The Importance of teaching ESP for Scientific Students

With globalization and the development of trade between nations, English has become the international language of industry, science and business. This new situation has gradually led to a change in the content of foreign language teaching in many countries, as it has become apparent that knowledge of this language and its mastery in professional contexts and applications are now becoming indispensable for learners. This paper focuses on English for Science and Technology (EST), which is a sub-category of English for Specific Purposes (ESP). We will attempt to reveal, on the one hand, the intrinsic interest of this discipline conveyed by coursework and, on the other hand, we will show the progress it has made both in purely linguistic research and in language teaching.

Keywords: *ESP, EST, learners, sciences, teaching.*

Introduction

There are some characteristics relating to teaching methodology and language elements that differentiate English for specific purposes (ESP) from General English (GE). Within the broadest field of the ESP is English for Science and Technology (EST), which is one of its sub-categories. EST differs from GE in that it focuses mainly on the language appropriate for these activities, including grammar, lexicon, register, study skills, discourse and genre.

Teachers of EST deal with a specific academic language to help learners produce academic science register through language-compatible content, such as key grammatical and content patterns, in order to communicate their knowledge of scientific concepts, analyze scientific ideas, evaluate experimental evidence, and acquire the competence to ask scientific questions: "For every academic topic, certain language is essential for understanding and talking about the material".[1]

English for Specific Purposes (ESP)

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This is the case in Morocco, where it was previously almost exclusively reserved for commercial higher education institutions; widespread teaching of

[1]Snow, M.A. Met, Genesee, M. 1992. A conceptual framework for the integration of language and content instruction. In P. A. Richard-Arnato and M.A.

English has been institutionally introduced at university level during in recent years.

What is required of teachers in this framework is not "general English" according generally to accepted standards, but specific "*Englishes*" with well-defined linguistic objectives that differ according to the university courses: for example, either by allowing students to consult bibliographies in English, by reading various documents in their specialty (mainly textbooks or machine equipment, research articles, etc.), or by helping them master the language and culture of the corresponding professional field in order to facilitate their subsequent integration into an English-speaking work environment.

Future teachers of English are therefore hardly at a disadvantage when they find themselves in a context where "General English" is no more appropriate.

This gap is all the more surprising given that, in Anglo-Saxon universities, many BA and MA degrees in teaching English as a foreign language have integrated the notion of ESP (English for Specific Purposes) into their curriculum. It must be said that this specialization is often perceived by institutions as less prestigious than traditional teaching, which leads to a negative view of teachers of this discipline:

> "*Applied linguists, in fact, have generally been seen as inhabiting the less glamorous, low rent neighborhoods of the academy, and this is particularly true of those concerned with English for Academic Purposes, which is generally regarded as a hand-maiden to those 'proper' disciplines which are more directly engaged in the serious business of constructing knowledge or discovering truth. EAP, in fact, has come to be regarded as an almost mercantile activity and attracted to itself negatively evaluative concepts such as pragmatic, cost-effective and functional, untroubled by theoretical issues or questions of power as it merrily seeks to accommodate students to the faceless and impersonal prose of their disciplines."*[2]

Such a vision is fundamentally inequitable; the very numerous works published in many countries over the last few decades have, on the one hand, revealed the intrinsic interest of this discipline and, on the other hand, shown the progress it has made possible both in purely linguistic research and in language teaching:

> *"EAP has pushed itself to the forefront of innovative research and educational practice to provide insights into the structures and meanings of English, into the demands placed by academic contexts on communicative behaviors, and into the pedagogic practices by which these behaviors can be developed."*[3]

The Objectives of the ESP Course

[2]Hyland, K. 2006. The 'Other' English: Thoughts on EAP and Academic Writing. The European English Messenger, 15.2. p. 34.

[3]Hyland, K. 2006. The 'Other' English: Thoughts on EAP and Academic Writing. The European English Messenger, 15.2. 35.

- Establish assessment criteria for students learning scientific English according to internationally established norms and standards;
- Experiment with and apply new approaches to the teaching and learning of scientific English;
- create strategies for the development of reading, writing, listening and speaking skills in scientific English;
- Designing and collecting new written materials, books, worksheets, tests, and scientific documents, to help students improve their English language skills in chemistry, biology, geology, physics, mathematics, etc;
- Combine science and language approaches to the teaching of English for Science and Science in English and explore their relationship to improve students' abilities to learn science subjects;
- Provide appropriate career guidance to students and special educators who need it to read, write and edit scientific articles of interest in English;
- Use modern computer-based sources for online teaching and assessment of student achievement in science and English language arts.

