	7	34	4	11	6	7	5	6	6	7	32	66
GbN17Ta	37	23	8	34	6	8	5	7	6	6	7	8	32	66
GbN6Ta	40	24	8	36	6	8	5	5	7	7	5	8	31	67
GbN8Ta	40	24	8	36	5	5	6	8	6	6	7	9	32	68
GbN14Ta	37	23	8	34	5	9	7	5	7	7	6	9	34	68
GbN12Ta	42	25	7	37	5	12	5	8	8	6	4	6	33	70
GbN18Ta	40	24	8	36	5	10	6	8	7	6	5	8	34	70
GbN11Ta	40	23	8	36	5	12	5	8	7	7	8	8	37	72
GbN3Ta	42	27	9	39	6	13	6	6	8	6	6	7	35	74
GbN19Ta	41	24	8	37	4	14	7	7	8	6	8	9	38	75
GbN10Ta	44	28	8	40	5	14	6	8	7	7	6	8	37	77
GbN15Ta	44	28	8	40	6	13	6	7	8	7	8	8	38	78
GbN1Ta	42	28	9	40	6	11	5	6	7	7	6	6	39	79
GbN13Ta	43	29	8	40	6	13	7	8	8	6	7	9	39	79
GbN20Ta	44	28	9	41	6	18	7	8	6	6	8	8	41	81
GbN2Ta	44	29	13	43	5	19	6	8	7	6	8	8	41	84

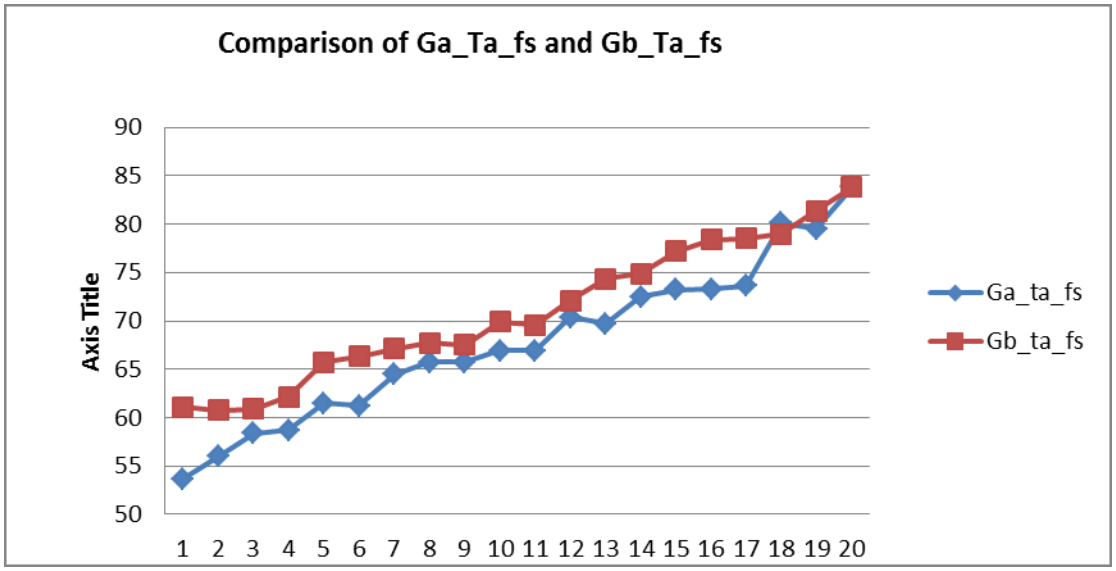
In order to evaluate the improvement that the students in Group B have made after the four months' training, the author has to compare the results of the second test (Tb) with the results of the first test (Ta). Therefore, the results of the second test done by Group B, namely, GbTb, are rearranged following the order dictated in Table 39. The information in Table 40 below is presented in accordance with the new order of ID numbers (column in blue) as in the previous Table 39, rather than the fs results of Tb:

Table 40: GbTb results

Number	sp1-1	sp1-2	sp1-3	sp1	sp2-1	sp2-2	sp2-3	sp2-4	sp2-5	sp2-6	sp2-7	sp2-8	sp2	fs
GbN4Tb	38	22	10	35	9	18	10	7	5	6	13	0	42	77
GbN7Tb	37	21	8	33	7	12	8	6	2	3	16	0	34	67
GbN9Tb	37	22	8	34	7	14	8	5	4	4	10	1	33	66
GbN16Tb	44	27	9	40	8	18	10	7	7	5	15	0	43	83
GbN5Tb	43	26	9	39	10	17	10	5	6	5	14	0	41	80
GbN17Tb	39	23	9	35	10	17	10	7	5	4	15	1	43	78
GbN6Tb	41	24	10	38	10	20	9	5	7	4	15	0	43	81
GbN8Tb	42	25	9	38	10	17	9	7	7	5	15	0	44	82
GbN14Tb	39	24	8	36	8	14	8	6	4	5	15	0	37	73
GbN12Tb	44	27	9	40	8	14	10	5	5	4	15	1	38	78
GbN18Tb	42	25	11	39	11	17	9	6	6	7	17	1	46	85
GbN11Tb	45	27	9	41	11	17	9	6	5	7	16	0	44	84
GbN3Tb	43	26	10	40	11	19	9	7	6	6	16	0	46	86
GbN19Tb	41	24	9	37	10	18	9	6	5	7	17	0	44	81
GbN10Tb	44	28	9	41	10	18	9	6	6	6	13	1	43	83
GbN15Tb	44	29	9	41	10	15	10	6	6	5	16	1	43	84
GbN1Tb	46	30	10	43	9	20	9	7	6	6	16	1	46	89
GbN13Tb	46	31	9	43	9	19	9	6	4	5	16	1	43	86
GbN20Tb	45	27	9	41	9	12	8	5	5	5	17	0	38	78
GbN2Tb	47	30	14	46	10	20	10	6	7	4	17	1	46	92

After the rearrangement, the data are comparable and, for instance, if Table 37 and Table 38 above are used to compare the fs values of the students of Ga and Gb who have taken Ta, the figure generated would be as follows:

Figure 6: Comparison of the fs values of GaTa and GbTa based on the tables in the rearranged order



Compared with Figure 5, which does not show any patterns or trends between the two tables of data, the above Figure 6 does show clearly that nearly all students in Gb that have taken test A have ended up with a higher fs score than the students in Ga, with only three exceptions (chart numbers 18, 19 and 20). This comparison is presented here as an example to show the reader the purpose of rearranging the order of the students in each of the tables. What can thus be ascertained is that tables 37, 38, 39, and 40 can be deemed to be comparable and hence will be used for the statistical analysis carried out in sections 5.3 and 5.4.

From Figure 6, the x-axis is numbered from 1 to 20, representing different student numbers for Group A (Ga) and Group B (Gb). If Table 37 (GaTa) and Table 38 (GaTb) are taken as examples, it can be seen that the new sequence of Group A is:

11 – 15 – 20 – 18 – 10 – 14 – 5 – 2 – 9 – 16 – 19 – 6 – 7 – 4 – 3 – 17 – 13 – 8 – 12 – 1

Tables 39 and 40 above show that the new sequence of Group B is:

4 – 7 – 9 – 16 – 5 – 17 – 6 – 8 – 14 – 12 – 18 – 11 – 3 – 19 – 10 – 15 – 1 – 13 – 20 – 2

Hereafter, in the various figures used in the coming chapters, the numbers from 1 to 20 on the x-axis each represent one student number of Ga (Group A) and one student number of Gb (Group B), but not necessarily the originally randomly assigned number. For instance, the number 2 on the x-axis in Figure 7 represents number 15 of Ga and Number 7 of Gb. For ease of representation, the following Table 41 shows the numbers 1 to 20 on the x-axis and their corresponding numbers for students of Group A and Group B:

Table 41: Numbers on the x-axis and their corresponding student numbers for Ga and Gb

Number on the x-axis	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Corresponding student number of Ga	11	15	20	18	10	14	5	2	9	16	19	6	7	4	3	17	13	8	12	1
Corresponding student number of Gb	4	7	9	16	5	17	6	8	14	12	18	11	3	19	10	15	1	13	20	2

This reordering process can be seen as the author's effort to pair up the students from the experimental Group A and the control Group B based on their translation ability level and so as to make the data comparable. The numbers on the x-axis are the rankings of students based on the fs score of the first test (Ta), with Number 1 representing the lowest scorer

and Number 20 the highest scorer. In this sense, the x-axis number 3 represents the 3rd lowest scorers from both groups: Number 20 from Group A and Number 9 from Group B.

Once completed the data collection process, the analysis of the data is conducted from a horizontal and longitudinal perspective. The horizontal analysis looks at the scores of the two groups after having finished the same test, comparing first the results between GaTa and GbTa and then between GaTb and GbTb. The longitudinal analysis, on the other hand, concentrates on the comparison between the scores of two tests obtained by the same student within the same group, that is, between GaTa and GaTb and between GbTa and GbTb. It also compares the overall improvement made by both groups of students by contrasting Ga (Tb-Ta) and Gb (Tb-Ta).

The purpose of the horizontal analysis is to find out some of the factors that may justify the scores obtained by students in GaTa, GaTb, GbTa, GbTb, according to the answers provided in their questionnaires. By contrast, the purpose of the longitudinal analysis is to calculate the actual score differences between Ta and Tb for both groups, so as to find out whether Ga and Gb have made any improvements in Tb.

Finally, a correlation is established between the potential factors found in the horizontal analysis and the score differences discussed in the longitudinal analysis, so as to connect the training of CAT tools with the significant improvement made the experimental group (Ga).

5.3 Horizontal analysis

As discussed, the horizontal analysis contrasts, on the one hand, the results between GaTa and GbTa and, on the other, the scores between GaTb and GbTb. The comparison is carried out by considering the final score (fs) obtained by each student and aims at finding out the factors behind the performance of each student in each test. The horizontal analysis also scrutinises the answers provided by the students in the questionnaires in an attempt to determine the factors that may have played a role in each student's performance and, consequently, in their scores.

5.3.1. Translation ability levels suggested by Test A results (before the training)

As described in Chapter Four when discussing the experiment methodology, it is assumed that the two groups of students will have a similar performance in Ta because the author supposed that they share a similar education level and background and have not received previous training in the use of CAT tools or in the translation of scientific and technological tests. To consolidate and testify this assumption, a comparison is made between the results obtained in GaTa and GbTa.

Table 42 below displays the x-axis numbers, their corresponding student numbers for Ga and Gb, and the final score (fs) of each student:

Table 42: Ga_Gb_Ta_fs

x-axis no.	Group A id	Ga_Ta_fs	Gb_Ta_fs	Group B id
1	GaN11	54	61	GbN4
2	GaN15	56	61	GbN7
3	GaN20	58	61	GbN9
4	GaN18	59	62	GbN16
5	GaN10	61	66	GbN5
6	GaN14	61	66	GbN17
7	GaN5	64	67	GbN6
8	GaN2	66	68	GbN8
9	GaN9	66	68	GbN14
10	GaN16	67	70	GbN12
11	GaN19	67	70	GbN18
12	GaN6	70	72	GbN11
13	GaN7	70	74	GbN3
14	GaN4	72	75	GbN19
15	GaN3	73	77	GbN10
16	GaN17	73	78	GbN15
17	GaN13	74	79	GbN1
18	GaN8	80	79	GbN13
19	GaN12	80	81	GbN20
20	GaN1	84	84	GbN2
	mean	**68**	**71**	**mean**

As shown in the above table in blue, the mean value of GaTa is 3 points lower than that of GbTa; a result which deviates from the initial supposition that Ga and Gb will have a similar performance in Ta. As further discussed in section 5.4, 3 points difference in mean value is a significant difference. It can also be seen from Table 42 that four students from Ga failed Ta (60 is the pass score), with the scores of 54, 56, 58, and 59 respectively, while none of the students from Gb failed the test. The results obtained by these four students are partly responsible for the slightly large difference between GaTa and GbTa mean values. To try and find out why these four students performed so poorly, the author turned to the

questionnaires of their tests, namely, the Ta questionnaires done by GaN11, GaN15, GaN20, GaN18.

GaN11 stated in the Ta questionnaire that there were too many complex sentences in the English text, that s/he had never been trained in the use of CAT tools neither in the translation of scientific and technological texts, and that s/he only used Baidu.com and Google.com as assistance in translating, which may help explain why s/he had a low score in Ta. Another factor worthy of noticing is that GaN11 did not have a Bachelor's degree in languages, but in microbiology instead. This strongly points to the fact that s/he may have never been trained in translating and to some extent justifies the low score obtained.

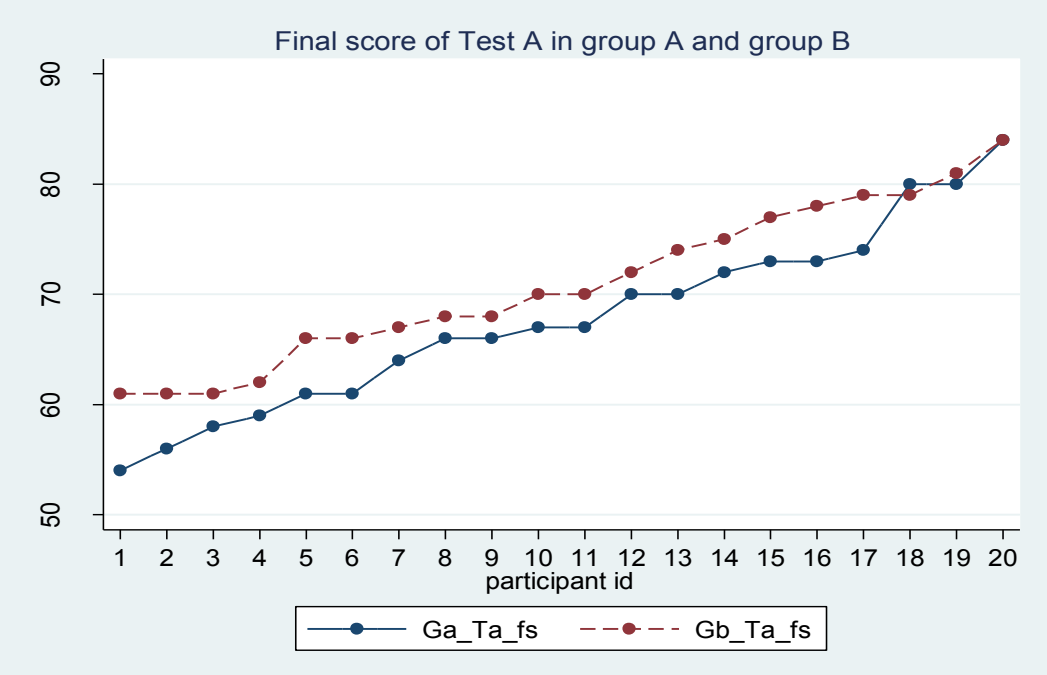
GaN15 found it very hard to understand some of the original sentences, and mainly used online dictionaries to assist translating, even though s/he had started learning the software Wordfast three weeks before sitting the test. Interestingly, s/he could not manage to finish the test in the 2 hours allocated and two sentences were left untranslated, which helps explain the disappointing score.

As with the previous students, GaN20 also mentioned the existence of too many long sentences in the English text along with phrases in parenthesis and specialised terminology that s/he found difficult to deal with. S/he acknowledged not to have been trained with either CAT tools or scientific/technological translation, and confirmed that s/he had mainly used online dictionaries and Google.com for assistance.

GaN18 is a more inscrutable case as s/he had a Bachelor's degree in English language and had been trained with Trados for one and a half years in Swansea University. With this

background, s/he would have been expected to be one of the higher achievers. The reasons for this below par performance are not to be found in the questionnaire as s/he simply stated that s/he could not understand the source text and that s/he needed further background information. A more meticulous look at the translation itself and the scores obtained by this candidate may shed some light. The sp1 is 27 (out of 50) whilst the sp2 is 32 (out of 50). The low sp1-1, on comprehension of the source text, tallies with his/her claim that s/he could not understand the English. However, his/her overall sp2 score is not too bad and this can be attributed to the fact that s/he had been trained in the use of Trados for over a year before being enrolled on the MSc. And more importantly, she used the CAT tools when doing the test. To a great extent, this result is consistent with my hypothesis that knowledge of CAT tools will help students deal with features of scientific and technological texts. The following Figure 7 shows the fs values of Group A and Group B after having finished Test A:

Figure 7: Comparison of Ga_ta_fs and Gb_ta_fs



Almost all the GaTa fs values lie under the GaTb fs values, with only two exceptions: Figure No. 18 and 20. As explained in section 5.2, figure No. 18 is assigned to candidates GaN8 and GbN13, and figure No. 20 is assigned to candidates GaN1 and GbN2. GaN8 has a score of 80 and GbN13 of 79, whereas GaN1 and GbN2 have an identical score of 84 in Ta. The results in the upper end of the two groups are very similar, which suggests that their educational background may also be similar. Indeed, when comparing the questionnaires of candidates GaN8 and GbN13, the author found that both students had a Bachelor's degree in English language and had finished their test in around 1 hour and 30 minutes, without using CAT tools. The main difference between the two students is that GaN8 had been trained in the use of Trados for two months but not in the translation of scientific and technological texts, while GbN13 had received training in scientific and technological translation for two months but did not know how to use CAT tools.

As for GaN1 and GbN2, both students finished the test in 1 hour and 25 minutes and neither of them had been previously trained in the use of CAT tools or in the translation of scientific and technological texts. Nonetheless, what might make them achieve high scores is the fact that they both have a Bachelor's degree in Translation and Interpretation. In China, the traditional model for training translators is for students to study English language for their four-year Bachelor's degree and then specialized in Translation and Interpretation during their two-year Master's degree. However, in recent years, the undergraduate programme of Translation and Interpretation has come into being in some universities. The recruitment requirements for these students are higher than those for language students and they usually come from the high schools affiliated to the universities of foreign languages. This usually means that during their high school years, students are supposed to achieve great

competence in the English language so that they can study Translation and Interpretation in the undergraduate programme without further language training. Both GaN1 and GbN2 fall into this category of students and they get the highest scores in Ta. It is worth mentioning that neither of the two students had been trained with using CAT tools during their undergraduate programme, according to their answers to the questionnaire.

All in all, Figure 7 shows that the students from Gb have performed generally better than the students from Ga in Ta. In the following subsections, some information contained in the questionnaires that is deemed to be relevant in order to justify the students' performance is analysed in detail.

5.3.1.1 Average time spent on Test A

The test was scheduled to be finished in 2 hours. The average time spent by students in Ga was 1 hour and 43 minutes whereas students in Gb took 1 hour and 40 minutes, indicating that there is no significant difference between the groups. Most students finished the test in less than 2 hours, with only two exceptions in Ga and one in Gb. In Ga, N12 spent 2 hours and 30 minutes doing the test and N15 took 2 hours and 15 minutes, with the rather surprising outcome that GaN12 obtained the second best score in Ga (i.e. 80), while GaN15 was ranked second from the bottom with only 56. This seems to indicate that spending more time on a translation may not necessarily lead to better results.

