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The vocabulary of English for scientific and technological occupational purposes

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Vocabulary acquisition is and has always been one of the core activities in foreign language learning – whether it is for general purposes or for professional ones - very simply because no communication is possible without words. However it seems that comparatively little research work has been published about the place of vocabulary in a professional environment. In a previous article entitled “Enseigner l’anglais pour la technologie” [11], I briefly discussed this issue, but here I would like to be more complete and specific .

The title above may seem rather unusual when one would rather have expected a paper about “the vocabulary of English for Science and Technology” but this article stresses that language needs– vocabulary needs , for that matter - in professional life are far wider than the vocabulary of English for science and technology (EST), strictly speaking, and cannot be restricted to the latter.

This article, however, will limit itself to the paradigm of vocabulary acquisition in classes of English (as a foreign language) for scientific and technological occupational purposes at intermediate (or low intermediate) level. (Henceforth, ESTOP)

1. Foreign language communication needs

A survey was conducted in Finland in 1998 by the National Board of Education. (Language/Communication Skills in Industry and Business) [9]. It studied the language/communication needs of industry and business employees and was aimed at determining how language teaching could best equip students with the skills required in professional life. Similar studies have been carried out in other European countries by the German Ministry of Education, Science Research and Technology, the University of Trier (Germany) and the British Department of Trade and Industry and the findings largely corroborate those of the Finnish government. (page 29)

The focus will be placed here on two groups of employees, a/ engineers and other high-level

designers, b/ people in lower positions (hereafter called technicians), from skilled operators to foremen and advanced-level technicians.

A - According to the Finnish survey, their foreign language communication situations in different occupations are as follows:

	Communication situations	Engineers (%)	Technicians (%)
1	Talking about oneself and one's work	70	48
2	Travel	80	71
3	Social situations (introduction, small talk)	90	80
4	Routine telephone calls	85	52
5	Client contacts	70	42
6	Hosting visitors visiting companies	77	40
7	Describing a process or working methods	70	57
8	Discussion on deliveries, installation, maintenance	68	60
9	Fault analysing, solving problems	67	60
10	Tutoring a new employee	39	22
11	Reading manuals, instructions	80	78
12	Reading Company documentation	61	24
13	Writing email messages, faxes, notes	72	28
14	Writing, documents	60	20
15	Giving a presentation	37	20
16	Meetings, negotiations	68	26

See notes 1 and 2

Here we can see that engineers are busy with client contacts (socialising, speaking on the phone, negotiating). In addition to having to describe and solve technical problems, they are also expected to write both formal and informal documents (email messages, faxes, notes, reports and memoranda).

Compared with engineers, employees in production jobs, installation and repair workers do not need to use foreign languages as much as the members of the other group. However it is clear that they have to read instructions, socialise and travel. They rarely get involved with writing formal papers, giving presentations or negotiating.

It also seems that the need for oral communication overrides written skills (reading and writing) in the first group, while the discrepancy in the second is smaller.

B - When we turn to the interviewees' educational background we notice there are few differences between university graduates' needs and others'.

"Employees with a polytechnic background need foreign languages in oral situations such as social talk, travel, routine telephone calls and client contacts. They communicate frequently in writing through email and faxes. They must read manuals and other company documentation. [...] Contacts often include visits and different kinds of meetings and negotiations."

(page 101)

"The situations with employees with a university background are similar to those with a polytechnic background. The differences are that university graduates need more of all kinds of situations. Especially, they need to talk more about themselves and their work, host visitors and socialize, describe processes and draw up documents." (page 103)

C - Among the conclusions of the study two items seem to be particularly relevant to this paper.

" 5 - The communication interest in the workplace lies in how well individuals demonstrate the competencies and skills necessary for the industrial/business community. All employees need workplace communication in foreign languages, irrespective of educational background." However " the extent and context of communication varies. Therefore language education should focus on the identified key elements of workplace communication [...]