Scientific English: International English

Sciences include a variety of disciplines such as mathematics, geology, biology, physics, astronomy, chemistry, computer science and many others.

These various disciplines deal with different objects, some of which are very real and often visible to the naked eye, while others, such as mathematics, are purely abstract and depend on human imagination. There is little overlap between the study and analysis materials that each of them uses.

Moreover, such an approach gives the impression of disproportionate ambition, as the terminologies will inevitably have nothing in common and will even represent a difficult set to grasp: "Scientific nomenclature comprises most of the English vocabulary, and no one understands more than a fragment of it"[4]. It is therefore obviously impossible to deal exhaustively with scientific terminology.

The approach to scientific English will therefore have to be treated in a global manner and attempt to differentiate between the different disciplines according to context. According to Petit[5], one must be attentive and focus on:

- the discourse typology,
- textual typology, and
- the production situation.

Is Scientific English Different?

In scientific English, we are faced with a very particular variety of English that is certainly representative of a community discourse. But when this

[4]Crystal, D. 1995. Glossary of linguistic terms. The Cambridge encyclopedia of the English language. Cambridge: Cambridge University Press. P. 372.

[5]Petit, M. 1997. « Stylistique(s) contrastive(s) du discours scientifique ». *ASp* 15-18, p. 141.

community does not necessarily have English as its mother tongue, we seek instead a simplification of the discourse. This is the first characteristic of scientific English since textbooks take this criterion into account:

According to Higham[6], the most fundamental principle of technical writing is to keep prose simple and straightforward. Much written English is unnecessarily complicated. When writing research, it is important not to alienate some of it with long or imprecise text. English may not be the mother tongue of many students; they will particularly appreciate the simplicity of the writing.

However, this English is not a vulgar Globish with scientific terms. If, sometimes, the quality of oral communications at conferences seems poor, especially in terms of pronunciation, written English that can be read in international journals is better.

The Morphosyntactic Constituents of Scientific English

Scientific English and Grammar

English, like any other natural language, has one grammar and one only. There is no particular grammar for a variety of specialty English. However, there are trends and uses that are more common than others.

The most characteristic grammatical cases of scientific discourse that are widely used, especially in research articles, can be classified into the following categories.

The Passive Voice is one of these major characteristics since the basic function of the passive is to erase the agent in favor of the relationship. This grammatical form is therefore well suited to describe an experience. The same is true for the analysis of the results, which is based on an objective reality. "we" offers four rhetorical functions of the passive as opposed to "we" plus an active verb:

(1) "we" indicates the author's choice of a single procedure, while the passive form indicates an established or standard procedure;
(2) "we" is used to describe the author's work and the passive form is used to describe the work of others, unless that work is not referred to as the author's work, in which case the active form is used;
(3) the passive is used to describe the author's proposed studies; and the use of the active or the passive is determined by focus due to the length of an element or the need for emphasis.
(4) the passive form is used to describe the studies proposed by the author
(5) the use of the active or passive form is determined by focusing due to the length of an element or the need for emphasis.

[6] Higham, N. J. 1993. *Handbook of Writing for the Mathematical Sciences*. Philadelphie: Siam (Society for Industrial and Applied Mathematics).

The Use of Modals

The expression of modality is frequent, especially when it comes to hypothesis statements and then during the analysis phase of the observed results. There is also the use of the expression of the possible, and it is necessary to underline here the difference between the theoretical possible expressed by "can" and the factual possible expressed by "may"[7].

"Time and Aspect" also Plays a Role in Scientific English.

Geology, for example, makes great use of the past (notions of anteriority), whereas the three traditional branches of mathematics: arithmetic, algebra or geometry make little use of the past. Mathematics, demonstrating a double originality, is probably the only discipline that uses the imperative in scientific English, at least in published articles, particularly in the formulation of geometry problems as in the expression "let the figure be a square".

Scientific English sometimes uses Ellipse

"The warm temperatures in the northern hemisphere during the previous interglacial reflected a maximum in the cycle of warming from the sun"[8]. Pergebois specifies that this use of substantive adjectives[9] in the singular is reserved for scientific contexts in more formal level of language.