5.3.1.2 Subjects of students' Bachelor's degree

The following two figures show the nature of the students' Bachelor's degree subjects:

Figure 8: Bachelor's degree subjects of students in Group A

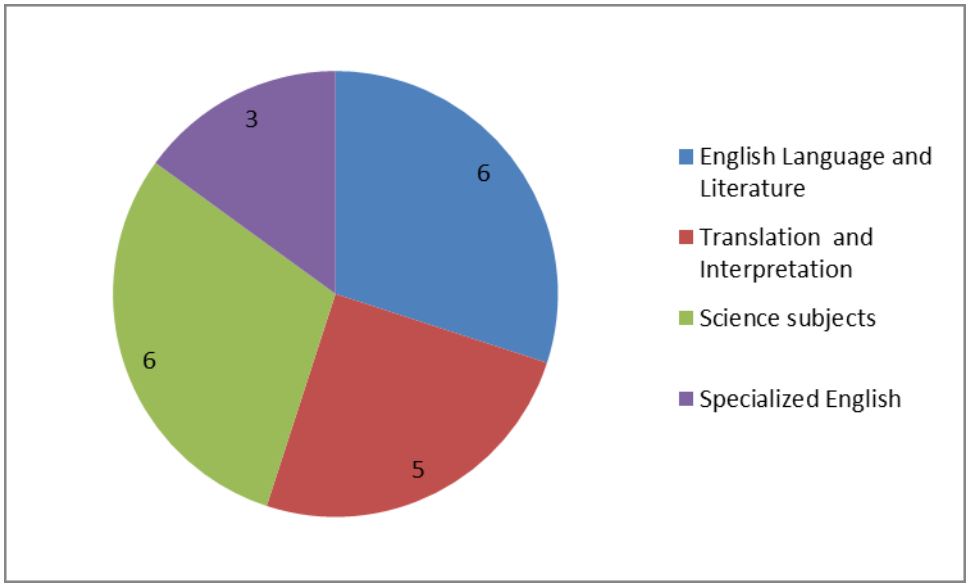
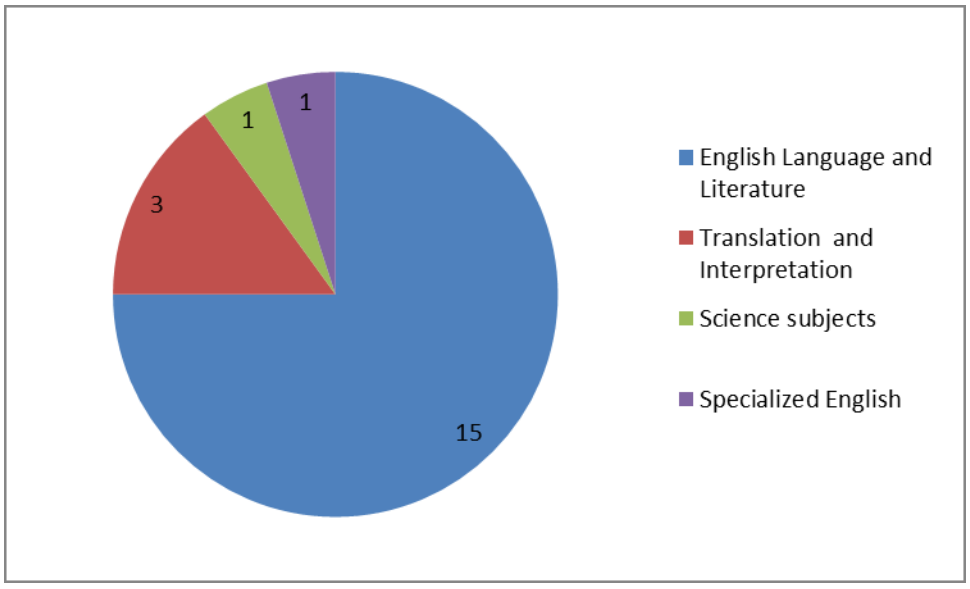


Figure 9: Bachelor's degree subjects of students in Group B



Only 6 students in the Imperial Ga had studied English Language and Literature in their undergraduate years, while 15 students in the Beijing Gb had done so. Five students in Ga

had their Bachelor's degree in Translation and Interpretation, but only 3 in Gb. The other 9 students from Ga had combined science subjects with specialised English, including two in Material Science and Engineering, one in Mechanical Engineering, one in Microbiology, one in Sociology, one in Cultural Studies, one in Business English, one in Commercial English, and one in Sports English. On the contrary, only 2 students from Gb had studied other subjects: one Mechanical Engineering and the other one English for Science.

The greater heterogeneity in Ga in terms of students' background knowledge, particularly in fields not traditionally related to translation or languages, may explain, to some extent, why the average score of GaTa is 3 points lower than that of GbTa. It also seems to indicate that, unsurprisingly, students with a science and technology background are not as good as language and translation students when they have to translate in the early stages of their training. This result also reflects the fact that, in China, it is still the language students who are trained to deal with scientific and technological translation, while in the UK, and perhaps in other European countries, more students with a science background seem to enrol onto postgraduate courses in Translation.

5.3.1.3 Time lived in an English-speaking country before starting the Master's course

The following pie figures show the experience of long-term stay in an English-speaking country for Group A and Group B respectively:

Figure 10: Experience in an English speaking country for Group A

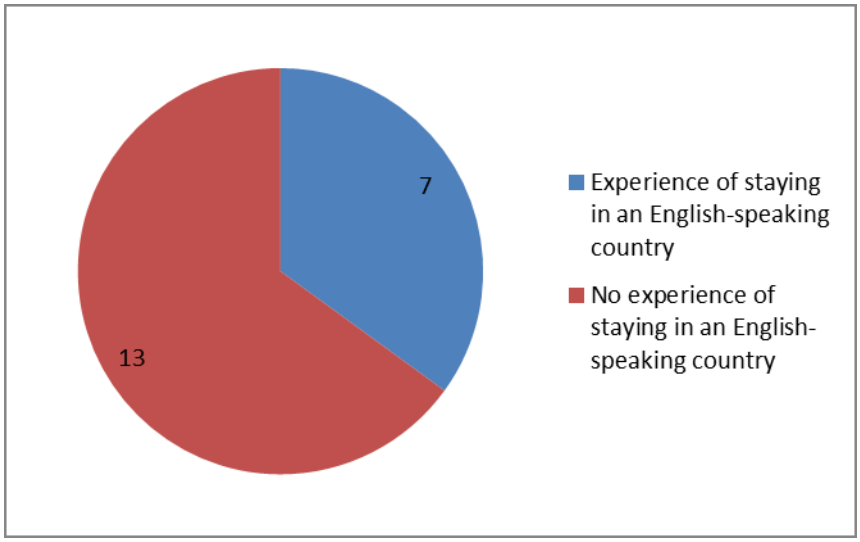
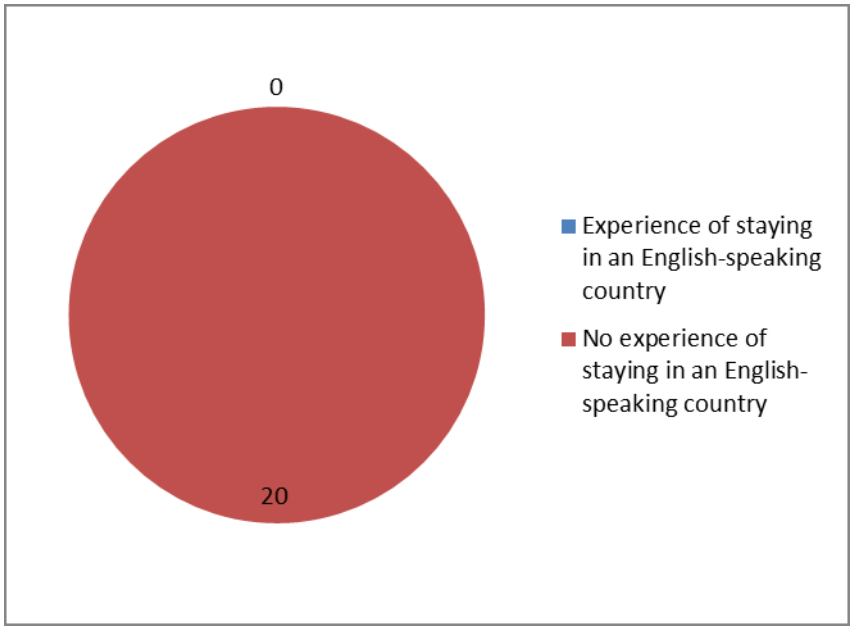


Figure 11: Experience in an English speaking country for Group B



In Ga, 7 students had spent long term stays in English-speaking countries such as Canada and the UK, ranging from 9 months up to 6 years, whilst, on a very sharp contrast, none of the students in Gb had ever stayed in an English-speaking country. It seems reasonable to assume that living in a native language environment should have a positive influence on the acquisition of a foreign language and, consequently, on the individual's translation ability. However, the results show that even though many students in Ga had spent long periods of

time in an English-speaking country, this experience did not seem to make them score higher when translating scientific and technological texts. The reason for this may lay in the nature of the language and the texts involved in these experiments. Indeed, exposure to the language and habits of a community may well enhance an individual's ability for interpreting, translating drama or subtitling, because the language and register used in these source texts are closer to daily life. It then follows that a student who has spent a considerable period of time in the native language environment may well perform better in these translation activities than students who have not lived abroad. However, scientific and technological texts seldom use daily language, if at all. A closer look at the results obtained by the 7 students who had lived in English-speaking countries shows that the scores are very much scatter. For instance, GaN11 had lived 2 years in the UK before starting his/her Master's course but s/he only scored 54 in Ta, the lowest result out of the 20 students. By contrast, GaN1, who had only spent 9 months in the UK before enrolling on his/her Master's study, is the highest scorer of Ga, with 84 points.

These examples demonstrate that, in this case, there is no significant relevance between the students' ability to translate scientific and technological texts and their having spent a long term stay in an English-speaking country.

5.3.1.4 Background on the use of CAT tools

A total of 14 students in Ga had not been systematically trained in the use of CAT tools before Test A, and the remaining 6 students had just attended some introductory, theoretical sessions on CAT tools that had lasted less than a month and had not allowed

them to practise with the actual software. In a rather parallel manner, 16 students in Gb had not received any systematic training in the use of CAT tools and the other 4 students had attended a one-month course on Machine Translation, during which their teacher had only introduced them to some CAT tools from a theoretical perspective, with no hands-on sessions. To summarise, in this stage, neither group of students had been systematically trained in the use of CAT tools before sitting Ta.

5.3.1.5 Background on the translation of scientific and technological texts

According to the data from the questionnaires, 5 students in Ga claimed to have received a month's training in scientific and technological translation, whilst the number goes up to 11 students in Gb, who stated that they had two months' training in the same field. As it turned out, the training they were referring to was a module that they had been doing since the start of their Master's study. Test A was taken by both groups of students in early December 2012, and Gb had started their Master's course in the middle of the previous October, while Ga had started theirs in early October. As there was only one class per week for both groups, the 20 students in Ga had attended 4 lessons in scientific and technological translation, while the 11 students in Gb had attended 8 classes. The difference in training length and the different number of students being trained might have resulted in the difference of the two groups' average scores in Ta.

5.3.1.6 Difficulties in translating Test A

The following Table 43 lists the various difficulties that students claimed to have encountered when translating the scientific and technological texts chosen for Ta. The numbers refer, in decreasing order, to the times that each difficulty is mentioned by students from Group A and from Group B:

Table 43: Difficulties encountered by students when translating Test A

	Times mentioned by students in Ga	**Times mentioned by students in Gb**
Long, complex and complicated Sentence structures	14	15
Terminology	9	14
Background knowledge of the subject	2	4
Phrases and word combinations	2	1
Passive voice	2	0
Grammatical aspects	1	1
Abbreviations and acronyms	1	0
Cultural issues	1	0

As can be seen, students in both groups – 14 in Ga and 15 in Gb – opined that one of the main difficulties they encountered when translating the texts was that they contained many long, complex and complicated sentence structures. Another substantial number of students – 9 in Ga and 14 in Gb – mentioned that the specialised terminology used in the texts was hard to translate. The difference between the two groups may be explained by the fact that, as mentioned in 5.3.1.2, many students from Ga had a science background, meaning that they were familiar with more scientific and technological terms, or simply that given their experience as science students they knew where to document themselves about the meaning (and translation) of the specialised terminology.

A few students also mentioned that they did not have the background knowledge of the subject area dealt with in the text, which made it difficult for them to understand the source text. Some other aspects that contributed to the difficulty of the translation task, as mentioned by some students, were: the use of specialist phrases and word combinations, the abundance of the passive voice in the original, and the appearance of abbreviations and acronyms. Incidentally, all these difficulties mentioned by students coincide with the ones discussed in Chapter Two, where the specific features of scientific and technological texts are discussed in detail.

5.3.1.7 Resources used by students to assist translating Test A

Table 44 below lists the answers provided by all students from Ga and Gb to the question 'What resources did you use to assist this translation task?'. In addition, two columns have been also included indicating the results obtained by the students in Ta, with the aim of gauging what resources were used and how they used them and the impact on the final score:

Table 44: Resources used by Ga and Gb in Ta

Student Id no.	GaTa-Resources used by students	GaTa-fs	GbTa-Resources used by students	GbTa-fs
1	Google Translate, Iciba online dictionary, Wordfast Anywhere, Wiki	84	online dictionary	79
2	Online dictionaries, online automatic translation interface, online scientific forums	66	http://dict.youdao.com	84
3	Online dictionary, Bing Translator, CNKI Translation	73	Youdao, the search engine of Baidu, and Baidu Encyclopedia	74
4	Google trans, Google, CASIO dictionary	72	downloaded dictionary	61
5	Electronic dictionary, Google Translate	64	Youdao dictionary and Baidu Baike	66
6	http://dict.youdao.com, www.google.com	70	The 21st Century English-Chinese Dictionary	67
7	Youdao online dictionary	70	http://dict.youdao.com	61
8	Online dictionary	80	You dao e-dictionary, Google	68
9	Online dictionaries	66	Online dictionary	61
10	Youdao.com, Wikipedia	61	Baidu.com, Longman English dictionary online, dict.baidu.com.	77
11	Baidu, Google	54	Youdao dictionary, google	72
12	www.zaixianfanyi.com, Google translate, baidu.com, youdao.com	80	Google, Baidu, Youdao dictionary	70
13	Google translate, youdao dictionaries	74	Youdao,google, baidu	79
14	www.google.com, www.dict.youdao.com	61	Youdao online dictionary	68
15	Online dictionaries	56	Online dictionary and search engine	78
16	Youdao and Google translate	67	on-line dictionaries	62
17	Wordfast Free TM. Baidu. ICIBA. CNKI. YOUDAO	73	nothing	66
18	Microsoft, google	59	http://cn.bing.com, http://dict.youdao.com	70
19	Youdao Dictionary, Google Translator, Baidu	67	Youdao, Google	75
20	Youdao online dictionary; Google search engine	58	Youdao Dict,Lingoes,Baidu.	81

a) Resources used by Group A in Test A

As illustrated, online dictionaries, used by 17 students, are the most frequently used resources. Some students just mentioned ‘online dictionaries’ in the questionnaire, while

others were more specific and provided the names of the online dictionaries that they had used. Of the 17 students, 10 mentioned that they had used Youdao online dictionary (http://dict.youdao.com), making it the most popular dictionary. To test its functionality, the author browsed the Youdao website and performed some trial searches for words and phrases appearing in Ta, including 'reconfiguring' and 'industrial symbiosis'. The first-choice translations provided by Youdao are 重新 配置 (reconfiguring) and 工业共生 (industrial symbiosis), of which the latter is not suitable for the context of Ta. Youdao translates 'industrial symbiosis' as 工业 共生/gongye gongsheng, while the appropriate translation to fit the context of Ta should be 产业 共生/chanye gongsheng, which, as can be seen differs in the way 'industrial' is translated. In the Chinese language and culture, 工业 has a narrower sense of meaning than 产业 and, most of the time, is used to refer to manufacturing enterprises, while 产业 has a broader sense of meaning and can be employed to designate any type of company. In the original English text, 'industrial symbiosis' means 'the symbiosis of any kind of enterprises or companies' and therefore should be translated as 产业 共生. To evaluate the extent to which the translations from Youdao may have influenced the students' translations, the author turned to the Excel table containing all the specific features, their standard translations, and the students' translations. For the term 'reconfiguring', only one Ga student had mistranslated it, while the other 19 students had the right translation, of which 12 had the very same translation as Youdao. On the other hand, for the phrase 'industrial symbiosis', 18 students had opted for the translation 工业共生, which was the one suggested by Youdao but did not fit the context. These two examples clearly demonstrate that the students' translations of

specialised words and phrases are much influenced by the translations offered by online dictionaries.

Online automatic translation tools were the second type of resources most frequently used, with 9 students, of which 7 acknowledged to have used Google translator. Other resources used by Ga were: search engines such as google.com or baidu.com (8 students); Wikipedia for information about certain concepts that appeared in the original texts (2 students); online scientific journals and forums (1 student); and Wordfast (1 student). Incidentally, the latter obtained the highest score in Ta, though it cannot be concluded that this high score is associated with the use of CAT tools as it may be a coincidence. Further research and comparisons of the students' scores in Tb and Ta in the coming sections may help answer the question.

To conclude, online dictionaries were used by most students and nearly half of them also resorted to online automatic translation tools, with only a few individuals consulting other resources.

b) Resources used by Group B in Test A

As seen in Table 44 above, 17 students used online dictionaries, of which 12 specifically stated to have used Youdao. This result is very similar to the one found with students from Ga. The author also turned to the Excel table recording all the features, their standard translations, and students' translations to see how the students from Gb had translated the two phrases mentioned above. For the term 'reconfiguring', 3 students had the wrong

translation, while the other students had come up with the right translation, of which 13 had the exact translation as Youdao. This finding is again consistent with the finding with Ga students. For the term 'industrial symbiosis', 18 students had translated it wrong, with 15 of them employing the suggested translation by Youdao, 工业共生. This finding complies with the earlier finding when discussing Group A, i.e. that the students' translations of specialised words and phrases are much influenced by the translations offered by online dictionaries.

A surprising result is the fact that none of the students in Gb mentioned to have used automatic translation tools (vs. 9 in Ga), although 9 of them acknowledged that they had visited search engines such as baidu.com and google.com. Although this could, of course, be true, it may also hide another reality; i.e. that they only mentioned the search engines because they thought it would be disrespectful to acknowledge that they had used automatic translation websites for doing the test. However, this guess cannot be taken as a conclusion and further scrutiny of the students' answers and their actual translations is carried out in section 5.3.2.5 in an attempt to discover the real impact of automatic translation tools.