9 - The contents and methods of vocational/occupational language teaching should be focused on the needs of work. The methods should concentrate more on oral skills and prepare students for integrated work tasks." (pages 12 and 13)

2. Definitions of EST

After analysing learners' need, we must now turn to "English for Science and Technology"

As Dudley-Evans & St John [2] and Anthony [1] put it, English for Specific Purposes (ESP) , and consequently EST – which is a branch of the former- is centred on the language appropriate to the activities of the discipline it serves in terms of grammar, lexis, register, study skills, discourse and genre. (This is one of Dudley-Evans' "Absolute Characteristics")

Another definition is Komarova & Lipgart's [7]: « By ESP we understand a variety of English characterised by the two most important features: 1) a definite conceptual orientation, 2) a set of linguistic restrictions imposed upon the contextual functioning of words. »

These definitions insist on teaching the particular language of one's specific occupational context as well as a number of academic skills such as writing papers. Although ESP does not *de facto* eliminate teaching informal language – which is not only the kind of chit chat around the coffee machine for instance- the latter tends to be removed from ESP/EST syllabi to the benefit of various strategies based on discourse analysis, genre analysis, etc. EST, as it may sometimes be taught, does not necessarily encompass the whole range of language requirements that an engineer or a technician may have in his professional life - as we have been shown above. Komarova & Lipgart simply state: " A student should be able to read literature pertaining to his subject, to discuss it with his colleagues, to give lectures and write his own articles in English. [...] these studies may indirectly develop one's ability to use English for communicating on any subject. But [...] this is only a by-product of teaching ESP"

I can now argue that ESTOP cannot be strictly limited to EST but must include elements from general English – not necessarily simply for small talk but also for professionally-oriented activities (like travelling), the need for which has been clearly established by the above survey.

3. Vocabulary taxonomy

The article will now analyse the taxonomy of vocabulary from several different points of view. They are as follows 1/ required abilities in professional life 2/ taxonomy of vocabulary relative to ESP/EST 3/ active and passive vocabulary 4/ other semantic fields 5/ a teacher's tentative classification

3.1. Required abilities in professional life

Gatehouse [5] identifies three abilities that are necessary for successful professional activities:

3.1.1. "ability to use informal language to communicate effectively, regardless of

occupational context".

Items #1, 2, 3 and 4 of the above Finnish study refer to this ability, the proficiency of which is required by the vast majority of both engineers and technicians.

3.1.2. "ability to use the particular jargon characteristic of that specific occupational context". This is clearly the domain of ESP (EST in the case of this article). (Refer to items # 7 to 9 and 11 to 13)

3.1.3. "ability to use a more generalized set of academic skills, such as conducting research and responding to memoranda ". (Items #14 to 16 in the above table.)

The last point refers to a language proficiency that is only partly related to L2 learning, strictly speaking and that is rather a question of university vs. occupational education.

Moreover, one must not forget that ESP/EST is not limited to engineers and executives, who will have to conduct research or write abstracts , but also concerns people such as technicians or even machine operators and other low level personnel who are very seldom expected to engage in elaborate formal writing.

Finally, one will certainly realise that vocabulary teaching and learning play little part in such academic skills that require an advanced mastery of the language. Besides, in most cases, (low) intermediate students are not (or not yet) proficient enough in English to be able to focus solely on problems of methodology, on organising and structuring documents using the rhetorical patterns and formats usual in scientific and technological written texts. On the contrary intermediate students require more basic language training. When dealing with them, as teachers of English (as a foreign language) for science and technology, we are concerned by the first two abilities almost exclusively. We must improve the students' general level in English while teaching them more specialised communication skills. However, barring rare and special situations, academic skills are likely to be out of our range.

3.2 Taxonomy of vocabulary relative to ESP/EST

Robinson [9] in 1991 divided the vocabulary of ESP into three categories depending on their semantic ambiguity

3.2.1. First the ultra specialised vocabulary belonging to each scientific or technical field or sub-field. The words – one could almost say the jargon – to be found there are never used to communicate – except within the closed circle of specialists in that field.

Moreover these words refer to elaborated concepts and therefore have no semantic ambiguity, i.e. every word has but a unique and precise meaning in the scientific or technological domain that is being considered. The meaning corresponds to a concept, a notion which is referred to by a term.

One teacher's issue is to know whether or not this vocabulary has to be taught. This will be discussed below. (See 3.5.2.)

3.2.2. The second layer consists of general scientific and technological words , the kind of vocabulary referring to situations, actions, problems, etc. common to every field (or most fields) from research to technology. One should not overlook that the vocabulary pertaining to this second category is not necessarily a simple and basic scientific and technological one, but may also be extremely complex. Granted, part of this vocabulary may be basic - for instance to refer to simple hand-held tools or to users' instructions- but may also be more elaborate: in industry there are plenty of transverse activities which are common to several industrial domains, fields and

situations and which require language (and vocabulary) proficiency that is far from basic.