This ellipse phenomenon also makes it possible to create a noun from a nominal adjective, preceded by a conversion. Pergebois gives the example of renewable energy sources becoming "renewable".[10]

She defines the process that has just been given as an example, as the process that allows to change the class of a word without changing its form. The conversion of a noun into a verb is the most common, but it is also possible to convert a verb into a noun, a noun into an adjective, a verb, and so on. Finally, for Pergebois, some articles sometimes create neologisms by using verbal compositions constructed from non-verbal elements, for example: « The UK is working to mainstream climate change risks and impacts [...] », or « The U.N. Development and environment agencies will advise on how to 'climate proof' poor nations [...] »[11].

The last point concerns the high frequency of comparison items, not only the usual ones such as: as much as, as many as, more than or less than, but also less common forms that are rarely used in traditional grammar such as: every other, every third one, one in three, one fifth as many as, half as much as or half as many as.

[7]Sionis, C. 2002. « Quelques spécificités de la modalisation dans le discours scientifique ». *ASp* 35-36, p.50.

[8]Pergebois, J. 2009. «Les procédés d'économie linguistique ». In GREENSTEIN, Rosalind (dir.), *Langue et culture: mariage de raison?* Paris: Publications de la Sorbonne, p.20.

[9]Substantive adjective is an adjective used alone in the absence of the noun that it modifies

[10]Pergebois, J. 2009. «Les procédés d'économie linguistique». In GREENSTEIN, Rosalind (dir.), Ibid.

[11]Pergebois, J. 2009. « Les procédés d'économie linguistique ». In GREENSTEIN, Rosalind (dir.), *op.cit.* p.36.

Scientific English and Terminology

As we have seen above, there is no clear boundary between specialized and general English at the syntactic level. This is also true for terminology. Instead of a boundary that clearly separates the terminology of a discipline within the lexicon of a language, there is rather a continuum. This view is relatively recent because, in the early days of large-scale research on specialized discourse, lexicological researchers established a difference between general and specialized vocabulary.

While each discipline uses its own terminology, terms can also be found in everyday language: the name "computer", although attested by the Oxford English Dictionary since 1646, and now one of the most widely used words in the English language, was known only to a small number of electronic engineers barely half a century ago.

Borrowed Words

Many words in English have been borrowed from Greek and Latin words that have an impact on the formation of the plural. Three different cases can be found[12]:

Table 1. The Plural of Origin is kept

Singular	**Plural**
Criterion	*criteria*
Phenomenon	*Phenomena*
Thesis	*theses*
Axix	*axes*
Analysis	*analyses*
Bacterium	*bacteria*
Nucleus	*nuclei*

Table 2. The Plural of Origin Coexists with a Form of Modern Plural

Singular	**Classical plural**	**Modern plural**
focus	*foci*	*focuses*
locus	*loci*	*locuses*
hyperbola	*hyperbolae*	*hyperbolas*
parabola	*parabola*	*parabolas*
fulcrum	*fulcra*	*fulcrums*
maximum	*maxima*	*maximums*
minimum	*minima*	*minimums*

- **particular cases:**

The word "Data" is considered to be singular as well as plural, whereas the Latin singular “datum” is not usual.

[12]Pergebois, J. 2009. « Les procédés d’économie linguistique ». In Greenstein, Rosalind (dir.), *op.cit.*

At the same time, there are some irregularities: "matrices" is the plural of "matrix" and "vertices" is the plural of "vertex".

It should also be mentioned that mathematics, mechanics, dynamics, physics, electronics are singular and not plural nouns.

Borrowed Words from General Language

Scientific English also borrows from general English, particularly to name or describe very complex phenomena or concepts that are expressed and represented in scientific discourse.

Astronomy is rich in examples in this field such as the "Big Bang", "black holes", "white dwarfs" and "red dwarfs". Although these examples are recent, astronomy has long provided a famous expression borrowed from the "Milky Way" (14th century) which shows that the metaphor is present in English of specialty.

Astronomers, who remember stories from their childhood, also gave the planet Virginis the nickname Goldilocks because of its temperature, neither too hot nor too cold, which allowed water to exist in a liquid state.

Apart from astronomy, computer science uses words such as "mouse", "chip", and "virus". One variety of virus is the "Trojan Horse" which is a Trojan War tale about the subterfuge the Greeks used to enter the city of Troy and win the war. There is also "worm", not forgetting the famous spam borrowed from a sketch by the British actors of the group Monty Python.

Examples of recent metaphorical neologisms can be found in the field of the environment: carbon footprint, environmentally-friendly, etc[13].

Some of these borrowed words can also be funny, such as "degeneration" and "frustrated", which are used to describe certain states presented by electrons

Truncated Words

There is a great use of truncated words in scientific English, on the one hand by double truncation, i.e. by apocope or apheresis, and on the other hand by mixing the resulting syllables.