Apart from online dictionaries and search engines, a few students also mentioned resorting to other resources such as encyclopaedias (1 student) and downloaded dictionaries (1 student). One student used the CAT tool Lingoes, and his/her score was 81, the second highest in Gb.The following figures give an overview of the resources used by the students of Group A and Group B during Test A:

Figure 12: Resources used by Group A in finishing Test A

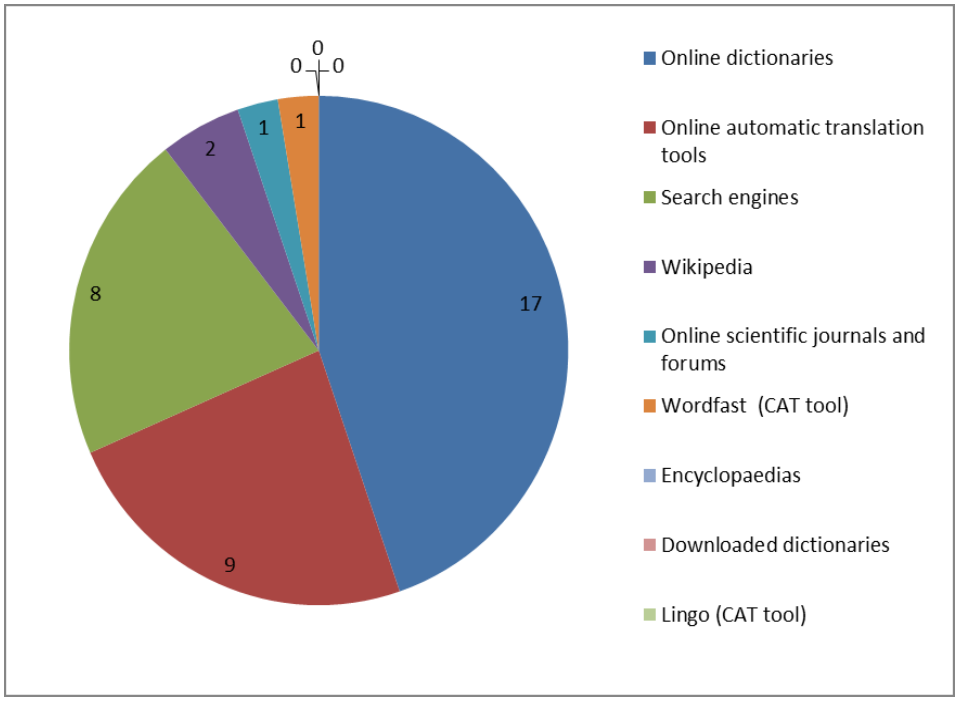
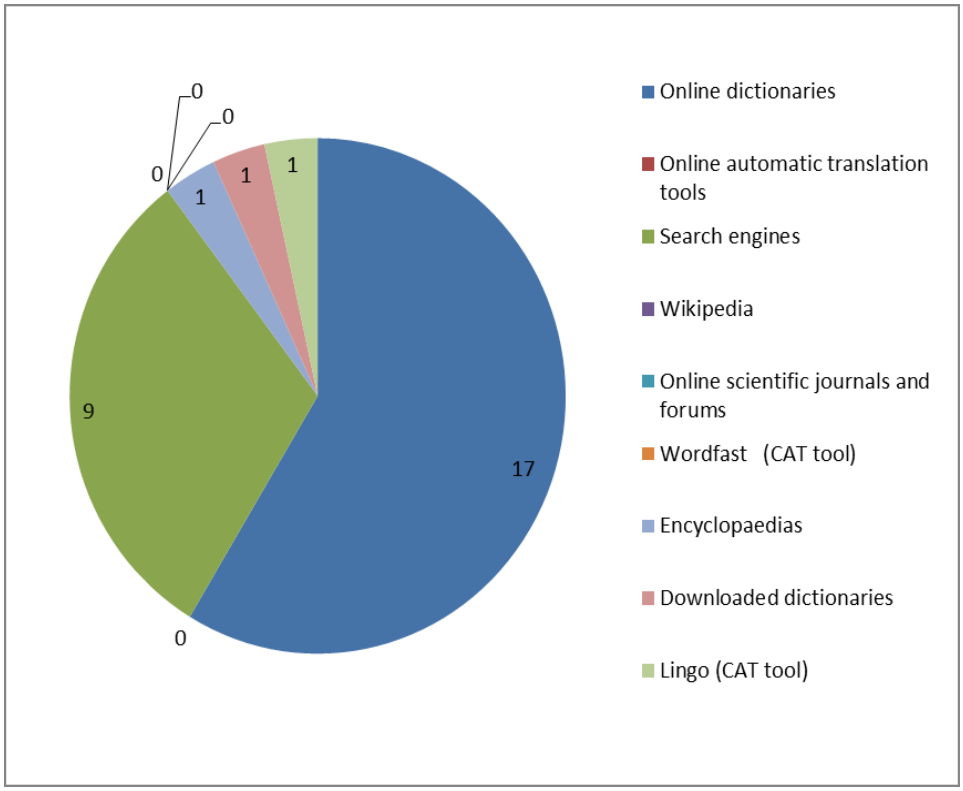


Figure 13: Resources used by Group B in finishing Test A



To summarise, the resources most frequently used by Ga and Gb to complete Ta were online dictionaries followed by Google and Baidu search engines. A contrasting factor is that a rather large number of students in Ga (9) mentioned they had used online automatic

translation tools whilst none of the Gb students did. The other notable result is that very few other resources were used.

As for the use of CAT tools at this early stage, only one student in Ga resorted to Wordfast and one in Gb to Lingoes, which can be said to have a negligible impact on the experiment and allows us to accept the assumption that CAT tools did not play a significant role in the students' performance of Test A.

5.3.2. Translation ability levels suggested by Test B results (after the training)

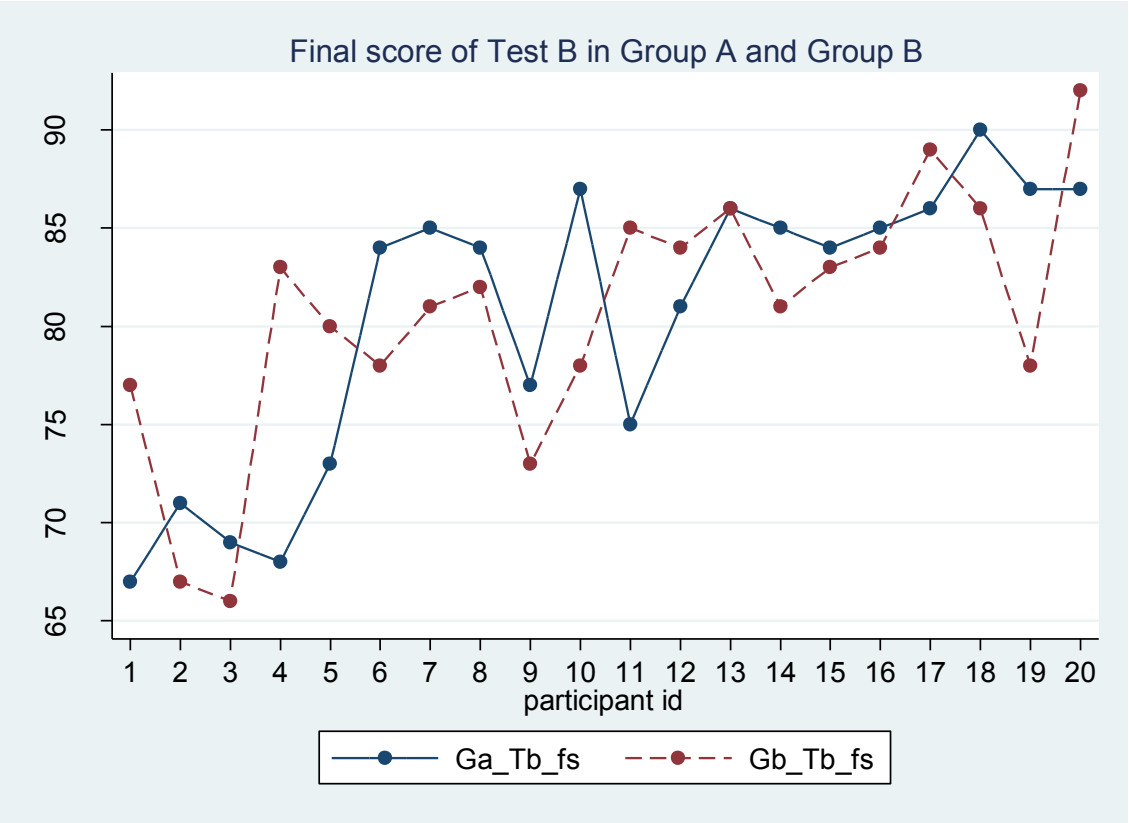
One of the initial premises of this experiment was that all students in both Ga and Gb would obtain a higher score in Tb than in Ta, simply because they have been trained in translation for four months, as part of their Master's studies, and regardless of whether they had been trained in the use of CAT tools or not. As illustrated in Table 45 below, the mean value of GaTb is 81, which is considerably higher than the mean value of 68 for GaTa, whilst the mean value of GbTb is also 81, ten points higher than the mean value of 71 obtained in GbTa. This result clearly confirms the hypothesis that both groups of students have performed better in the second test than in the first one.

Table 45: Ga_Gb_Tb_fs

Graph no.	Group A id	Ga_Tb_fs	Gb_Tb_fs	Group B id
1	GaN11	67	77	GbN4
2	GaN15	71	67	GbN7
3	GaN20	69	66	GbN9
4	GaN18	68	83	GbN16
5	GaN10	73	80	GbN5
6	GaN14	84	78	GbN17
7	GaN5	85	81	GbN6
8	GaN2	84	82	GbN8
9	GaN9	77	73	GbN14
10	GaN16	87	78	GbN12
11	GaN19	75	85	GbN18
12	GaN6	81	84	GbN11
13	GaN7	86	86	GbN3
14	GaN4	85	81	GbN19
15	GaN3	84	83	GbN10
16	GaN17	85	84	GbN15
17	GaN13	86	89	GbN1
18	GaN8	90	86	GbN13
19	GaN12	87	78	GbN20
20	GaN1	87	92	GbN2
	mean	**81**	**81**	**mean**

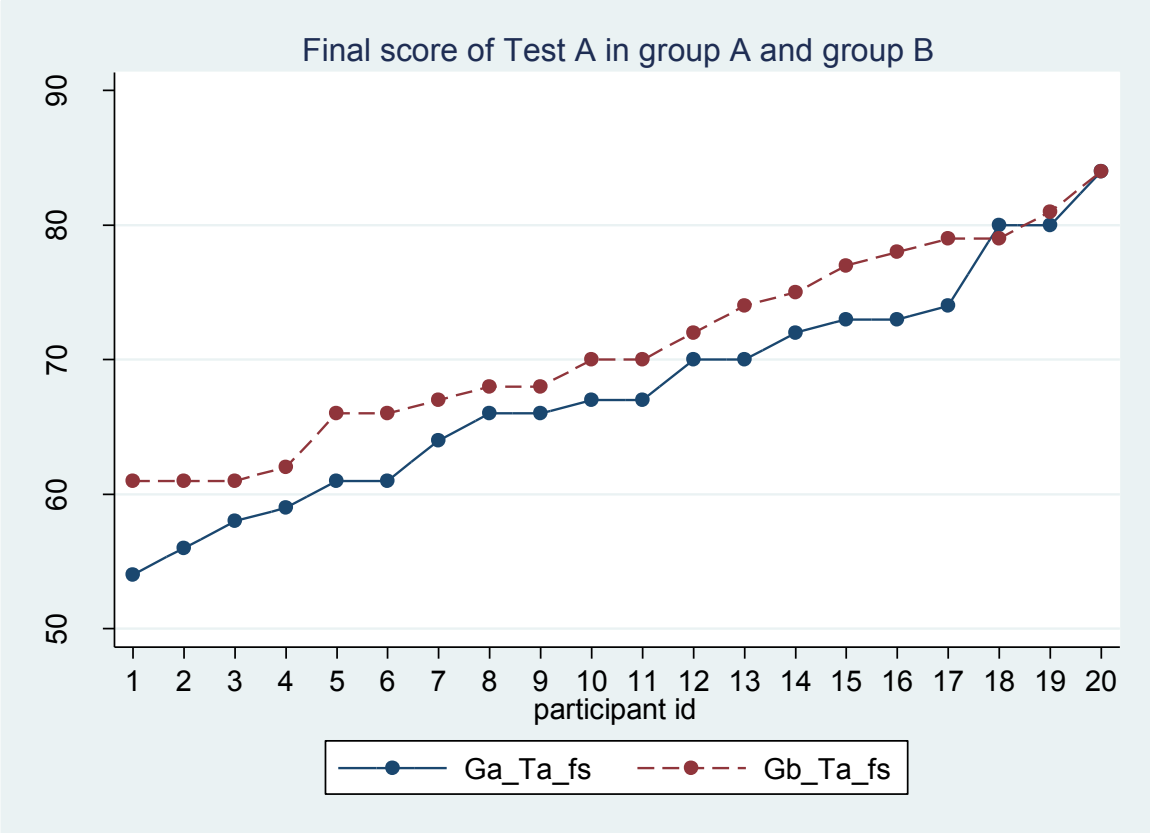
If we were to assume that all students have progressed in a similar fashion, the lines for GaTb (blue) and GbTb (red) in Figure 14 below should be both ascending, which, as can be seen, is not the case, indicating that, in an individual manner, students in each group have improved differently:

Figure 14: Comparison of Ga_Tb_fs and Gb_Tb_fs



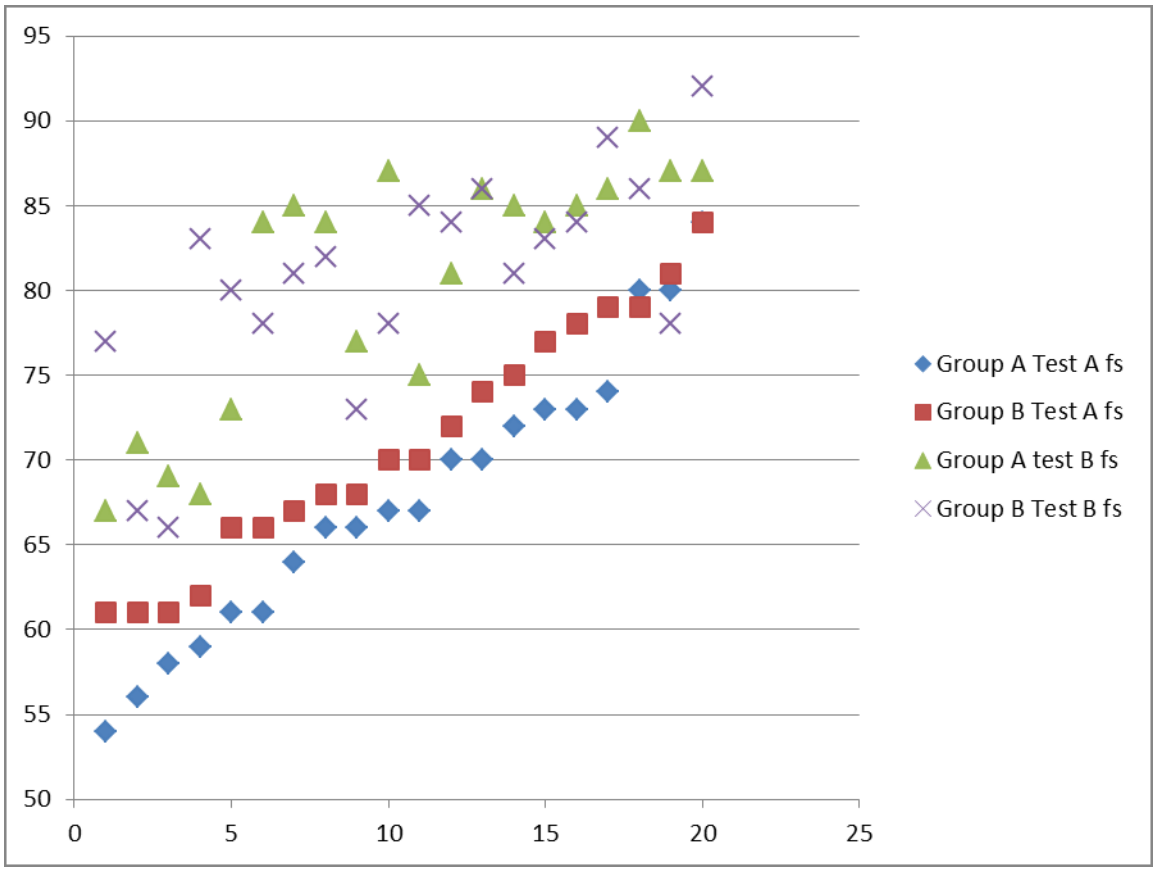
Furthermore, when compared with Figure 7, already discussed in section 5.3.1 and copied below for the reader's ease, the lines for Ga_Tb_fs and Gb_Tb_fs intertwine with each other in a different fashion than in Ta, when the line showing the final score for Ga ran always lower than the one for Gb:

Figure 15: Comparison of Ga_Ta_fs and Gb_Ta_fs



This means that some students in Ga have improved their performance much more than the students in Gb. The following scatter figure has an overall view of the final scores of Test A and Test B done by all individual participants from both groups:

Figure 16: Scatter chart for the fs values of GaTa, GbTa, GaTb, and GbTb



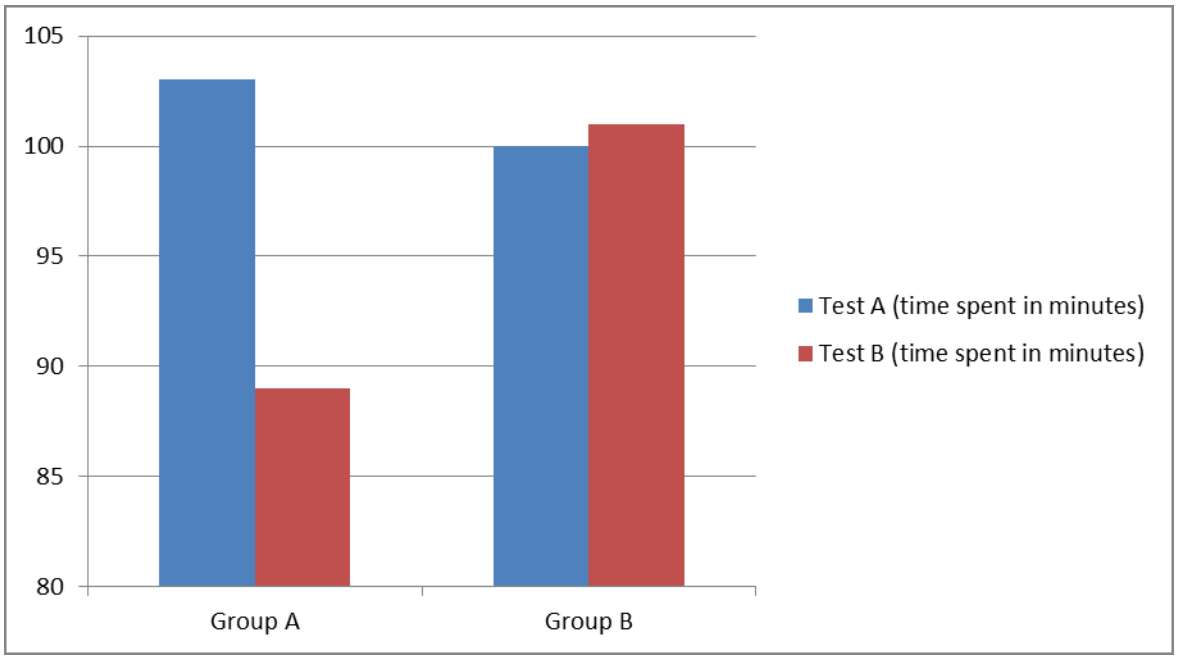
The scatter figure shows that nearly all Test B results from both groups are higher than the Test A results, indicating that all students have made some improvement between the two tests. As mentioned, many GaTa results (blue diamonds) lie under GbTa (red squares), while, on the contrary, most GaTb results are higher than those obtained by Group B, suggesting that Group A has experienced a bigger improvement in terms of the overall final score.