Here are a few of these cross-speciality themes:

total quality management, total quality control; total productive maintenance; design to cost, life cycle cost; concurrent engineering ; project management; productivity improvements; modelling; how enterprises adjust to environmental issues; expert systems; multi-technology systems etc.

Robinson notices that the semantic ambiguity of this category of vocabulary may be slightly higher than that of ultra-specialised words, yet, it remains very low.

Examples are provided below:

The vocabulary of quality: (reliable, low-cost, affordable, failure, improve, etc.); that of users' manuals: (check, fasten, perform, avoid, supply, fit, insert etc.) or that of basic computing (hardware - software – word processor - spreadsheet - hacker - byte - data – digit).

3.2.3. Robinson differentiated a third category, on the fringe of general English. This is words which exist and are used in general, even familiar English, which are found in any kind of communication but whose frequency of use is greater in or even characteristic of EST.

The boundary between this class of words and the former is impossible to draw: as soon as an invention or a new device leaves the closed circle of scientists and technicians, gains popularity and is used in everyday life, the corresponding word passes from the category of general scientific and technological words to that of general English. For instance, which domain do these words belong to: 'computer', ' walkman', ' thermometer'? However, in such cases, categorising these words as 'scientific' or 'general' is immaterial since, whatever their category, they are equally necessary for scientific and technical communication.

In terms of ambiguity and meaning, these words may have high ambiguity, which may make them difficult to understand, since the exact meaning is not always immediately perceivable even to the L2 learner who 'knows' the word. Even such a usual verb as 'clean' can be a problem: a mechanics will clean a carburettor, an electrician can clean a wire, while a farmer cleans a field or a ditch!

Examples are provided below:

Verbs: account for, avoid, , display, enable, store.

Nouns: bolt, device, indicator, manufacturer, thickness, training.

Adjectives: harmful, low-cost, loose, suitable.

Note 3 gives the URLs of Websites that may be useful for listing the vocabulary defined in sections 3.2.2. and 3.2.3.

3.2.4. This classification leaves out the largest part of general English vocabulary whose frequency of use in scientific or technological communication is considered as ranging from rare to nil. As a matter of fact, scientific and technological language is concerned with providing accurate information and facts, so that expression of personal reactions or emotions, ethical or stylistic appeals are reduced or even discarded . This means that 80% or 90% of general English vocabulary falls outside the range of EST, and therefore one may discuss whether it should be taught at all in an EST course. Nevertheless, one must not forget that among the immensity of general English vocabulary there is a large number of words that are so usual, common and found in any context, in any communication activity – whether specialised or not - that it is impossible to

ignore them, and are as essential as the next category described hereafter. If we now turn to their semantic ambiguity, we notice that it is maximum, as, unfortunately, any L2 learner has already noticed!

3.2.5. The last class of vocabulary is that of articles, auxiliary verbs, preposition, particles, linking words, etc. These words half way between lexis and grammar are the backbone of the language and without which no complex meaningful sentence can ever be built. They, naturally, do not belong to the language of ESP, as such, but are essential nonetheless.

3.2.6. One should not forget that a word may have very different semantic fields and belong to several categories at the same time. Take this usual noun: 'a plate'. It belongs to general English when you think about kitchenware or about your car's licence plates. But it is specialised vocabulary when used in the printing, electrical or building industry, not to mention railway lines. Thus, the same word may be classified into different categories, depending on its meanings and uses.

3.3 Active and passive vocabulary

Vocabulary may be classified according to other criteria. For instance, it can be divided into active and passive. Active vocabulary is the one that the speaker or writer is able to use, while passive vocabulary is the one he can simply recognise and understand without mastering it enough to use it. Each of these two categories can be further subdivided into oral and written skills. However, depending on the context, the scientific and technical domain one is dealing with , a word can be classified in a section or in another, all the more so if it possesses different meanings..

These four categories have no special correlation with general English or ESP/EST, they are, however, another taxonomy that a teacher may have in mind when planning his course.

3.4. Other semantic fields and classes.

After considering macro-classifications, it is possible to turn to more limited semantic fields, two of which are particularly relevant to vocabulary acquisition. They are as follows:

3.4.1. synonyms: these words have the same meaning (or very similar meanings) as others, e.g. remotely-operated vehicle, ROV; computing, data processing; carry out, perform, execute, etc.