The truncation of a single word, not followed by a mixture with the second element, can however give rise to a new word[14]:

- by apocope (zoo for zoological garden);
- by apheresis (bot, in computer science, which itself becomes compound-based, comes from robot);
- by double truncation (flu for influenza).

This phenomenon, usual in common language for the sake of economy, is found in scientific context: hydroelectricity, for example, is shortened to “hydro” in some articles.

[13]Pergebois, J. 2009. «Les procédés d’économie linguistique». In Greenstein, Rosalind (dir.), *op.cit*. p.22.

[14]Tournier, J. 1998. Les mots anglais du français. Paris, Éditions Belin. 139-141.

Nouns and Compound Adjectives

For the sake of brevity, scientific English makes extensive use of compounds:

In "human-induced climate change" and "industry-based environmental standards" there is an identical formation, "human-induced" qualifies "exchange" and "industry-based" qualifies "standard". In contrast, in "wastewater treatment plants", "wastewater" does not refer to "plants" but rather to "treatment".

The last example shows that, for abbreviations at least, English does not follow systematically an international standard.

As in general language, there are also differences between British English and American English in scientific English. Centre or center, programme or program, vapour or vapor, sulphur or sulfur are usual spelling differences, which are only superficial modifications.

As for compound adjectives, there are examples where the element on the left consists of an apocopated noun, such as eco-friendly, while eco- is obviously the apocope of ecology or ecologically.

As with the general language, there are also differences between British English and American English in scientific English. Centre or center, programme or program, vapour or vapor, sulphur or sulfur, sulfite or sulfur are usual spelling differences, which are only superficial modifications.

Other differences can be found between them in the pronunciation of certain words as in "anti", which the British pronounce [aenti] when the Americans say [aentai].

English Language Strategies in Teaching Science

Buxton[15] argues that the success of students' LEP (Limited English Proficiency) in science classrooms may be enhanced by explicitly addressing vocabulary and technical terms, carefully integrating language functions such as summarizing, rephrasing, classifying and evaluating, and making explicit the different structures and features of the language of science.

This section presents some effective strategies recommended by some linguists for teaching science in English.

Shaw[16] suggests that to help students read more, the science teacher could identify the language requirements (e.g., cause and effect, comparison/contrast and sequencing) and teach specific strategies to help students understand each type of discourse using simple worksheets and graphic organizers.

According to Crawford "Students learn new terminology and word meanings best when they encounter them during purposeful activities and

[15]Buxton, C. 1999. The emergence of a language of instruction for successful model-based elementary science learning: Lessons from a bilingual classroom. (ERIC Document Reproduction Service No.436 957).

[16]Shaw, J. 2002. Linguistically responsive science teaching. Electronic Magazine of Multicultural Education Vol. 4, No. 1.

investigations. Therefore, teachers will want to teach vocabulary as part of their core instruction, not as a separate activity" [17].

Henderson and Wellington[18] report that the Directed Activities Related to Texts (DARTS) program has been successful in helping students focus on important parts of the text and make them think about its content. The two main categories involved are as follows:

1. Reconstruction DARTS - These are essentially problem-solving activities that use modified texts. The text, table or diagram has missing parts (words, sentences or labels removed), or the text is divided into segments that must be reordered in the "correct" sequence according to a logical order or time sequence.
2. DARTS analysis - These analyses use unmodified text and are more akin to studies. It involves finding intruders in the text. The teacher decides which "categories of information" in the text to focus on. These are the intruders that students should look for and involve them in finding and categorizing the information in the text. The teacher can also ask students to construct diagrams or tables from the information given.

Conclsion

As in many countries around the world, most Moroccan students learn English as a foreign language based on their L1 through grammar-translation, so they are used to using a literal translation which, most of the time, misleads on the whole meaning. In this process, the meaning they get from a given text is derived from the Arabic (or French) translation of the text and not from the English itself. Thus, for many students, the process of reading scientific English is a great challenge; it is therefore an essential challenge because the course will probably be the only opportunity for them to develop their reading comprehension skills.

That is why, teachers of scientific students must emphasize on strategies aimed at building student' language skills in all scientific fields, while providing necessary supports and positive classroom settings.

[17]Crawford, J. 1995. Bilingual education: History, politics, theory and practice (3rd ed.). Los Angeles, CA: Bilingual Educational Services, Inc. p.16.

[18]Henderson, J., & Wellington, J. 1998. Lowering the language barrier in learning and teaching science. School Science Review, 79 (288), pp. 35 – 46.

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