The following sections analyse some of the factors that, to a larger or lesser extent, can be considered to have been instrumental in the students' improvement.

5.3.2.1 Average time spent on Tb

The second test (Tb) was also scheduled to be completed in two hours. The average time spent by Ga was 1 hour and 29 minutes, which is 14 minutes less than the average time they spent on Ta, which was 1 hour and 43 minutes. For Gb, the average time they spent on Tb was 1 hour and 41 minutes, similar to the average time spent on their Ta tests, which was 1 hour and 40 minutes. The following figure shows the average time spent on the two tests by each group, shown as GaTa, GaTb, GbTa, and GbTb:

Figure 17: Average time spent by GaTa, GaTb, GbTa and GbTb



The average time of GbTa and GbTb does not show much difference, whilst the average time of GaTa and GaTb does show a significant difference of 14 minutes. Considering that in this second test 14 of Ga students had used CAT tools, this result seems to justify the author's hypothesis that students can save time when translating if they make use of CAT

tools. As in the previous Ta, one student from each group needed more than 2 hours to finish Tb: GaN15 spent 2 hours and 30 minutes and GbN14 spent 3 hours. The former scored 71, raking fourth from the bottom in Ga, while the second got a score of 73, ranking third from the bottom in Gb. These results consolidate the earlier finding that spending more time than necessary on a translation does not necessarily guarantee a good result.

5.3.2.2 Training in translating scientific and technological texts

As discussed in section 5.3.1.5, at the time of Ta, many Beijing Gb students had already been trained in the translation of scientific and technological texts but nearly no-one from Ga had had such training before. It was then concluded that this difference might have been the reason why Gb had an overall higher score than Ga in Ta.

In the four months between Ta in November 2012 and Tb in March 2013 students from both groups attended some courses on scientific and technological translation. On average, students from Ga in London were trained for 4.1 months while students from Gb received similar training for 3.9 months, an almost identical period, which would indicate that the training in this area should not be a decisive factor causing any different improvement in Tb.

5.3.2.3 Training in the use of CAT tools

For the experiment, all the students from Ga had been trained in the use of CAT tools for around 4 months before sitting Tb, whereas students from Gb had not worked with CAT

tools, as attested by their answers to the questionnaire. Four students, however, claimed to have received some training for a period of about 3 months. As it turned out, they had chosen an optional module named Machine Translation in which the lecturer had introduced a CAT tool to them from a theoretical perspective in each session. As the students had not done any hands-on practice with the software, the decision was taken that their training could not be considered systematic enough and that their Test B would indeed be used for the experiment.

5.3.2.4 Difficulties found by students when translating Test B

The following Table 46 shows a list of the main difficulties students found when translating the two short scientific and technological texts in Test B, with the number of times that each difficulty was mentioned by the students:

Table 46: Difficulties students found in translating sci-tech texts in Tb

	Times mentioned by students in Ga	Times mentioned by students in Gb
Long, complex and complicated sentence structures	15	15
Terminology	8	12
Background knowledge of the subject	3	4
Phrases and word combinations	2	1
Passive voice	2	0
Grammatical aspects	1	0
Logic between sentences	2	0
Proper nouns	0	2

As can be seen, the same number of students in both groups (15) considered that there were too many long, complex and complicated sentences in the original texts, a result similar to that encountered after Ta (see Table 42). Also similar to the findings after Ta is the number of students who found terminology hard to translate: 12 in Gb and 8 in Ga. The reason why fewer students mentioned this difficulty in Ga than in Gb may be because more students in Ga have a science background. The rest of findings are similar to the ones from Ta: the wish of having better background knowledge of the subject and the difficulty of dealing with the passive voice and other grammatical aspects.

When compared to Ta, only two new factors were raised by students: the difficulty in following and maintaining the logic between the sentences and the difficulty in transferring some of the proper nouns.

All in all, the difficulties found in Tb by Ga and Gb were similar to those encountered by students when translating Ta, which proves that Ta and Tb shared a similar difficulty level. Therefore, it seems legitimate to assume that the students' score differences between Ta and Tb were not caused by a different level of difficulty of the texts, but rather they can be attributed to a potential change of circumstances for the students.

5.3.2.5 Resources used by students during Test B

Table 47 below contains the answers provided by all students from Ga and Gb to the question "What resources did you use to assist this translation task?". In addition, two

columns have been also included indicating the results obtained by the students in Tb, with the aim of ascertaining until what extent the use of more or less resources may have had an impact on the final score:

Table 47: Resources used by Ga and Gb in Tb

Student Id no.	GaTb-Resources used by student	Ga-Tb-fs	GbTb-Resources used by students	Gb-Tb-fs
1	WFA, ICIBA, Microsoft Translation, Google, SDL Trados	87	Youdao Dict, Baidu online translation, Google	89
2	Trados	84	Youdao dictionary	92
3	SDL Trados 2011 and Bing Dictionary Online	84	Youdao online dictionary, Baidu research engine	86
4	Googletrans, Bingtrans, Wordfast anywhere	85	Lingoes, a computer-assisted translation software	77
5	SDL Trados and its inside MT	85	Google, youdao dict	80
6	Wordfast Anywhere, Youdao Dictionary	81	Youdao	81
7	Wordfast Anywhere	86	Youdao	67
8	Google translate, youdao dictionary	90	Google translation, youdao e—dictionary	82
9	Online dictionaries, search engines, online automatic translation interface and SDL Trados	77	On-line information	66
10	Wordfast Anywhere and online dictionaries, google and baidu search	73	Baidu.com ,longman english dictionary online ,dict.baidu.com	83
11	Google, wikipedia, baidu, baidu dictionary	67	Youdao on-line dictionary	84
12	Youdao Online Dictionary, Google Translate, Baidu	87	Google, Baidu, Youdao dictionary	78
13	Wordfast anywhere, youdao，google translate	86	Youdao dic. Baidu	86
14	Wordfast anywhere, youdao dictionary, google	84	youdao online dictionary	73
15	Machine translation: google translate, Online dictionary: youdao; CNKI	71	Online dictionary and search engine	84
16	Wordfast anywhere, youdao	87	online dictionaries, website	83
17	Wordfast Anywhere, Google Translate, Youdao Dictionary, Iciba Dictionary	85	Youdao, Powerword, Baidu dictionary	78
18	Google, Cnki, Haici	68	http://dict.youdao.com	85
19	Wordfast Anywhere, SDL Trados, Google, Youdao Dictionary	75	Google,youdao	81
20	Google, Youdao online dictionary	69	Youdao Dictionary	78

a) Resources used by Group A in Test B

The above table shows that online dictionaries are still the most popular tools for Ga students (16 of 20). Nine of these students specified that they had used Youdao online dictionaries, a number very similar to the 10 in Ta, whilst the other 7 students mentioned Bing (http://cn.bing.com/dict), Baidu (http://dict.baidu.com), and Haici (http://dict.cn). These findings are very similar to those found in GaTa.

The second type of resource most frequently used is CAT tools, with 14 students, of which 2 used both SDL Trados and Wordfast, 4 students used SDL Trados, and 8 students used Wordfast. When it comes to the scores, the students who did not use CAT tools tend to get lower scores and, for example, GaN11 and GaN20 received 67 and 69 respectively, whereas the performance of all students who had used CAT tools was over 73 points and most of them score over 80 points. This increase in the number of students using CAT tools in Tb (14) as opposed to Ta (1) can be considered a contributing factor in the observed improvement.

Nine students in GaTb, similar to the 8 in GaTa, said that they had used search engines like Baidu.com and Google.com to assist in their translation. Automatic translation tools were used by 8 Ga students, namely Google Translate (6) and Bing Translator (2). Apart from these frequently used resources, only one student mentioned the use of Wikipedia.

To conclude, online dictionaries are used by most students in Tb, a substantial number of students (14) used CAT tools, 9 students used search engines, 8 students used online automatic translation tools, and a few individuals used other resources, such as Wikipedia.

A most noticeable outcome is that although all the 20 students have been trained with using CAT tools, only 14 of them actually used CAT tools and the ones who did not use CAT tools tend to have the lowest scores. A closer look at the results was deemed pertinent to ascertain whether the students who had used CAT tools actually performed better than students who had not use CAT tools. Therefore, the mean value of the overall scores (fs) of the students who had used CAT tools was compared with the mean value of the fs of those who did not. The following two tables display the students' ID numbers and their fs scores, with the mean value in blue:

Table 48: Ga students who used CAT tools in Test B

Student_id	fs
1	87
2	84
3	84
4	85
5	85
6	81
7	86
9	77
10	73
13	86
14	84
16	87
17	85
19	75
mean	**83**

Table 49: Ga students who did not use CAT tools in Test B

Student_id	fs
8	90
11	67
12	87
15	71
18	68
20	69
mean	**75**

The two tables above demonstrate that the mean value of the Ga students who used CAT tools in Test B is 83, while that of the students who chose not to use CAT tools is 75. The

average score difference between these two types of students, 8 points, indicates that the students who used CAT tools scored significantly higher, substantiating the initial hypothesis of this thesis.

b) Resources used by Group B in Test B

Based on Table 47 again, 18 students from Gb used online dictionaries, the most common one being Youdao (15) by far, with only one student using the *Longman English Dictionary Online*. Ten students acknowledged to have used search engines to assist with their translation, a similar number to that found in GbTa.

What is different on this occasion is that two students from Gb, GbN1 and GbN8, did confirm their use of online automatic translation tools, when in GbTa none had mentioned it. Despite this change in the approach of some of the students, the number is too small and not significant enough to be a decisive factor causing the average score differences for the group. Additionally, if their scores in Ta and Tb are compared, no significance is found either. GbN1 had a score of 84 in Ta and 89 in Tb, while GbN8 had a score of 80 in Ta and 82 in Tb. The improvement of GbN1 is 5 points and the improvement of GbN8 is 2 points. Compared with the average improvement made by Gb students, which is 7.4 points, it is not persuasive to say that online automatic translation tools have helped the students to translate better.

The following figures provide an overview of the resources used by the students of Group A and Group B during Test B:

Figure 18: Resources used by Group A in finishing Test B

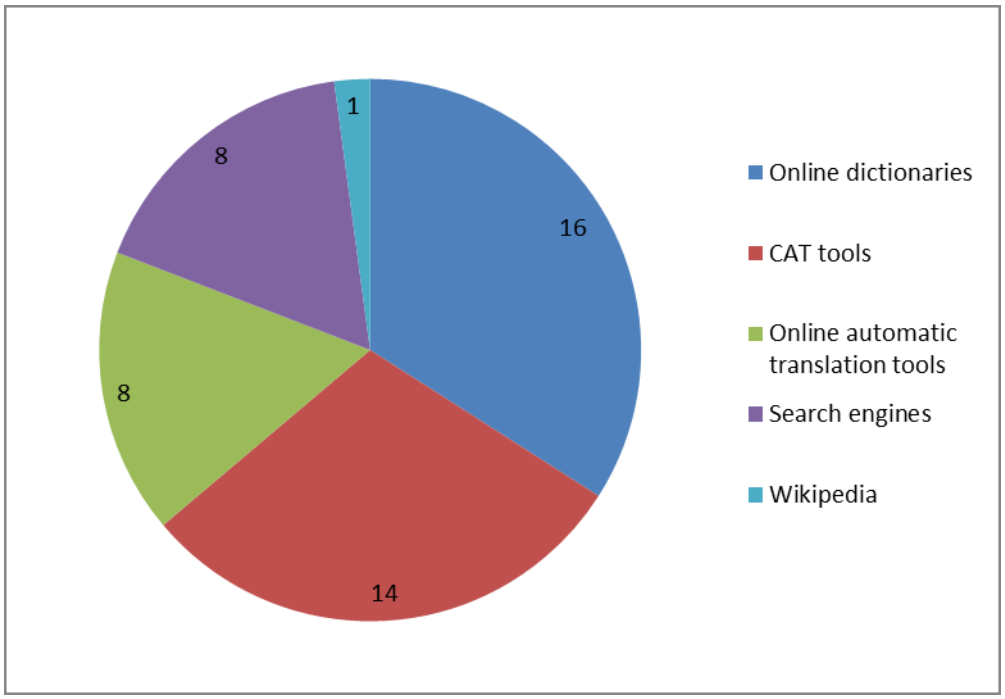
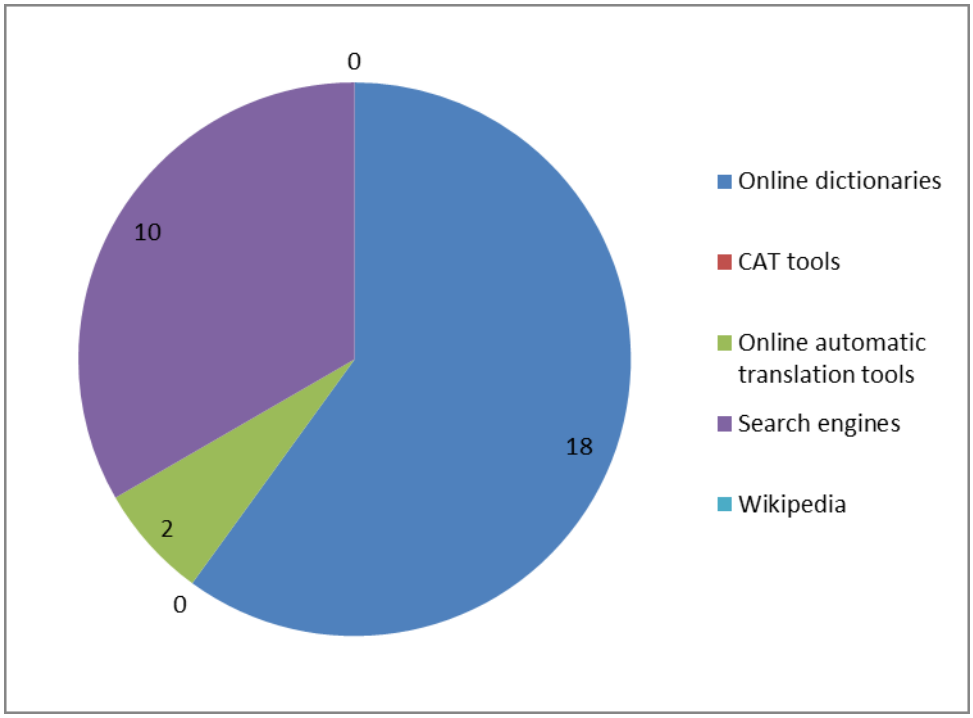


Figure 19: Resources used by Group B in finishing Test B



To summarise, the most salient point found is that 14 students from Ga used CAT tools in Tb, while only one Ga student had used CAT tools in Ta, which may be considered, arguably, a decisive factor for the significant improvement experienced by Ga students in Tb. On the contrary, none of Gb students used CAT tools in Tb.

5.3.3 Factors behind students' scores

Table 50 below summarises the multiple factors discussed in the previous pages that may have had an impact on the students' scores in tests GaTa, GbTa, GaTb, GbTb. The numbers in the table refer to students, unless otherwise indicated:

Table 50: Factors that may have an impact on students' scores

Factors	GaTa	GbTa	GaTb	GbTb
Subjects of students' Bachelor's degree:				
English Language and Literature	6	15	**6**	**15**
Translation and Interpretation	5	3	**5**	**3**
Science	6	1	**6**	**1**
Specialised English	3	1	**3**	**1**
Time lived in an English speaking country	7	0	**7**	**0**
Average time spent on the test	1:43	1:40	**1:29**	**1 :41**
Experience of being systematically trained with CAT tools:	0	0	**4 months**	**0**
Experience of being systematically trained in translating scientific and technological texts	5 1 month each	11 2 months each	**4.1 months**	**3.9 months**
Difficulties students find in translating:				
long, complex and complicated sentences	14	15	**15**	**15**
terminology	9	14	**8**	**12**
background knowledge of the subject	2	4	**3**	**4**
phrases and word combinations	2	1	**2**	**1**
passive voice	2	0	**2**	**0**
grammatical aspects	1	1	**1**	**0**
Resources used to assist translating:				
online dictionaries	17	17	**16**	**18**
online automatic translation tools	9	0	**8**	**2**
search engines	8	9	**9**	**10**
Wikipedia or Encyclopaedia	2	1	**1**	**1**
online scientific journals and forums	1	0	**0**	**0**
CAT tools	1	1	**14**	**0**
downloaded dictionaries	0	1	**0**	**0**

Section 5.3 has presented the results obtained by students in Test A and Test B and discussed some of the factors behind the students' performance. The following section 5.4 will analyse the actual score difference between the two tests, so as to find out whether there is a correlation between the factors argued above and the score difference achieved by the two groups of students.

5.4 Longitudinal analysis

As explained in section 5.1, the purpose of the longitudinal analysis is to calculate the actual score differences between Ta and Tb for both Ga and Gb, so as to ascertain the improvements accomplished by students as a group. To this aim, the first step will consist in comparing the results between GaTa and GaTb, on the one hand, and between GbTa and GbTb on the other hand. The second stage will look into the improvements made by Ga and Gb after the fourth months' training, which are demonstrated by the calculations Ga_Tb-Ta_fs and Gb_Tb-Ta_fs respectively, where Ta is subtracted from Tb. These results will help ascertain which of the two groups has made more improvements overall. However, in order to find out in which specific aspects the students have improved their translation ability most, it will be necessary to contrast the two sub-components of the fs, i.e., sp1 (DipTrans) and sp2 (translation of specialised sci-tech features). To be able to reach any meaningful conclusions on whether students have made improvements in terms of sp1 or sp2, comparisons will be made between Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1, and between Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2. Table 51 below offers a synopsis of the 12 research questions to be answered in this section together with the corresponding methods of analysis employed to find the various answers:

Table 51: Research questions and methods

Research questions	Methods of analysis to find the answer
1. Has Ga made any improvements in terms of the fs?	compare Ga_Tb _fs and Ga_Ta_fs
2. Has Gb made any improvements in terms of the fs?	compare Gb_Ta_fs and Gb_Tb_fs
3. What is the difference between the improvements made by Ga and Gb in terms of the fs?	compare Ga_Tb-Ta_fs and Gb_Tb-Ta_fs
4. Are the improvements made by Ga and Gb significantly different in terms of the fs?	calculate P-value for Ga_Tb-Ta_fs and Gb_Tb-Ta_fs
5. Has Ga made any improvements in terms of the sp1?	compare Ga_Tb _sp1 and Ga_Ta_sp1
6. Has Gb made any improvements in terms of the sp1?	compare Gb_Ta_sp1 and Gb_Tb_sp1
7. What is the difference between the improvement made by Ga and Gb in terms of the sp1?	compare Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1
8. Is the improvement made by Ga and Gb significantly different in terms of sp1?	calculate P-value for Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1
9. Has Ga made any improvement in terms of the sp2?	compare Ga_Tb _sp2 and Ga_Ta_sp2
10. Has Gb made any improvement in terms of the sp2?	compare Gb_Ta_sp2 and Gb_Tb_sp2
11. What is the difference between the improvement made by Ga and Gb in terms of the sp2?	compare Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2
12. Is the improvement made by Ga and Gb significantly different in terms of sp2?	calculate P-value for Ga_Tb-Ta_sp2and Gb_Tb-Ta_sp2

Before presenting the actual results, the software that has been used to process the data will be introduced and some key concepts used during the data analysis will be explained. The software employed for the data analysis is called Stata (www.stata.com) and can only be used by registered users. To assess whether the sample means of two groups are different from each other and statistically significant, the t-test function of Stata has been used. Just like any other statistical tests, the outcome of the t-test is based on the acceptance or rejection of the null hypothesis (H_0). The null hypothesis (H_0) establishes that there is no statistical difference between the two means, while the alternative hypothesis (H_a) implies that there is statistical difference. In general, the null hypothesis (H_0) is the logical antithesis of whatever hypothesis (H_a) the investigator is seeking to examine. For example, in the present research, the alternative hypothesis (H_a) is that there is significant difference between the improvements made by Ga when compared to those made by Gb; in

other words, that the difference between Ga_Tb-Ta and Gb_Tb-Ta is significant. Accordingly, the (H_0) claims that there is no significant difference between Ga_Tb-Ta and Gb_Tb-Ta.