But true synonyms hardly ever exist, even in a language like English which features a lot of pairs of words, due to its Germanic and French origins. True synonyms exist all the less in EST as it tends towards maximum clarity and accuracy. It is the teacher's task to show his students the different uses of so-called synonyms.

3.4.2. Concept fields and vocabulary networks:

Teachers may find another useful classification which more or less loosely associates words around a key one: for instance drawing a list of words that have a relationship with the concept of safety , of environment , of production or of machine tools, etc.

This may prove useful for students to revise or re-activate the vocabulary of a specific field.

(See note 4 for examples of vocabulary networks)

3.5. A teacher's tentative classification

3.5.1. After the various ways to classify vocabulary that have been quickly examined above, I

would now like to draw from Beaurain [3] and suggest another path, which is not taxonomy as such, but a series of questions a teacher should have in mind and ask himself when he develops materials and determines the vocabulary he will teach.

a - How often do we find this word a/ within a specific context b/ within a general context? Is it rare (or very rare)? It is relatively common? Is it a frequently-used word?

b - What the is the range of this word? Is it mono-semantic or poly-semantic? Do I choose to teach all the meanings or only those related to today's lesson?

c - Is the word to be taught in isolation or in a phrase ? Is it part of a usual collocation?

d – How useful is the word? Is it superfluous, accessory, useful, indispensable?

e – What is the use/effort for learning ratio? How transferable is the new word?

3.5.2. These questions require a number of comments:

- First of all, it is clear they are not specific to teachers of EST, but can be a guide to any teacher of English as a foreign language.
- Instead of categorising words into theoretical and formal classes, the questions offer practical guidelines for a teacher to take his decision.
- They do not exactly correspond with the categories that have been discussed above.
- Finally, several questions pose the problem of transferability: is a given word relevant to a range of scientific or technical domains or is it useful only in a unique specialised discipline? This concept underlies Robinson's categories (see supra, 3.2.1. to 3.2.3.) and prompts me to address the issue of teaching or not specialised scientific or technical vocabulary.

If we bear in mind this paper's limited scope – i.e. (low) intermediate students - it seems obvious that, before tackling specialised vocabulary, students still have more urgent and pregnant one to learn, the vocabulary belonging to general scientific and technical English (see 3.2.2.) or those general English words that are often found in EST (see 3.2.3.). Moreover, one could argue that there exist specialised dictionaries to which a student can refer , should he or she happen to come across such terms, which is very unlikely at intermediate level. Finally, what seems more important to teach than specialised lexis are strategies for understanding new words, such as the use of context or word composition.

4. Content language acquisition and general language acquisition

One must finally address the problem of content-based language acquisition and general language acquisition.

4.1. Need of basic language proficiency

The very existence of the vocabulary characterised above at the end of part 3.2.4. and in part 3.2.5 entails basic language proficiency prior to the study of EST— or at least it involves that, together with learning EST proper, a student should also be trained into handling skills, abilities and proficiency that clearly belong to the domain of general English (henceforth, EGP). Although it is theoretically feasible to teach (for instance) very basic general vocabulary, how to conjugate a verb or how possessive cases work while remaining within the context of EST, it seems far easier and probably more sensible to do it within the context of EGP. Indeed, this avoids piling together two different sets of difficulty, basic English syntax and lexis and more specialised knowledge pertaining to EST.

4.2. Analysis of a course book

Consider this course book, Basic Technical English" [4]. As an EST book, it is very carefully planned and it efficiently focuses on the basic language forms and functions of EST

In the introduction the authors clearly aim at "people requiring English for use in technical areas who have no previous knowledge of the language." It is true that the authors introduce very basic notions in lesson one (be ; have; a/an) , but as early as Unit 7, a student is supposed to understand such fairly complex language as " There are two main assemblies at the front of the milling machine above. The upper assembly is called the overarm assembly and the lower one is known as the knee assembly. The latter has three main parts [...]" . Unit 11 requires using passive verbs and students are asked to produce such sentences as "The flanges are welded onto the pipes. Then they are bolted together."

The grammatical, lexical and functional features quickly become so complex that it can be doubted whether an absolute beginner could keep up with the progression.