The t-test result is usually expressed in terms of a probability value (P-value) quantifying the strength of the evidence against the null hypothesis in favour of the alternative (Chu, 1999: 28-34).Traditionally, the mathematical calculation for the P-value has been a rather tedious process, but nowadays the situation has been greatly simplified thanks to the availability of some statistical analysis programmes, such as Stata. Once the data has been loaded onto Stata, the t-test programme can be easily executed, and a numerical P-value is automatically calculated and displayed.

Table 51 below, borrowed from Bland (2000), summarises the meaning according to the different ranges of the P-value:

Table 52: Meaning of different ranges of P-value

P > 0.10	Little or no evidence of a difference or relationship
0.05 < P < 0.10	Weak evidence of a difference or relationship
0.01 < P < 0.05	Evidence of a difference or relationship
P < 0.01	Strong evidence of a difference or relationship
P < 0.001	Very strong evidence of a difference or relationship

In ulterior analyses, the output from Stata will show the P-value as P(|T| > |t|), in which P stands for P-value, |T| refers to the values of the group to compare (in the current research the experimental Group A, and |t| stands for the values of the group to be compared (the

control Group B in the current research). This formula is important because it reveals whether the improvement made by these two groups of students is significantly different and will be highlighted in yellow, as in the example contained in Table 52 below, where the P-value generated by Stata is shown as P(|T| > |t|) = 0.0630:

Table 53: P-value example for illustration

```
ttest fs_ Tb-Ta_Gb == fs_Tb-Ta_Ga, unpaired

Two-sample t test with equal variances

------------------------------------------------------------------------------

Variable |     Obs       Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

---------+--------------------------------------------------------------------

fs_Tb_Ta_Gb |      20        9.7     1.1923    5.332127    7.204488    12.19551

fs_Tb_Ta_Ga |      20       12.8    1.094484     4.89468    10.50922    15.09078

---------+--------------------------------------------------------------------

combined |      40      11.25    .8364685    5.290291    9.558083    12.94192

---------+--------------------------------------------------------------------

    diff |            -3.1    1.618479           -6.376439    .1764391

------------------------------------------------------------------------------

    diff = mean(fs_Tb_Ta_Gb) - mean(fs_Tb_Ta_Ga)                 t =  -1.9154

Ho: diff = 0                     degrees of freedom =       38

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0

P(T < t) = 0.0315         P(|T| > |t|) = 0.0630          P(T > t) = 0.9685
```

5.4.1 Comparing the final score (fs)

As previously explained, the longitudinal analysis in the current study looks at the comparison between the scores obtained by the same student in the first (Ta) and second (Tb) tests. Any potential discrepancies between the final scores (fs) achieved in Ta and Tb will indicate the degree of overall improvement experienced by the group. This first comparison is a general comparison of the students' overall performance, by contrasting Ga_Ta_fs and Ga_Tb_fs, and intends to find out the average level of improvement experienced by the Ga students after the four months' training. Likewise, the purpose of comparing Gb_Ta_fs and Gb_Tb_fs is to find out how much improvement the students from Gb have made on average after their four months' study. Finally, the comparison between Ga_Tb-Ta_fs and Gb_Tb-Ta_fs aims to find out which of the two groups of students has improved more on average.

5.4.1.1 Comparing the fs of GaTa and GaTb

The following table displays the Group A (Ga) students' ID numbers, the final score (fs) of their first (Ta) and second tests (Tb), and the score difference between the two tests (Tb-Ta_fs), in blue:

Table 54: Ga_Tb_Ta_fs

Original id number	Chart_id	Ta_fs	Tb_fs	Tb-Ta_fs
GaN11	1	54	67	**13**
GaN15	2	56	71	**15**
GaN20	3	58	69	**11**
GaN18	4	59	68	**9**
GaN10	5	61	73	**12**
GaN14	6	61	84	**23**
GaN5	7	64	85	**21**
GaN2	8	66	84	**18**
GaN9	9	66	77	**11**
GaN16	10	67	87	**20**
GaN19	11	67	75	**8**
GaN6	12	70	81	**11**
GaN7	13	70	86	**16**
GaN4	14	72	85	**13**
GaN3	15	73	84	**11**
GaN17	16	73	85	**12**
GaN13	17	74	86	**12**
GaN8	18	80	90	**10**
GaN12	19	80	87	**7**
GaN1	20	84	87	**3**

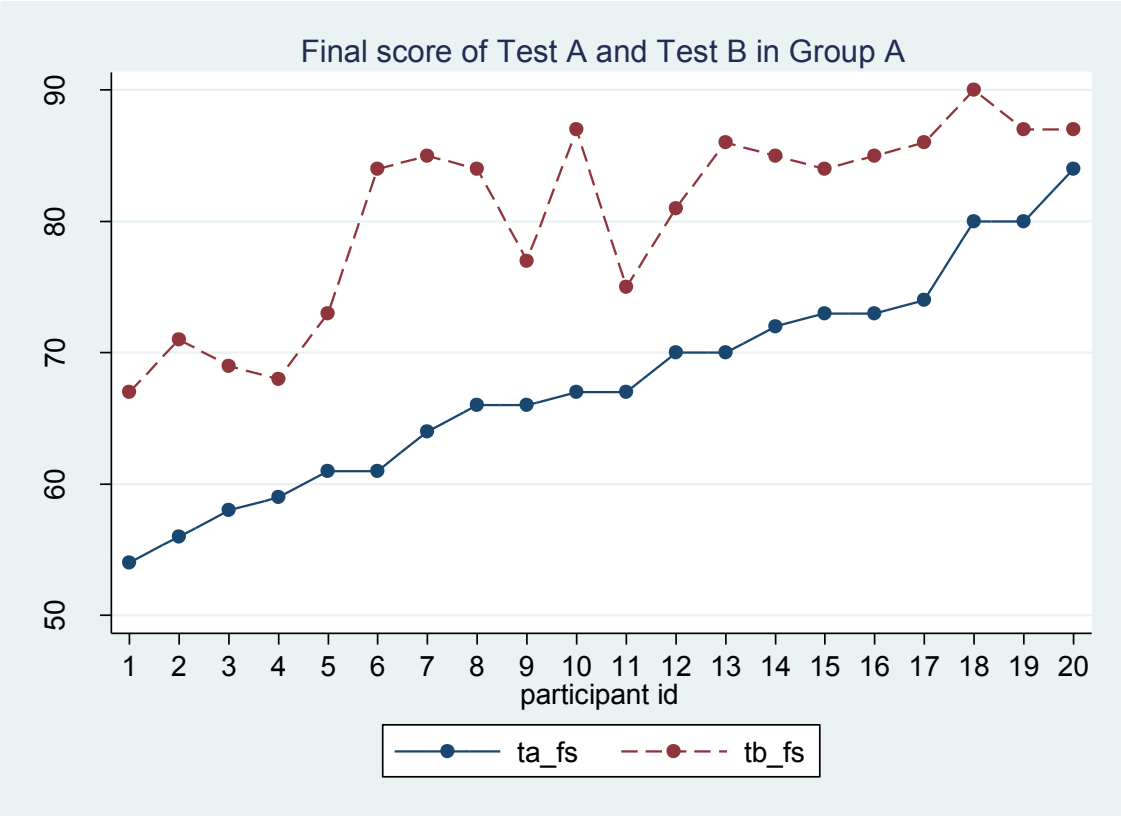
As illustrated, all Tb-Ta_fs values are positive values, indicating that, as expected, all students in Ga managed to get a higher fs in Tb than in Ta and thus improved their performance after the four months' training. Students such as GaN14, GaN5, and GaN16 are the ones to have made the most significant improvement, illustrated by the Tb-Ta_fs values of 23, 21, and 20 respectively, whereas the students who have made the least progress are GaN1, GaN12, and GaN18, whose Tb-Ta_fs values are 3, 7 and 9 respectively. The individual cases of GaN14 and GaN1are further studied because they are the ones who have improved the most and the least.

The above table shows that GaN14 scored 61 in Ta, with a sp1 of 35 (out of 50) and a sp2 of 26 (out of 50), the latter score indicating that, at the time of Ta, GaN14 could not translate very well the specialised features of scientific and technological texts. By contrast, s/he reached a very high score in Tb (84), consisting of 40 for sp1 and 44 for sp2. The increment of 5 points in sp1 and of 18 points in sp2 indicates that s/he has improved considerably more in terms of sp2 than sp1, foregrounding that the student's ability of translating the specialised features has been decisive for the increase of the overall score.

On the other hand, GaN1 scored 84 in Ta, with a sp1 of 43 (out of 50) and a sp2 of 41 (out of 50) and achieved a similar score in Tb (87), with a sp1 of 43 and a sp2 of 44. The overall improvement made by GaN1 is a modest 3 points in sp2, which is understandable because s/he had already scored very high in Ta and it is therefore extremely difficult to make a significant score difference in the second test.

The following chart illustrates the final scores obtained by Group A students in Test A (blue) and Test B (red). The lines indicate the trend of the scores, whereas the dots display the exact scores:

Figure 20: fs of Ta and Tb in Ga



As expected, all Ga students scored higher in Tb than in Ta, highlighting a certain level of progress after the four months' study. To note is the fact that, in general, students in the low scores zone and the high scores zone made less improvement than the students in the middle range.

5.4.1.2 Comparing the fs of GbTa and GbTb

The following table presents the ID numbers of students in Group B, their final scores (fs) for Test A (Ta) and Test B (Tb), and the score difference between the two tests (Tb-Ta_fs), shown in blue:

Table 55: Gb_Tb_Ta_fs

Original id number	Chart_id	Ta_fs	Tb_fs	Tb-Ta_fs
GbN4	1	61	77	**16**
GbN7	2	61	67	**6**
GbN9	3	61	66	**5**
GbN16	4	62	83	**21**
GbN5	5	66	80	**14**
GbN17	6	66	78	**12**
GbN6	7	67	81	**14**
GbN8	8	68	82	**14**
GbN14	9	68	73	**5**
GbN12	10	70	78	**8**
GbN18	11	70	85	**15**
GbN11	12	72	84	**12**
GbN3	13	74	86	**12**
GbN19	14	75	81	**6**
GbN10	15	77	83	**6**
GbN15	16	78	84	**6**
GbN1	17	79	89	**10**
GbN13	18	79	86	**7**
GbN20	19	81	78	**-3**
GbN2	20	84	92	**8**

As illustrated, all Tb-Ta_fs values are positive except for GbN20, meaning that all students but one have improved their performance after four months' training. The students who made the most significant improvement include GbN16, GbN4, and GbN18, with increased

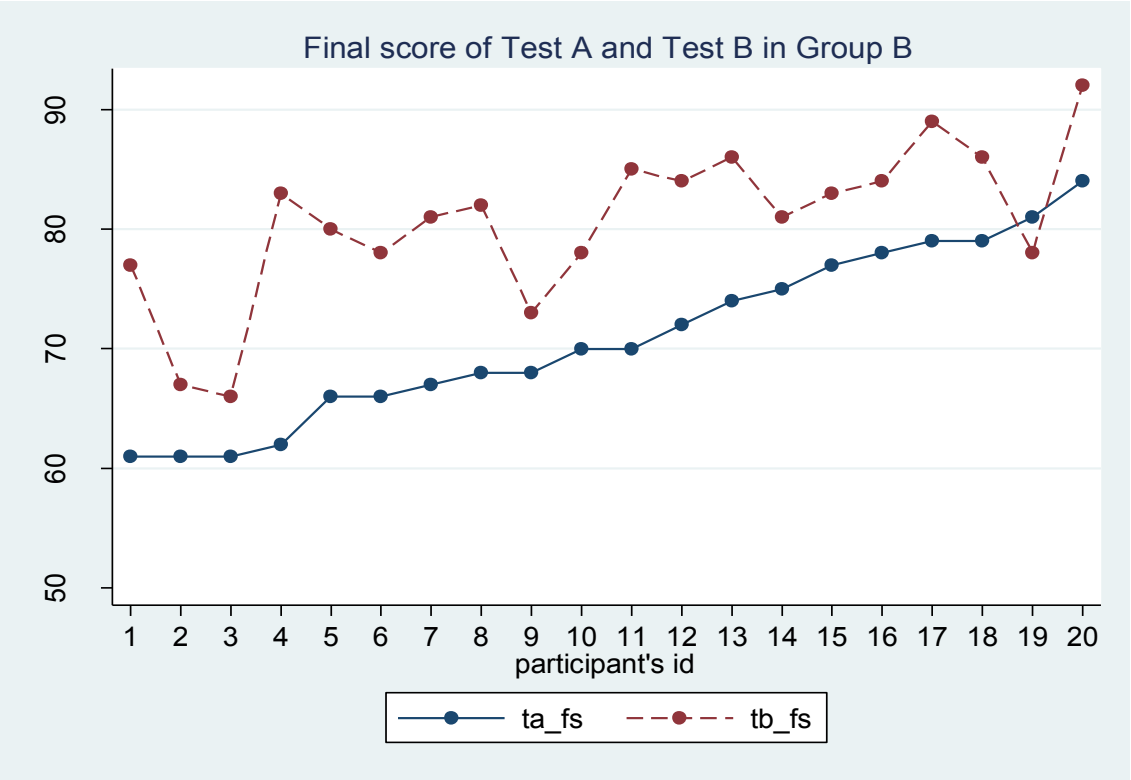
scores of 21, 16, and 15 points respectively, whereas the least improvement, apart from GbN20, corresponds to GbN9 and GbN14, who only increased their score by 5 points.

Given the unexpected performance by GbN20, with a negative Tb-Ta_fs value of -3, the author turned to the original tests, the marking sheets and the questionnaires to try and find an explanation. The candidate spent 1 hour and 40 minutes in finishing Ta, but only 1 hour to do Tb. Furthermore, s/he was the only student to have used CAT tools (Lingoes) in Ta but decided not to employ any CAT tools in Tb. Although the decrease can be considered minor (-3) and it only affects his/her sp2, it is possible that the worsening performance is due to the candidate not having employed any CAT tools in Tb. It is also likely that the difference is due to the fact that the student completed the test in only one hour.

GbN16, on the other hand, is the student who improved most in Gb, going from 62 in Ta (sp1 = 33 + sp2 = 29) to 83 in Tb (sp1 = 40 + sp2 = 43). According to the questionnaires, s/he did not use any kind of translation resource in Ta but did use online dictionaries and search engines in Tb, which somehow explains the better performance in the second test. By the time s/he took Tb, the candidate had never been trained on either the use of CAT tools or the translation of scientific and technological texts, precluding these to be the factors causing the increase of score.

Figure 20 below shows the final scores obtained by Gb students in Test A and Test B, with the scores of Test A shown in red and those of Test B in blue:

Figure 21: fs of Ta and Tb in Gb



As can be appreciated, all students from Gb scored higher in Tb than in Ta except for student 19, whose performance actually worsened. As in the case of Group A (see Chart 15), the students in the low and the high scores zone made on average less improvement than the students in the middle range.

5.4.1.3 Comparing the mean value of Ga_Tb-Ta_fs and Gb_Tb-Ta_fs

In this section, the mean value of the increased scores between Test A and Test B of Ga students is compared to that of the students of Group B, so that it can be revealed which

group of students has made more improvement on average. To this aim, the following table displays the ID numbers of students from the two groups as well as the score differences between Test A and Test B for each student. The bottom row of the table displays the mean values of Ga_Tb-Ta_fs and Gb_Tb-Ta_fs, in blue:

Table 56: Mean value of Tb-Ta_fs of Ga and Gb

Chart no.	Group A id	Ga_Tb-Ta_fs	Gb_Tb-Ta_fs	Group B id
1	GaN11	13	16	GbN4
2	GaN15	15	6	GbN7
3	GaN20	11	5	GbN9
4	GaN18	9	21	GbN16
5	GaN10	12	14	GbN5
6	GaN14	23	12	GbN17
7	GaN5	21	14	GbN6
8	GaN2	18	14	GbN8
9	GaN9	11	5	GbN14
10	GaN16	20	8	GbN12
11	GaN19	8	15	GbN18
12	GaN6	11	12	GbN11
13	GaN7	16	12	GbN3
14	GaN4	13	6	GbN19
15	GaN3	11	6	GbN10
16	GaN17	12	6	GbN15
17	GaN13	12	10	GbN1
18	GaN8	10	7	GbN13
19	GaN12	7	-3	GbN20
20	GaN1	3	8	GbN2
	mean	**12.8**	**9.7**	**mean**

The mean value of the increased score of Ga is 12.8, while the mean value of the increased score of Gb is lower at 9.7, suggesting that, on average, students in Ga have made more improvement than students in Gb. A result of this nature seems to justify the initial hypothesis that Ga would improve more than Gb because they had been systematically

trained with CAT tools. The next step in the analysis is to prove whether this difference can be considered significant. To this aim, the P-value of the results obtained in Ga_Tb-Ta_fs and Gb_Tb-Ta_fs has been calculated in the table below:

Table 57: P-value generated by comparing Ga_Tb-Ta_fs and Gb_Tb-Ta_fs

```
ttest fs_ Tb-Ta_Gb == fs_Tb-Ta_Ga, unpaired

Two-sample t test with equal variances

------------------------------------------------------------------------------

Variable |     Obs       Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]

---------+--------------------------------------------------------------------

fs_Tb_Ta_Gb |     20        9.7     1.1923    5.332127    7.204488    12.19551

fs_Tb_Ta_Ga |     20       12.8    1.094484     4.89468    10.50922    15.09078

---------+--------------------------------------------------------------------

combined |     40      11.25    .8364685    5.290291    9.558083    12.94192

---------+--------------------------------------------------------------------

    diff |            -3.1    1.618479           -6.376439    .1764391

------------------------------------------------------------------------------

    diff = mean(fs_Tb_Ta_Gb) - mean(fs_Tb_Ta_Ga)                 t =  -1.9154

Ho: diff = 0                     degrees of freedom =       38

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0

 P(T < t) = 0.0315         P(|T| > |t|) = 0.0630          P(T > t) = 0.9685
```

The P-value obtained by comparing Ga_Tb-Ta_fs and Gb_Tb-Ta_fs is 0.0630, which, according to Table 52 explaining what the different ranges of P-value mean (see section 5.4), falls into the range of 0.05 < P < 0.10; i.e., weak evidence of a difference or relationship. The point to be made here is that the sample of 20 students per group in the current study is

very small and the P-value is very likely to fall into the range of $0.01 < P < 0.05$ (evidence of a difference or relationship), if the sample size were to be larger.

5.4.2 Comparing the score awarded based on the DipTrans criteria (sp1)

The comparison between the sp1 obtained in Ta and in Tb aims to find out whether the students have improved their translation ability regarding the DipTrans criteria (see section 4.4) after the four months' training. If, as expected, both Ga and Gb have a higher sp1 score in Tb than in Ta, the next step is to find out which group has increased more, as shown by the score of Tb-Ta_sp1, where Ta is subtracted from Tb. The comparison between Ga_Ta_sp1 and Ga_Tb_sp1 intends to foreground the average improvement experienced by Ga students in sp1, whereas the comparison between Gb_Ta_sp1 and Gb_Tb_sp1 aims to evaluate the progress made by Gb students on average. Finally, the comparison between Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1 is conducted in order to assess which of the two groups has improved most in terms of sp1.

5.4.2.1 Comparing the sp1 of GaTa and GaTb

Table 58 below presents the ID numbers of the students from Group A (Ga), their sp1 scores in test A (Ta) and Test B (Tb), and the sp1 score difference between Ta and Tb, in blue:

Table 58: Ga_Tb_Ta_sp1

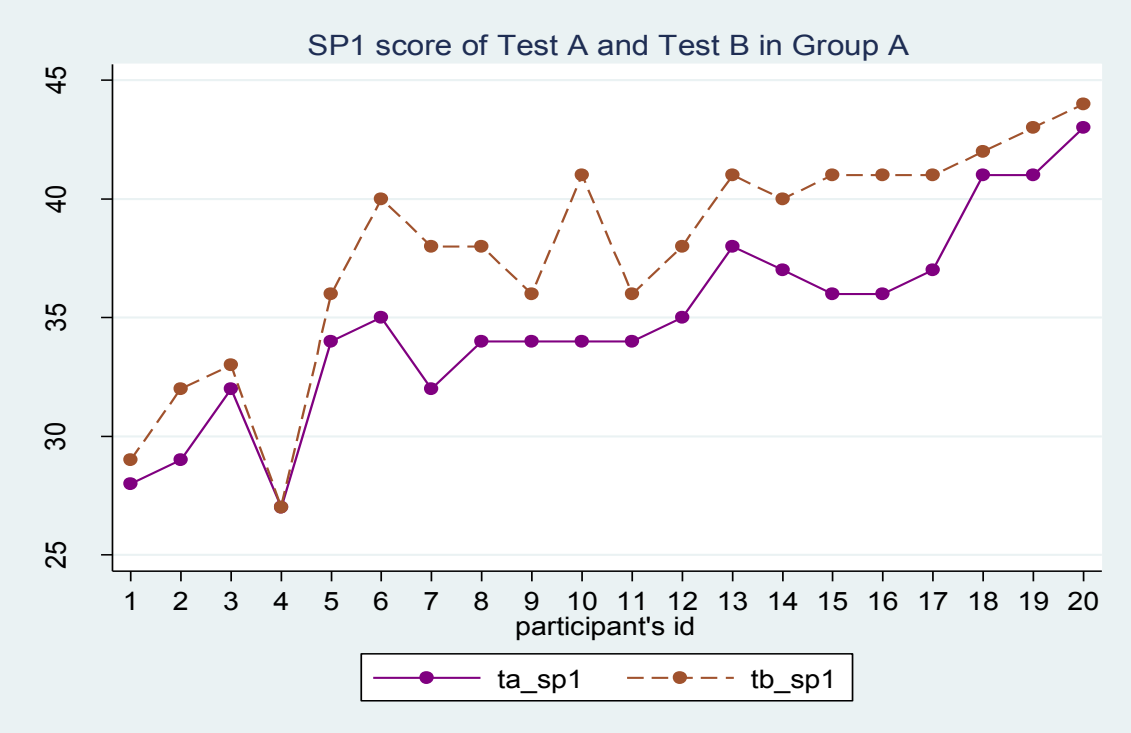
Original id number	Chart_no	Ta_sp1 (of 50)	Tb_sp1 (of 50)	Tb-Ta_sp1
GaN11	1	28	29	1
GaN15	2	29	32	3
GaN20	3	32	33	1
GaN18	4	27	27	0
GaN10	5	34	36	2
GaN14	6	35	40	5
GaN5	7	32	38	6
GaN2	8	34	38	4
GaN9	9	34	36	2
GaN16	10	34	41	7
GaN19	11	34	36	2
GaN6	12	35	38	3
GaN7	13	38	41	3
GaN4	14	37	40	3
GaN3	15	36	41	5
GaN17	16	36	41	5
GaN13	17	37	41	4
GaN8	18	41	42	1
GaN12	19	41	43	2
GaN1	20	43	44	1

As illustrated, nearly all the Tb-Ta_sp1 values are positive, indicating that students performed better in Tb than in Ta in terms of sp1, except for GaN18, which remains unchanged at 0. With 7 points difference, GaN16 is the student showing the highest improvement. This candidate had resided in the UK for three years before starting the Master's course in Translation, during which time s/he studied and was awarded a Bachelor's degree of Material Science and Engineering. Although in the horizontal analysis it was found out that a long term stay in an English speaking country does not necessarily improve the student's translation ability in dealing with scientific and technological texts, the case of this particular student seems to suggest that a long term stay in an English speaking country, together with training in a relevant area, has the potential to help students improve their sp1 really fast once they are systematically trained in translation.

As mentioned, GaN18 did not make any improvements in terms of sp1. The candidate spent exactly 2 hours on both Ta and Tb, had not been trained in the translation of scientific and technological texts before sitting Tb; had an undergraduate degree in English Language and had not spent any substantial time in an English speaking country before commencing the Master's course. These parameters do not show a clear explanation for this unusual outcome.

Figure 21 below contains the sp1 scores of Ga students in Test A (purple) and Test B (orange), showing that most students have achieved a slightly higher sp1 score in Tb than in Ta, except for number 4, who has the same score in both tests. The chart also shows that, as in the previous case, the students in the low and in the high scores zone made less improvement than the students in the middle range.

Figure 22: sp1 score of Ta and Tb in Ga



5.4.2.2 Comparing the sp1 of GbTa and GbTb

Table 59 below contains the ID numbers of the students from Group B, their sp1 scores in Test A (Ta) and Test B (Tb), and the sp1 score difference (in blue) between Ta and Tb:

Table 59: Gb_Tb_Ta_sp1

Original id number	Chart_no	Ta_sp1 (of 50)	Tb_sp1 (of 50)	Tb-Ta_sp1
GbN4	1	33	35	2
GbN7	2	32	33	1
GbN9	3	31	34	3
GbN16	4	34	40	6
GbN5	5	34	39	5
GbN17	6	34	35	1
GbN6	7	36	38	2
GbN8	8	36	38	2
GbN14	9	34	36	2
GbN12	10	37	40	3
GbN18	11	36	39	3
GbN11	12	36	41	5
GbN3	13	39	40	1
GbN19	14	37	37	0
GbN10	15	40	41	1
GbN15	16	40	41	1
GbN1	17	40	43	3
GbN13	18	40	43	3
GbN20	19	41	41	0
GbN2	20	43	46	3

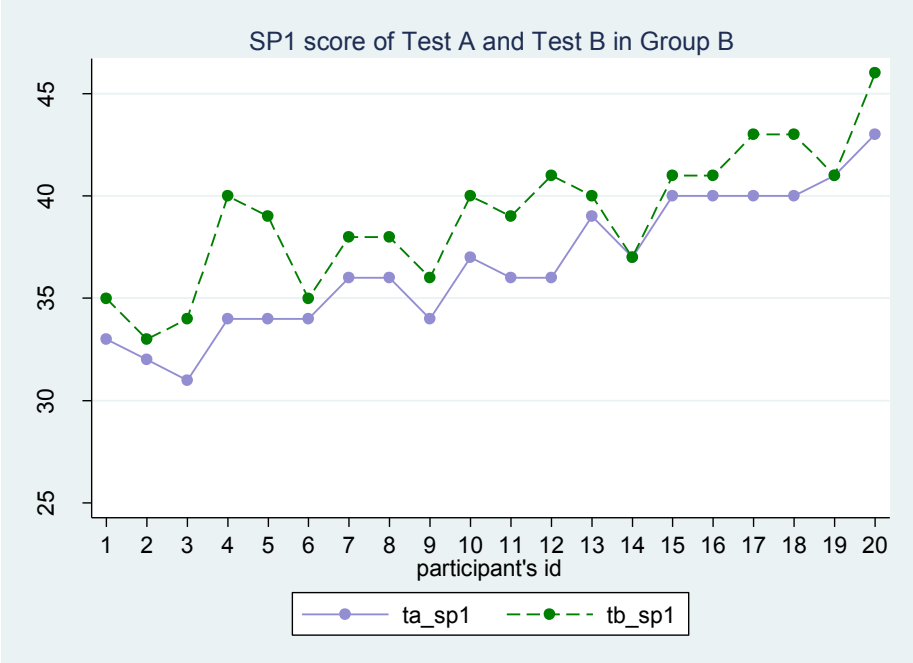
Similar to the findings in the previous section, the above table shows that most students in Gb achieved a higher sp1 score in Tb than in Ta, except for students GbN19 and GbN20, who obtained the same sp1 score in both tests. With 6 points difference, GbN16 is the student who has improved most.

GbN19 and GbN20 had both an educational background in English Language, had never enjoyed a long term stay in an English speaking country before starting the Master's course, and had not received any training in the use of CAT tools prior to sitting Tb. Neither of them

had been trained in the translation of scientific and technological texts when doing Ta, but both of them had had around 4 months' training in this field before doing Tb, which, in theory, should have resulted in them reaching a higher sp1 score in Tb than in Ta. The reason behind this unexpected outcome may lie in the the fact that both candidates spent around 15 minutes less time on doing Tb than on Ta, offseting the potential improvement that their four months' training in the translation of scientific and technological texts could have afforded them.

The following figure reveals the sp1 scores of Ta and Tb done by Gb students, with the sp1 of Ta in green and the sp1 of Tb in purple. As in previous cases, the results show that most students have slightly higher sp1 scores in Tb than in Ta, but, unlike in previous cases, the improvements made by Gb students seem to be more randomly distributed, rather than clustered in the middle range.

Figure 23: sp1 of Ta and Tb in Gb



5.4.2.3 Comparing the mean value of Ga _Tb-Ta_sp1 and Gb_Tb-Ta_sp1

The table below displays the ID numbers of the students from both groups with the sp1 score difference between Test A and Test B for each student. The last row of the table contains the mean value of Ga_Tb-Ta_sp1 (the score difference between Ta and Tb of Group A students) and the mean value of Gb_Tb-Ta_sp1 (the score difference between Ta and Tb of Group B students):

Table 60: Mean value of Tb-Ta_sp1 in Ga and Gb

Chart no.	Group A id	Ga_Tb-Ta_sp1	Gb_Tb-Ta_sp1	Group B id
1	GaN11	1	2	GbN4
2	GaN15	3	1	GbN7
3	GaN20	1	3	GbN9
4	GaN18	0	6	GbN16
5	GaN10	2	5	GbN5
6	GaN14	5	1	GbN17
7	GaN5	6	2	GbN6
8	GaN2	4	2	GbN8
9	GaN9	2	2	GbN14
10	GaN16	7	3	GbN12
11	GaN19	2	3	GbN18
12	GaN6	3	5	GbN11
13	GaN7	3	1	GbN3
14	GaN4	3	0	GbN19
15	GaN3	5	1	GbN10
16	GaN17	5	1	GbN15
17	GaN13	4	3	GbN1
18	GaN8	1	3	GbN13
19	GaN12	2	0	GbN20
20	GaN1	1	3	GbN2
	mean	**3**	**2.35**	**mean**

According to these figures, the mean value of the increased sp1 by Ga is 3 points, slightly higher than the increase of sp1 experienced by Gb students (2.35), suggesting that there is

no much difference in the improvement made by the two groups of students in terms of sp1 score. To confirm that the difference is not significant, the P-value has been generated by Stata as follows:

Table 61: P-value generated by comparing Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1

```
ttest  sp1_Tb-Ta_Gb= sp1_Tb-Ta_Ga, unpaired

Two-sample t test with equal variances

------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------

sp1_Tb-Ta_Gb |      20        2.35    .3647277    1.631112    1.586616    3.113384

sp1_Tb-Ta_Ga |      20           3    .4230217    1.891811    2.114605    3.885395

---------+--------------------------------------------------------------------

combined |      40       2.675    .2805386    1.774282    2.107557    3.242443

---------+--------------------------------------------------------------------

    diff |            -.65    .558546           -1.780717    .4807174
------------------------------------------------------------------------------

    diff = mean(sp1_Tb-Ta_Gb) - mean(sp1_Tb-Ta_Ga)                t =  -1.1637

Ho: diff = 0                               degrees of freedom =       38

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0

 Pr(T < t) = 0.1259         P(|T| > |t|) = 0.2518          Pr(T > t) = 0.8741
```

According to this result, the P-value obtained by comparing Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1 is 0.2518, which falls into the range of P > 0.10 (little or no evidence of a difference or relationship). On this occasion, the figures are too wide apart and even if the sample size were larger, the P-value will still be higher than 0.10. It can be safely concluded that there is no significant difference between the performances of the two groups in this respect.

5.4.3 Comparing the score awarded based on the translation of the scientific and technological features (sp2)

By comparing the sp2 obtained by the same individual in Ta and in Tb it is expected to ascertain whether, on average, the students of a given group have improved their translation ability in terms of how they have dealt with the transfer of the specialised features pertaining to scientific and technological texts. In the first instance, the two groups are compared individually and later a comparison is made between the two groups so as to gauge which of the two groups has improved more in terms of sp2.

5.4.3.1 Comparing the sp2 of GaTa and GaTb

Table 62 below displays the ID numbers of the students of Group A, their sp2 scores in Test A and Test B, and the sp2 score difference between Ta and Tb (in blue):

Table 62: Ga_Tb_Ta_sp2

Original id number	Chart_id	Ta_sp2 (of 50)	Tb_sp2 (of 50)	Tb-Ta_sp2
GaN11	1	26	38	12
GaN15	2	27	39	12
GaN20	3	27	36	9
GaN18	4	32	41	9
GaN10	5	27	38	11
GaN14	6	26	44	18
GaN5	7	33	47	14
GaN2	8	32	46	14
GaN9	9	32	41	9
GaN16	10	33	46	13
GaN19	11	33	39	6
GaN6	12	35	44	9
GaN7	13	32	45	13
GaN4	14	36	45	9
GaN3	15	37	43	6
GaN17	16	38	44	6
GaN13	17	37	45	8
GaN8	18	40	48	8
GaN12	19	39	44	5
GaN1	20	41	44	3

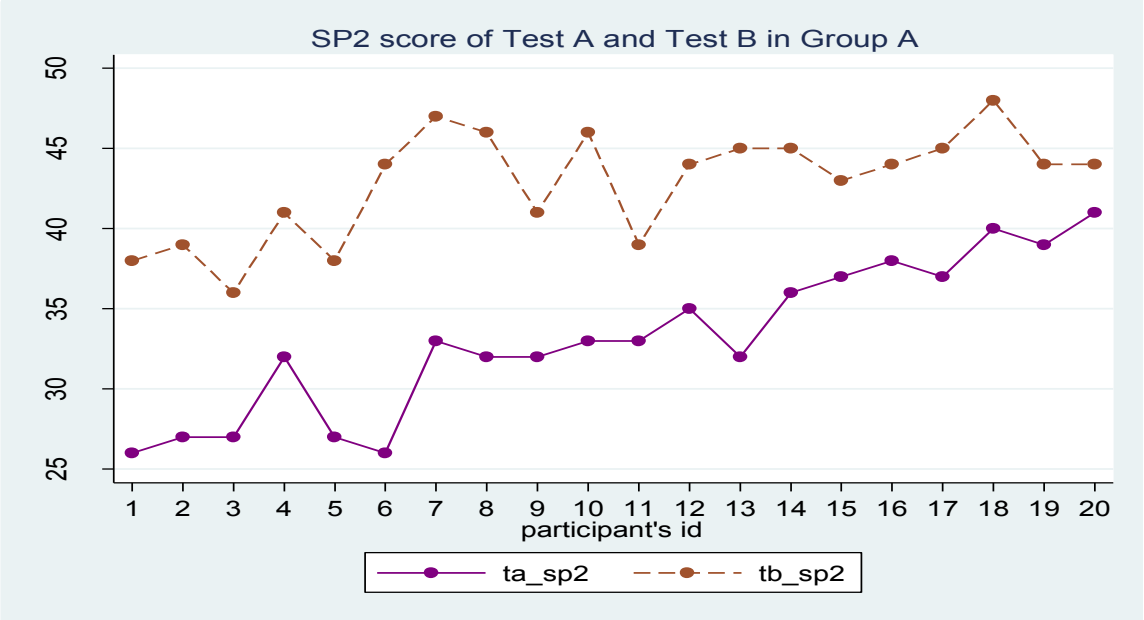
As evidenced by the figures above, all students in Ga reached a higher sp2 in Tb than in Ta, with the improvement of eight of them in double digits. On average, students improved 9.7 points. With 18 points difference, GaN14 is the student whose performance has improved most, whilst the student who made the least improvement was GaN1, who only scored 3 points higher in Tb than in Ta. As sp2 evaluates how students deal with certain features of scientific and technological texts, and Ga is the group of students who were trained with access to CAT tools for four months, it can be concluded here that there is a correlation between these two factors, i.e., the training in the use of CAT tools may have resulted in the increase of sp2. In other words, the students who were trained with CAT tools performed better when it came to dealing with the translation of features typical of scientific and technological texts.

The questionnaires of GaN14 and GaN1 are looked into in order to figure out why they have made the most and least improvement respectively. GaN14 came from an English Language background, had not been trained in the use of either CAT tools or the translation of scientific and technological texts at the time of taking Ta, but did receive training in these two areas during the four months between taking Ta and Tb. In addition, the candidate only employed Youdao online dictionary and Google search engine to assist translating Ta, whereas for Tb s/he made use of Wordfast and Trados as well as online dictionaries and search engines. It can thus be safely deduced that GaN14 highly improved his/her sp2 because of the training received in the use of CAT tools and in the translation of scientific and technological texts.

GaN1 had a bachelor's degree in Translation and Interpretation and, as discussed in the horizontal analysis, this type of students presented a higher level of foreign language competence and translation ability than the average students at the time of Ta, resulting in them achieving some of the highest scores in Ta. In addition, this candidate had attended a 9 months language course in the UK immediately before starting the Master's course. The increase of only 3 points between sp2 in Ta (41) and sp2 in Tb (44) is understandable given the very strong performance of this student in both tests and, although this student did not use CAT tools in Ta but did employ Wordfast and Trados in Tb, it is difficult to argue that the modest increase is solely due to the use of CAT tools.