Moreover, even if such a book did actually cater for beginners, it does not cover the whole field of ESTOP as it ignores all the vocabulary and grammar that are necessary for any communication – technical or not – such as making questions, talking about the past or the future or even the very basic 'yes' , ' no', ' hello' and 'goodbye'.

Take a more elaborate example: the Finnish survey above has established that non-native English speaking technology professionals are likely to have to engage in technical correspondence involving "technical visits abroad, technical visits from abroad, technical training, and requesting information" (Knoy [6]). Theses required abilities are not in the least addressed in the course book that is being examined.

This article's purpose is not to criticise the book , which is indeed a very useful EST book, but simply to wonder whether it is practical, possible or realistic to consider teaching EST without any prior basic language proficiency.

This must be certainly the reason why Dudley-Evans, [2] (page 4-5) noted as a characteristic of ESP that it is generally designed for intermediate or advanced students and assumes some basic knowledge of the language system.

4.3. The necessary part of EGP

Besides, while trying to classify ESTOP vocabulary, we have several times stumbled across the part played by EGP and have noticed that its mastery is required at two stages:

4.3.1. basic proficiency, i.e. a prerequisite minimum ability, a kind of foundation stone without which no further construction can ever be erected.. Even within the setting of EST, teaching basic general English cannot be disregarded if placement tests or other tests reveal gaps and blanks, which have to be filled before proceeding to higher level English.

4.3.2. informal communication, regardless of occupation.

Once basic proficiency is attained, it does not mean that the acquisition of general English is completed. Engineers and technicians often engage in activities (talking about themselves and their work; travelling, socialising) that require use of informal language. However this does not necessarily mean basic language. Think about having a conversation with a native speaker of English: it probably requires far more advanced training, abilities and skills than reading technical manuals or instructions.

Unless the students already possess these skills and abilities , which they do not at the (low) intermediate level that this paper considers, no EST teacher can avoid teaching general English in addition to more specific language. The general focus is clearly to improve the communicational language ability - both written and oral- in content-based domains as well as in general English. . As I tried to demonstrate in "When EST is not the same as EST" [12], we should not forget that we may be teaching EST, but that we are first and foremost teachers of a foreign language to non native speakers. This means helping a student learn general English is part of our task.

4.3.3. It is therefore essential to keep a fair balance between EGP and EST in order to harmonise what could be a Janus-like teaching and it is true that tensions may arise between conflicting needs.

However, one should not fall into extremes and give EGP a larger part than it ought to have. A certain mastery of EGP is necessary so as to provide a basic language proficiency, building from which a student can improve his skills both in general and specific English. But semantic and syntactic choices have to be made among the immensity of EGP

I think a teacher can ignore the functions and vocabulary required to express (for instance) indignation, relief or for comforting someone. We need not teach the vocabulary of literary appreciation either. In a word, the semantic and syntactic resources required for the expression of emotional, ethical or artistic attitudes and the like remain outside our range.

On the other hand, a teacher of ESTOP is likely to insist as much as possible upon how to talk about working life, travelling or economics without forgetting to browse through the vocabulary of media or everything connected with the consumer society, etc.

It is a teacher's job to help students acquire the abilities that he or she is likely to need in professional life. But a teacher also ought to remember that a student does not acquire and master the vocabulary but his (or her) vocabulary, depending on personality and needs.

Conclusion

In this paper, I have tried to analyse the requirements in foreign language communication of high and low level technical employees and I have noticed that EST did not fully meet those needs.

Examining the taxonomy of vocabulary, the paper has identified several lexical classes that make it possible to determine a fairly precise boundary between the vocabulary of EST and that of ESTOP.

The paper has finally addressed the place that has to be devoted to EGP by a teacher of foreign language acting as an EST instructor.

Tension between content-based learning and more general language can be alleviated when considering that both , within their limits, are equally necessary for technology professionals.

Notes

(1) The percentages indicated are not those against the total number of interviewees but against the number of interviewees who declared using a foreign language.

(2) It should be noted that this survey deals with the various foreign languages used in Finland so that the percentages might be slightly different if they had been limited to English.

(3) Two Websites can be recommended that list

a/ the most essential vocabulary of engineering (http://jcviel.multimania.com/vocab.htm)
b/ the language functions that are used in Anglo-Saxon science classes (http://www.mpcmcgrath.flyer.co.uk/taxomnew.htm)

(4) Examples of vocabulary networks can be found at htpp://jcviel.multimania.com/contents2/toolbox.htm

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