The following figure depicts the sp2 obtained by the students of Group A in Test A (brown) and Test B (purple), suggesting that all students have made some improvement. The chart also shows that the students in the low and middle range scores zone improved their performance more than the students in the high score zone:

Figure 24: sp2 score of Ta and Tb in Ga



5.4.3.2 Comparing the sp2 of GbTa and GbTb

The following table exhibits the ID numbers of the students of Group B, their sp2 scores in Test A and Test B, and the sp2 score difference between Ta and Tb, in blue:

Table 63: Gb_tb_ta_sp2

Original id number	Chart_no	Ta_sp2 (of 50)	Tb_sp2 (of 50)	Tb-Ta_sp2
GbN4	1	28	42	**14**
GbN7	2	29	34	**5**
GbN9	3	30	33	**3**
GbN16	4	29	43	**14**
GbN5	5	32	41	**9**
GbN17	6	32	43	**11**
GbN6	7	31	43	**12**
GbN8	8	32	44	**12**
GbN14	9	34	37	**3**
GbN12	10	33	38	**5**
GbN18	11	34	46	**12**
GbN11	12	37	44	**7**
GbN3	13	35	46	**11**
GbN19	14	38	44	**6**
GbN10	15	37	43	**6**
GbN15	16	38	43	**5**
GbN1	17	39	46	**7**
GbN13	18	39	43	**4**
GbN20	19	41	38	**-3**
GbN2	20	41	46	**5**

As illustrated, most students from Gb obtained a higher sp2 in Tb than in Ta, except for student GbN20, who scored 3 points lower. Two students, GbN4 and GbN16, experienced the biggest increased with 14 points apiece.

GbN20 had not been trained in the use of CAT tools and neither in the translation of scientific and technological texts at the time of taking Ta, whereas s/he had received some training in scientific and technological translation but not in CAT tools at the time of doing Tb. These factors do not explain why s/he had a lower sp2 in Tb than in Ta. As analysed

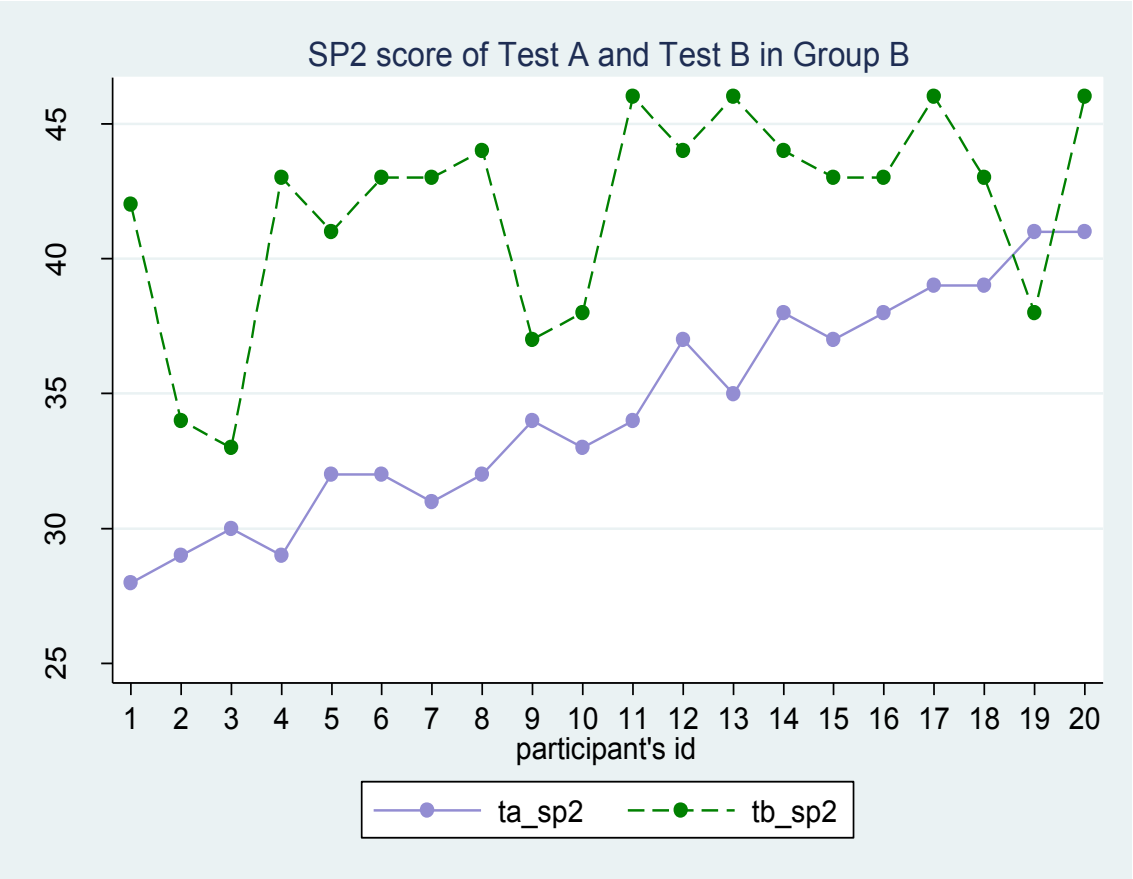
earlier, GbN20 used the CAT tool Lingoes in Ta, but did not use it in Tb. This may be the reason why s/he had a lower sp2 score in Tb than in Ta.

GbN4 had not been trained in the use of CAT tools or in the translation of scientific and technological texts at the time of taking Ta, but had been indeed trained in this area during the four months between Ta and Tb. What is more, this candidate had learned to use Lingoes by his/herself during the four months' training and used it for the translation of Tb. Therefore, it can be inferred that GbN4 made vast improvements because s/he used CAT tools in Tb and had been trained in how to deal with the translation of scientific and technological texts.

As most students in this group, GbN16 had not received any training in the use of CAT tools before sitting Tb. However, while s/he had only used online dictionaries as assistance in doing Ta, for Tb s/he also employed various search engines as well as Wikipedia to help in the background knowledge and to look for specialised terminology, which might explain why s/he spent more time in Tb (2 hours) than in Ta (1hour and 20 minutes).

Figure 24 below displays the sp2 scores reached by students from Group B in Test A (purple) and Test B (green), revealing that most students improved their performance. Again, students in the low and the high scores zone made less improvement than students in the middle range:

Figure 25: sp2 score of Ta and Tb in Gb



5.4.3.3 Comparing the mean value of Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2

Table 63 below presents the ID numbers of the students from the two groups and the score difference between Test A and Test B for each of the students, with the last row displaying the mean values for Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2, in blue:

Table 64: Mean value of Tb-Ta_sp2 in Ga and Gb

Chart no.	Group A id	Ga_Tb-Ta_sp2	Gb_Tb-Ta_sp2	Group B id
1	GaN11	12	14	GbN4
2	GaN15	12	5	GbN7
3	GaN20	9	3	GbN9
4	GaN18	9	14	GbN16
5	GaN10	11	9	GbN5
6	GaN14	18	11	GbN17
7	GaN5	14	12	GbN6
8	GaN2	14	12	GbN8
9	GaN9	9	3	GbN14
10	GaN16	13	5	GbN12
11	GaN19	6	12	GbN18
12	GaN6	9	7	GbN11
13	GaN7	13	11	GbN3
14	GaN4	9	6	GbN19
15	GaN3	6	6	GbN10
16	GaN17	6	5	GbN15
17	GaN13	8	7	GbN1
18	GaN8	8	4	GbN13
19	GaN12	5	-3	GbN20
20	GaN1	3	5	GbN2
	mean	**9.7**	**7.4**	**mean**

As illustrated, the mean value of the increased sp2 of Ga is 9.7 points higher than the average increased experienced by Gb, which stands at 7.4 points. This result is consistent with the initial hypothesis that Ga would improve more than Gb in terms of sp2, because the use of CAT tools when doing Tb would give students an advantage when dealing with the transfer of the main specialised features of scientific and technological texts.

The P-value generated below shows whether the improvement experienced by Ga and Gb is significantly different:

Table 65: P-value generated by comparing Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2

```
ttest  sp2_Tb_Ta_Gb= sp2_Tb_Ta_Ga, unpaired

Two-sample t test with equal variances

------------------------------------------------------------------------------
Variable |     Obs       Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
sp2_tb~b |      20        7.4    .9797959    4.38178    5.349264    9.450736
sp2_tb~a |      20        9.7    .8211032    3.672085    7.981411    11.41859
---------+--------------------------------------------------------------------
combined |      40       8.55    .6572573    4.15686    7.220572    9.879428
---------+--------------------------------------------------------------------
    diff |              -2.3    1.278362               -4.887909    .2879095
------------------------------------------------------------------------------
    Gb) - mean(sp2_Tb_Ta_Ga)                      t =  -1.7992
Ho: diff = 0                     degrees of freedom =       38

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0400         P(|T| > |t|) = 0.0799          Pr(T > t) = 0.9600
```

The above result generated by Stata shows that the P-value obtained by comparing Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2 is 0.0799, falling into the range of $0.05 < P < 0.10$, which indicates weak evidence of a difference or relationship. This result coincides with the one obtained for the P-value for the final score (fs) generated in section 5.4.1. Once again, having a very small sample of 20 students in each group has affected the outcome and, if the sample size were to be larger, the likelihood is that the P-value would then be very likely to fall into the range of $0.01 < P < 0.05$, showing evidence of a difference or relationship.

5.5 Conclusions

In the first sections, Chapter Five has dealt with the methodological issues of data collection and analysis, moving later to the presentation and discussion of the findings. The data collection procedures included the creation of Excel tables containing the textual sci-tech features of the English texts matched up with the corresponding translation performed by each individual student, the compilation of the students' scores in the various marking sheets, and the meaningful compartmentalisation of all the scores into tables in order to facilitate the comparison of data.

The data has been scrutinised by means of a horizontal and a longitudinal analysis. The former consisted in the comparison between the scores obtained by the two groups in the same tests, i.e. between GaTa and GbTa and between GaTb and GbTb, whereas the longitudinal analysis has looked into the scores of two tests done by the same group: GaTa and GaTb, on the one hand, and GbTa and GbTb, on the other. Part of the longitudinal analysis has been to gauge the improvement made by both groups of students by contrasting Ga_Tb-Ta and Gb_Tb-Ta.

The purpose of the horizontal analysis has been to elucidate some of the factors that may have impinged on the scores obtained by the students in GaTa, GaTb, GbTa, GbTb, by analysing their answers to the questionnaires. One of the aims of the longitudinal analysis has been to calculate the actual score differences between Ta and Tb for both groups, so as to find out whether the overall performance of the experimental Ga and the control Gb has improved in Tb.

The Horizontal analysis has led to two major findings and some minor findings.

The first major finding is that Group A, the experimental group, has improved more on average than the control group, because the students in this group have undergone four months' training in the use of CAT tools and 14 students did use various CAT tools during Test B.

The author first found that Ga achieved a lower average final score (68) than Gb (71) in Ta; a result that deviates from the initial supposition that Ga and Gb would get similar scores in Ta because they shared a similar education level and background. However, by analysing the students' questionnaires in detail, it turned out that they did not all have a similar education background. More students in Gb had a BA in English Language or Translation than in Ga, arguably giving them an advantage in terms of foreign language fluency which led them to achieve higher scores in the early stages of translation training. Another reason could be that 11 Gb students had already undergone around two months' training on the translation of scientific and technological texts at the time of Ta.

By analysing the scores obtained in Test B by both groups, it has been found that Ga and Gb achieved an identical average final score (fs) of 81 in Tb. This finding again deviates from the initial supposition that Ga would have reached a higher score than Gb in Tb because as the experimental group the students had been trained in the use of CAT tools for four months before sitting Tb, unlike Gb students who had not been trained in the use of CAT tools.

However, a closer look at the scores achieved by Ga and Gb shows that Ga has experienced a higher increase (13 points) than Gb (10 points); a finding consistent with the hypothesis that Ga will improve more after four months' study than Gb because they had been trained in the use of CAT tools. Nonetheless, in order to ascertain whether this difference of improvement is significant enough, a longitudinal analysis has also been conducted to find out the P-value of each of the tests and results.

The second major finding is that among the 20 students of Group A, 14 of them chose to use CAT tools when doing Test B, while 6 of them did not employ any CAT tool. An analysis of the mean value of the final scores achieved by these two types of students shows that, on average, the students who used CAT tools during the test scored significantly higher than the students who did not use them. The average score gap is 8 points. It is crucial, then, to encourage and ensure that students do not only learn how to use CAT tools but that they also use them in practice and in professional assignments.

Six minor findings can be also drawn from the horizontal analysis. By comparing the students' scores and the time devoted to the tests, it transpires that spending more time than necessary on a translation task may not guarantee a good result. Another finding is that, on the condition that all other factors are similar, students who have spent a long stay in an English speaking country do not necessarily perform better when it comes to the translation of scientific and technological texts. The third minor finding is that, in China, many students who enrol to do a Master's in scientific and technological translation have a foreign languages background while in the UK the candidates profile is more diverse, with more students with a science background choosing to pursue another degree in Translation.

The fourth minor finding is that the use of CAT tools in scientific and technological translation helped students to save a significant amount of time (section 5.3.2.1): the average time spent by the experimental Group A in Test B was 1 hour and 29 minutes; 14 minutes less than the average time they had spent on Test A. Considering that in the second test 14 Ga students used CAT tools, this result seems to indicate that students can save considerable time when translating if they make use of CAT tools. The fifth minor finding is that when asked about the difficulties encountered when faced with the translation of scientific and technological texts, students from both groups coincided in their selection of factors, namely: the use of long, complex, and complicated sentences in the original text; obscure terminology; lack of background knowledge; and use of the English passive voice. Incidentally, these challenges also concur with the ones discussed in the existent literature on the topic (Chapter Two). The last minor finding is that once the students have learned how to make the most of the CAT tools, they will use them to translate scientific and technological texts, as illustrated by the fact that 14 Ga students used CAT tools to finish Tb when none had used them for Ta.

The longitudinal analysis leads to three major findings in terms of fs, sp1 and sp2 and two minor findings. As explained in section 5.4, the software Stata has been used to help with the data analysis. By calculating the P-value of the improvement made by Group A and Group B in terms of three aspects, namely, fs (overall score), sp1 (score awarded based on the DipTrans standards), and sp2 (score awarded based on how the student dealt with the translation of specialised features of scientific and technological text), meaningful conclusions can be reached in terms of the significant validity of the results obtained, which can be interpreted referring to the above mentioned Table 52.

The P-value generated by comparing Ga_Tb-Ta_fs and Gb_Tb-Ta_fs aims to find out the difference between the overall improvement made by the students from both groups in terms of the final score. On this occasion, the value is 0.0630, which falls into the range of $0.05 < P < 0.10$ and shows weak evidence of a difference. Although this result can be seen as a bit disappointing, the reality is that the experiment still shows that Group A has experienced a higher improvement than Group B in terms of the overall score, and if the sample size had been larger, it is very possible that the improvement would have been significantly higher.

In the comparison between Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1, which intends to discover whether the improvements made by the students from both groups are significantly different in terms of the sp1 score, the P-value (0.2518) is much higher than 0.10, indicating no evidence of a significant difference and suggesting that even if the sample size were larger, the P-value would still not show a significant difference. This result demonstrates that Group A and Group B made a similar improvement in terms of the sp1 score – the score based on the DipTrans marking criteria –, and that the increase of the sp1 score is not decisive for the significant difference found in the improvement of the overall score (fs) between the two groups.

Finally, the P-value generated by comparing Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2, which tries to ascertain whether the improvements made by the students from both groups are significantly different in terms of the sp2 score, is 0.0799. This result shows weak evidence of a difference but, as in the first case, with a larger sample size, it is very likely that the P-

value would had fallen into the range of $0.01 < P < 0.05$, showing evidence of significant difference between the performance of the two groups. This finding shows that the improvements experienced by both groups in terms of sp2 are different, and this difference is significant enough to have caused the pronounced difference of the overall score (fs) between the two groups.

The three P-values indicate that the two groups have improved in a similar way in sp1, but their improvement in dealing with the transfer of specialised features of sci-tech texts (sp2) has been different and Ga seems to have improved much more than Gb. The P value in terms of sp2 score is not much higher than that achieved in terms of the sp1 score. Therefore, it is concluded that the difference of the final score (fs) has been caused by the difference observed in the sp2 score rather than in the sp1 score.

Based on the horizontal analysis, the decisive factor that has led Ga to get a higher sp2 score seems to be the fact that they were trained for four month in the use of CAT tools before sitting Tb, which was the main variable parameter between the control and the experimental groups. A connection between this decisive parameter and the fact that the students of Group A improved more than the ones in Group B can therefore be established and support the initial hypothesis that training students in the use of CAT tools would improve their ability in dealing with the translation of the specialised features typical of scientific and technological texts.

Also telling, according to the longitudinal analysis, is the minor finding that students in the low and high score zones have made less improvement than students in the middle range

zone, signalling that the latter students seem to improve their performance more substantially after having been trained in the use of CAT tools than students with very low or very high translation ability.

Worth remembering at this point is the fact that the experimental Group A undertook the training on CAT tools in the very beginning of their MSc study. Against a rather traditional opinion that the teaching of CAT tools should be avoided at the beginning of the curriculum (the early stage of the MSc programme) so as not to have a negative impact on the students, who may feel overwhelmed by technology, the results of this experiment seem to point in the opposite direction; i.e., that training students with CAT tools from the very start of their MSc programme can indeed have a positive impact on their translation ability and help them improve their performance in a fast manner.

Chapter Six

Discussion and Conclusion

6.1 Research overview

This research was originally initiated because of the author's recognition of the necessity of training translators to be specialised in the translation of scientific and technological texts from English to Chinese. The phrase 'scientific and technological translation' in the current research refers to the translation of academic and scholastic documentation on science and technology, such as science text books, scientific journal articles and conference papers, but it deliberately excludes materials that fall within the remit of the traditional concept of 'technical translation', such as technical manuals, machinery specifications or even the range of popular science articles. Scientific and technological texts differ from other text types in that their composition shows some particular characteristics and features, such as the use of complicated sentence structure, the abundance of terminology and the recurrent use of the passive voice. When translating this type of text, it is assumed that resorting to computerised language tools, such as CAT tools, corpora and internet search engines can substantially help the professionals deal with these specific features in their translations. Therefore, the inclusion of CAT tool modules in translator training programmes is considered by many the right step in the right direction in order to enhance the students' translation ability in the scientific and technological translation field. Some scholars, such as

Zanettin (2003), advocate and foreground the positive impact that CAT tools can have on the translator training process. However, these arguments tend to be fundamentally of a notional and theoretical nature rather than empirically tested. Indeed, few experimental studies have been conducted to verify, or refute, the validity of such arguments from a quantitative perspective by using a statistical approach and methodology. To fill this research gap, the current study has adopted an experimental approach with the ultimate aim of validating the initial hypothesis that training students in the use of CAT tools enhances their translation competence when dealing with scientific and technological texts.

This research commenced by discussing the typical features of English scientific and technological texts, and the various strategies that translators apply when translating these features into their Chinese counterparts. These features have been elaborated on from five perspectives: grammatical, syntactical, lexical, functional and stylistic aspects. This elaboration has been completed with a list of twenty one specific features, a compilation of examples in the English original text and an illustration of the strategies regularly adopted to translate them into Chinese. However, only the eight most salient features have been finally investigated in the experimental stage to make the testing manageable. These were: passive voice, terminology, logico-grammatical items, personal versus impersonal forms, nominalisations, infinitive verb form, gerund form and past participle form.

After the discussion of the main textual features that characterise scientific and technological texts, the literature review continued with the exposition of three types of translation technology and resource: computer assisted translation (CAT) tools, electronic corpora and internet search engines. The author first defined the three concepts before

reviewing related studies carried out in the three areas to finally discuss and propose how these computerised language tools can be maximised when training translators. This section aimed to increase awareness, especially among trainee translators, on how they can improve (and speed up) their translation quality by using certain kinds of translation technology and resource.

After the completion of the literature review, the research progressed to the design and implementation of an experiment; the purpose of which was to validate the hypothesis that the application of computer-assisted translation tools to translator training will improve students' translation ability when confronted with the specific task of translating scientific and technological texts. Therefore, the experiment was carried out on two groups of students, an experimental and a control group, with the former being trained using CAT tools for a period of four months whilst the latter was not exposed to such training. Both student groups took a first test, called Test A, before the training as a means to gauge the students' translation ability at that time, before any of them had been exposed to CAT tools. After the four months of training in the use of CAT tools for the experimental group and general translation tasks in the case of the control group, the author administered the second test, called Test B, to both groups of students, so that the final scores could help reveal any divergence in the students' translation ability after four months of training in CAT tools or general study in translation.

Additionally, a questionnaire was also given to all the students after each one of the two tests, through which the author could try and understand the factors that may have affected an individual student's performance and the potential implications on the overall

performance of the whole group. The factor analysis was important because it helped ensure that the two groups were comparable at the baseline. In the current study, comparability lay in the fact that the experimental and the control groups were very similar in all parameters but one variable: i.e., the intervention of CAT tools in their training. If the intervention factor is actually a causal factor of certain results, then logic dictates that such result should manifest itself more significantly in the experimental than in the control group. In this research, the intervention factor was 'the training in the use of CAT tools'. So, if 'the training in the use of CAT tools' does cause some 'improvement in the translation ability' of the experimental group, this should occur at a significantly greater rate than in the control group to be significantly meaningful. In this study, the significance has been measured and demonstrated by the P-value, the different ranges of which seems to suggest whether the intervention factor 'the training in the use of CAT tools' is the causal and decisive factor for improving students' translation ability.

With the experiment finished as designed and scheduled, the author obtained 80 tests in total. The results were awarded according to two categories: first, the marking criteria suggested by the DipTrans and, second, the students' performance when dealing with the translation of scientific and technological text features. As it is normal practice, the maximum score for a test was 100, with 50 marks being assigned to the students' performance according to the DipTrans marking criteria, and the other 50 points being allocated to their performance when dealing with the transfer of the specialized scientific-technological features.

The first 50 points were awarded on the basis of the DipTrans criteria as is known as the 'score part one' (sp1, maximum 50 points), while the score awarded for the way in which the features were translated was named score part two (sp2, maximum 50 points). The final score for each test was, of course, the sum of sp1 and sp2. The aim of evaluating not only the final score but also the two sub-scores was to try and find out which were the specific aspects in which the students had improved most (or least) after the four months of training in the use of CAT tools or in general study in translation.

The results were then compiled and classified in four groups: (1) the students in Group A that had done Test A (GaTa); (2) the students in Group A that had done Test B (GaTb); (3) the students in Group B that had done Test A (GbTa); and, finally, (4) the students in Group B that had done Test A (GbTb). In addition, 20 questionnaires were also obtained per group and test (a total of 80), shedding some light on the factors behind the scores.

The analysis of the data was conducted across horizontal and longitudinal dimensions. The former compared the two groups' performances for the same test that was seated at the same time: Group A Test A (GaTa) vs Group B Test A (GbTa), and then Group A Test B (GaTb) vs Group B Test B (GbTb). The horizontal analysis also looked into the questionnaires answered by the students in an attempt to determine some of the factors behind the scores.

The longitudinal analysis, on the other hand, compared the first and the second tests taken by the same groups, with the goal of gauging any potential improvement in the student's performance between the two tests and, furthermore, to determine whether the improvement was significant. The longitudinal comparison has been made between the

scores for Group A Test A (GaTa) and Group A Test B (GaTb), in the first instance, and then between the scores for Group B Test A (GbTa) and Group B Test B (GbTb). This comparison aimed to calculate the actual score differences between Test A and Test B for both groups, so as to ascertain whether Group A and Group B have made any improvements between the two tests.

The horizontal analysis concluded with two major and some minor findings, whilst the longitudinal analysis led to three major and two minor findings. In the following section, the author will discuss these findings and their implications to translator training, particularly, to the training of scientific and technological translators.

6.2 Findings and contributions of the study

The first major finding uncovered from the horizontal analysis is that Group A, the experimental group, improved on average more than the control group in terms of the final score (fs value) when comparing their performance in Test A and Test B. Group A had an average score of 68 in the first test (Test A), while Group B achieved an average score of 71. For the second test (Test B), both Group A and Group B scored an average of 81. The calculations reveal that Group A experienced a higher increase (13 points) than Group B (10 points) between Test A and Test B. As the intervention factor in the experiment was 'training in the use of CAT tools', it is deduced that the possible reason for Group A having improved more than Group B is down to the training in the use of CAT tools that student in

the experimental group received during four months. However, the difference of improvement might also be caused by chance, as discussed earlier in section 6.1.

To decide whether this difference is actually caused by chance or by the intervention factor, a significance measurement (P-value) was conducted in the longitudinal analysis stage, with the results summarised later in this section. At this point of the study, the assumption was that the experimental group had improved more on average than the control group, possibly because the students in the former group had undergone four months of training in the use of CAT tools and 14 of them had made use of various CAT tools during Test B.

This finding reveals the necessity and importance of incorporating translation technology, including CAT tools, term management tools, translation memories and the like into translator training programmes. Translation technology tools are commonly used in the profession and they play an increasingly more important part in the daily routine of translators. A survey carried out by the Association of Translators and Interpreters of Ontario (ATIO) on their members back in 2007 revealed that 44% of the respondents used CAT tools, translation memories and other translation technology tools. Lagoudaki (2006) had conducted a similar survey, though in her case targeting only technical translators, and had found out that 82.5% of the respondents used translation memories and other tools in their work, showing a significantly higher level of translation technology use among technical and localization translators. Even professionals who do not use translation technology on a regular basis acknowledged, in a survey conducted by LISA in 2005, that the use of such tools would produce benefits, such as improved linguistic consistency, efficiency and productivity. Furthermore, they were willing to employ translation technology tools if

the issues that discouraged them from doing so were solved, such as lack of training and accessibility to the software.

The value and usefulness of translation tools demonstrate the importance of integrating them in the translator training curriculum. Although some authors like Kenny (1999) claim that the inclusion of tools in translation programmes is a rule rather than an exception, the reality seems to point in a different direction. Indeed, according to Wheatley's (2003) survey on the type of translation technology training received by translators, 54% of respondents claimed to be self-taught, 12% stated that they had been formally trained by an independent trainer and only 3% indicated that they have been taught at university. These results seem to demonstrate that very few university translation programmes, whether at undergraduate or postgraduate level, incorporate translation technology in their curricula. Another finding of the same survey was the fact that 33% of respondents were of the opinion that universities should provide training in translation technology.

This situation of a lack of translation technology training in universities has, to some extent, changed during the past decade. Some Master's in Translation programmes offered by some universities in Europe and North America do integrate translation technology modules into their teaching. For instance, the MSc in Translation at Imperial College London, taken by the experimental group, incorporated translation technology as early as 2000, when this programme was launched. However, in other parts of the world few universities offer their students translation technology modules. In this study, the control group students were doing their MSc at Beijing University of Aeronautics and Astronautics where they could only

follow certain introductory courses on translation technology, albeit from a theoretical perspective and without any practical exercises or hands-on experience.

There are various reasons why the integration of technologies into translation programmes has been held back. From a financial perspective, the budget of many universities is rather limited and makes it virtually impossible to invest on what is perceived as expensive translation technology software that requires to be updated and paid for, with unusual frequency. As the prices of CAT tools continue to decrease, with many companies offering educational licenses, and the number of freeware applications soars, it can only be hoped that this issue will be resolved in the not so distant future.

Another reason behind this state of affairs is that some universities have not been keen to develop technology courses because their teaching staffs are not proficient enough in this area. In many cases, university lecturers did their studies before translation technologies became popular and started being integrated into the translation curriculum. Some more flexible universities did find solutions to this issue by recruiting new teachers trained and certificated on translation tools, or by resorting to trainers from the industry or to tool vendors equipped with the professional knowledge and expertise to take on this teaching.

In spite of these challenges, it seems clear that the use of CAT tools and other translation technology applications should be encouraged since, as the results obtained in this research seem to confirm, training students in this field significantly improves their translation ability when dealing with scientific and technological texts.

The other major finding from the horizontal analysis derives from the fact that of the 20 students in the experimental group, 14 chose to use CAT tools when doing Test B whereas 6

did not. An analysis of the mean value of the final scores achieved by these two subsets of students showed that, on average, the students who did use CAT tools during the test scored significantly higher than those who did not, with an average score gap of 8 points. This finding informs translation teachers that, although they may have received training, some students actually do not use CAT tools during assignments and, possibly, neither in real translation tasks. The reasons can be multifarious and, as Kiraly (2000) states, simply offering a course on technology does not ensure that students will actually acquire the technological competence needed to succeed in the profession. Indeed, students may feel that the training they have received is limited to a small number of classes, which may be sufficient to gain a superficial overview of the tools, but inadequate to become proficient users. On other occasions, they may have learnt the intricacies of how to use the technology but failed to understand how to maximise its potential to produce better target texts. Another problem is that translation tools are rarely integrated into other more practical modules such as media, legal or technical translation; a situation which reduces the opportunity to practice with the tools and heightens the gap between theory and practice.

From a student's perspective, the learning of CAT tools can be influenced by two factors: their language pair and their technological competence. As for the first factor, some students in multilingual groups may suffer from the fact that their translation technology instructor is usually an expert in only one or two languages and thus cannot provide far-reaching comments or feedback to all students. This can get compounded by the fact that for most translation software there are subtle differences between languages in terms of settings, interface, function and output, of which teachers may not be aware when it comes to languages that are not part of their linguistic expertise. To solve this, tutors should be

aware of the language pairs their students work on and consult colleagues or tool vendors for specific information on those languages. On the other hand, students working on the same language pairs should be encouraged to collaborate with each other and discuss any specific issues they find when using a particular tool. Finally, the technological know-how and disposition of students to learn new technologies varies greatly and if a student is in the 'wrong' ability group, either because the rest are more or less advanced, their learning experience may end up in sheer frustration.

All in all, it is crucial to encourage and ensure that students do not only learn how to use CAT tools but that they also understand their usefulness and employ them in practice and during professional assignments.

The major findings from the longitudinal analysis are the three P-values generated by comparing the score differences between the two groups in terms of their final scores (fs) as well as their scores for part one (sp1) and part two (sp2), illustrated as:

- Ga_Tb-Ta_fs vs. Gb_Tb-Ta_fs
- Ga_Tb-Ta_sp1 vs. Gb_Tb-Ta_sp1
- Ga_Tb-Ta_sp2 vs.Gb_Tb-Ta_sp2

Before discussing the actual results, the P-value ranges and their meanings are presented in Table 52, included below for the sake of clarity:

Table 52: Meaning of different ranges of P-value

P > 0.10	Little or no evidence of a difference or relationship
0.05 < P < 0.10	Weak evidence of a difference or relationship
0.01 < P < 0.05	Evidence of a difference or relationship
P < 0.01	Strong evidence of a difference or relationship
P < 0.001	Very strong evidence of a difference or relationship

The P-value generated by comparing Ga_Tb-Ta_fs and Gb_Tb-Ta_fs is 0.0630, which falls into the range of 0.05 < P < 0.10 and shows weak evidence of a difference. Since 0.0630 is very close to the dividing line of 0.05, it is very possible that if the sample size had been larger, the P-value would have suggested the existence of a significant difference. It is then concluded that the improvement made by Group A in terms of the final score is indeed different from that of Group B, though not significantly different.

The P-value generated by comparing Ga_Tb-Ta_sp1 and Gb_Tb-Ta_sp1 is 0.2518, which clearly falls into the range of P > 0.10 and irrefutably shows that there is little or no evidence of a difference or relationship, and even if the sample size were larger, the result would be the same. The conclusion, therefore, is that the improvement made by Group A in terms of the sp1 score is not different from that of Group B.

Lastly, the P-value generated by comparing Ga_Tb-Ta_sp2 and Gb_Tb-Ta_sp2 is 0.0799, showing weak evidence of a difference as in the case of the final score. However, with a larger sample size it is very likely that the P-value would have shown evidence of significant difference between the performance of the two groups. The conclusion reached is that the improvement made by Group A in terms of sp2 score is different from that of Group B but not significantly different.

Given these results, it is clear that the difference in the final scores (fs) obtained by Group A and Group B has been caused by the difference observed in the sp2 score, rather than the sp1 score, meaning that their most pronounced improvement has taken place in the translation of the typical features of scientific and technological texts. Since the intervention of CAT tools is the variable between Group A and Group B, it can be concluded that training in the use of CAT tools has allowed students to better deal with scientific and technological features and, accordingly, achieve higher scores overall.

Against a rather traditional opinion that CAT tools teaching should be avoided at the beginning of the curriculum so as not to have a negative impact on the students development because they may feel overwhelmed by technology, the results of this experiment seem to suggest an opposite outcome; i.e., that training students with CAT tools from the very start of their postgraduate studies can indeed have a positive impact on their translation ability and help them improve their performance quickly.

The question of when translation technology training should be offered on a translator training programme has long been debated, with authors like Bowker (2003a) claiming that there is no clear consensus. Some scholars are of the opinion that the teaching of translation technology should be reserved for the later stages of a translator training programme since, as postulated by Dillon and Fraser (2006), inexperienced translators do not have the breadth or depth of knowledge needed to allow them to properly evaluate the advantages or disadvantages of using a translation tool. Bowker and Bennison (2003) advocates a gradual approach and suggests introducing more general tools earlier in the

translator training process whilst leaving some of the more complex tools to the later stages. However, as discussed, the findings of the current research show that translation technology training during the early stages of training does not have a negative impact.

Among the other minor findings is the fact that students in the experimental group had particularly diverse education backgrounds, with nearly half of them (9 out of 20) coming from various scientific backgrounds. On the contrary, almost all students in the control group came from a background of Bachelor's degrees in humanities, especially in English Language and Culture. The research results show that when it comes to translating, students with a science and technology background are not as good as language students before training. However, once they have received some formal training, they improve very fast in terms of translation ability and some of them quickly perform better than students with an English language background. The study also reflects the fact that, in China, it is still language students who are trained to deal with scientific and technological translations, while in the UK a substantial number of students with a science background seem to enrol on postgraduate Translation courses, though more exhaustive research should be conducted on the profile of students across various universities and countries before being able to reach more solid conclusions on this front.

6.3 Limitations and suggestions for further research

In Chapter Two of this study, the author has selected and discussed 21 features that are considered to be characteristic of scientific and technological texts, both in English and in

Chinese. However, to ensure that the data collection and the subsequent analysis are manageable, only 8 of the most salient features have been tested in the experiment. In the future, it would be most interesting to conduct another experiment that tests all the 21 features, or perhaps the ones that have not been tested in this thesis, in an attempt to present a more comprehensive picture of how students translate these features with the assistance of CAT tools.

For the experiment discussed in previous pages, the author chose participants attending the MSc in Translation offered by the Translation Group at Imperial College London in the UK and the one offered by the Translation Group at Beijing University of Aeronautics and Astronautics in China, where the author used to study. These two groups of students were considered to offer scope for comparison in the sense that the students from Imperial College London undertook training in the use of CAT tools from the very beginning of their studies, while the students from Beijing University of Aeronautics and Astronautics did not. However, the vast physical distance between the two locations added an extra level of complication in the process of implementing the experiment and collecting the data, which could be avoided in future experiments if both groups are not too far from each other.

Concerning the profile of the various participants, their dissimilar backgrounds in education as well as in personal and translation experience, made it harder to pinpoint with certainty the factors that may have influenced their performance in the translation tests. In this sense, the experimental group showed a higher degree of heterogeneity in terms of education background than the control group. In the former, six students held a Bachelor's degree in English language, five had done one in translation and interpretation, and nine had studied

scientific subjects like mechanical engineering and biochemistry. In contrast, within the control group the majority of students (15) held a Bachelor's degree in English language, and three held one in translation and interpretation, whilst only two students had done scientific subjects in their undergraduate studies. This heterogeneity in the experimental group and the homogeneity in the control group made it difficult for the author to ascertain with total conviction whether a better performance is caused by a high level of English proficiency or is due to familiarity with the terminology.

Similarly, the students' experience of a long-term stay in an English speaking country also added to the complexity of the analysis. In the experimental group, 7 out of 20 students stated that they had spent a long time in an English speaking country, while none of the students in the control group had had a similar experience. This can be confusing when needing to determine whether differences in score are caused by the experience of long term stays in an English speaking country or by other factors. However, as a researcher, the author can only observe and present these differences between the participants, weighting and balancing the various parameters and ruling out the theoretically irrelevant ones and keeping the decisive ones as part of the overall picture.

Finally, the longitudinal analysis is a pure mathematical analysis of the quantitative data, using a statistical tool. The accuracy of such results always relies on the size of the tested subjects and, since in the current research only 20 participants for both the experimental and control groups took part, the results can be on occasions a bit inconclusive. To ensure the representativeness of the findings, future research should be conducted with a larger number of participants.

6.4 Concluding remarks

In the discussion about incorporating translation technology into translator training programmes, scholars hold divergent views on why this training might be necessary, on how the translation tools should be maximised for training, on how training classes should be designed and conducted, and on when translation tools should be introduced to the students. However, there seems to be overall consensus among teachers and researchers about the imperative necessity of training translation students in the use of CAT tools as well as other translation technologies, especially when dealing with texts of a non-literary nature, such as in the case of scientific and technological texts. The inclusion of some type of technology training on the translation curriculum has becomes a rule rather than the exception, as highlighted by Bowker (2003a).

However, simply providing a course on translation technology is not sufficient to guarantee that students will acquire the technology competence needed to succeed in the profession. Therefore, training in the use of translation technology should be designed in a way that is focussed on students learning the functionality of such software in class but without forgetting that they also need to practice outside the classroom and incorporate their use in as many assignments as possible. As for the issue of what might be the best time to introduce the tools to the students, the findings of this study suggest that learning about technology from an early stage in a postgraduate programme is beneficial and does not affect the students' learning experience in a negative manner.

Finally, with technological advancements taking place at a rather vertiginous speed, the reality is that existing translation technologies will necessarily evolve and be superseded by new, more powerful tools. In such a dynamic environment, it is of capital importance for trainers not only to be fully aware of those changes but also to keep pace with them by incorporating them in translator training programmes so that future generations of translators will be fully equipped to properly function in the translation industry.

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