Developing Creativity and Problem Solving Skills by English Grammar and Vocabulary Activities in Engineering

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Abstract: - This approach deals with developing logical/creative/critical thinking and problem-solving skills by means of clearly explaining grammar rules and by providing patterns and examples for organising effective dialogues or presentations in the foreign language, leading students towards free, meaningful communication. Enriching engineering students’ English vocabulary firstly focuses on the specialist lexis and its relationship with the general vocabulary, secondly on features of syntax and rhetoric in scientific texts, and thirdly on lexical competence improvement within academic contexts.

Key-Words: critical thinking, research skills, foreign language teaching, linguistic characteristics, specific lexis

1 Introduction

English has become the main language in international communication, especially in the fields of science and technology. Therefore, in recent years, many English courses for non-native speakers have appeared on the market, targeting both students and professionals already involved in business or research. This initiative was triggered by regional cooperation strategies, globalization, technological progress demanded by third world countries, environment protection policies, and, last but not least, collective research efforts in multinationals, demanding fast and effective data exchange.

In this context, and contrary to the labour markets’ expectations, traditional secondary school seems to have cultivated memorization, minimising practice for other thinking approaches. Students in universities are capable of memorizing anything, and will do so, given half a chance, and the process of logical reasoning often seems far from their range of experience. As a result, all teachers of English for Science and Technology have become increasingly concerned, because they must provide the language training for engineers and scientists who need skills in problem solving, deductive and critical thinking far beyond mere learning and memorization. Many attempts have been made to improve the situation, mainly by using student-centred approaches. The response was unenthusiastic at the beginning, (partly because learners were expected to progress too much and too fast as compared to the traditional, rigid type of thinking they had been accustomed to, and felt secure with), but it has changed over time.

2 Problem formulation according to educational objectives

In his Taxonomy of Educational Objectives, Bloom defines a sequence of thinking categories encompassing all intellectual educational objectives: knowledge, comprehension, application, analysis, synthesis and evaluation. In Classroom Questions, Norris Sanders renames the category of knowledge as memory and subdivides comprehension into translation and interpretation, with the definitions:

- memory: recalling or recognising information
- translation: changing information into a different symbolic form or language
- interpretation: discovering relationships among facts, generalizations, definitions, values and skills
- application: solving a lifelike problem requiring the identification of the issue and the selection and use of appropriate generalizations and skills
- analysis: solving a problem being aware of the parts and forms of thinking
- synthesis: solving a problem that requires original, creative thinking
- evaluation: judging according to standards designated by the students.

All these categories are sequential and cumulative, and it is seldom profitable to confront students with an advanced exercise in synthesis or evaluation until they have had some practice in the intermediate phases. Failure to proceed step by step may lead to difficulties, lack of confidence and a quick return to the initial and comfortable habit of mere memorization.
2.1 Integrating grammar teaching and group work technique

In this way professors hope to increase both self-confidence and self-expression as opposed to passive behaviour and mimicry of acquired models. What educators should do is persevere in asking for creative combinations of the existing structures, obeying the formal/informal standards of speech, just as they appear in every day spoken language.

Almost any idea can be taught in several ways, featuring several levels of thinking. A teacher who is aware of all possibilities can choose the most appropriate ones according to his didactic purposes, his students’ ability and motivation, the available time, and, last but not least, the cognitive objectives.

A foreign language teacher should formulate questions that encourage conversations and debates, questions that require students to use ideas instead of simply remembering them. Such an approach will stimulate the intellectual debate and the thinking skills learners need in their future career.

Acquisition and enforcement of grammar rules and correct patterns are favoured by the group technique. Here are some arguments:

- more learning takes place in an environment that encourages student-student interaction alongside with teacher-learner communication
- students unwilling to participate in conventional class settings are more active in groups/with peers.
- explanations/corrections/suggestions are accepted from peers more readily than from the teacher
- students become responsible for their learning.

There are significant reasons in favour of integrating grammar teaching and group work in engineering education (upper intermediate/advanced students). Firstly, the syllabus includes numerous aspects: reading, vocabulary, grammar, composition and study skills. Secondly, time is limited to one seminar per week, with an academic semester of twelve weeks, on average. Thirdly, priority is given to writing and to formal presentations, since the learners’ spoken language and oral communication are usually adequate, and their written errors seem more obvious than their imperfections in speaking. Moreover, written errors are easier for the students to monitor and correct than the mistakes in actual speech. In essence, group work achieves three goals:

- it generates a facilitating, productive and creative social climate with opportunities for all types of educational interaction
- it corrects some persistent grammar errors
- it gives the students the tools they need to continue improving their English after they have completed the course.

2.2 Sample activity outline

Here follows a sample procedure of group work activity focused on developing thinking and creativity through grammar lessons.

1. Identify a common problem, a mistake frequently made by the members of the group (word order, the sequence of tenses, the passive, the use of articles or genitives, irregular verbs or noun plurals).
2. Conduct a conventional review (it may be a brief lecture or a reading assignment – for instance the study of one or several chapters in a text book).
3. Distribute take-home exercises, adapted or taken from existing texts (contextualization is important).
4. Prepares the class for group work, going over ten sample items with the whole class, thus giving the students some idea of how to correct and how to interact during the group exercise.
5. Actual group work (4/5 students per group)
   - learners compare their responses and discuss items if they are in disagreement. Then they record the group’s consensus
   - they give the teacher the consensus answers on a clean exercise sheet that was handed to the spokesman in each group.
6. The teacher corrects group responses, giving feedback to the entire class, clarifying residual problems and providing oral drills to practise correct forms.
7. Follow-up written exercises dealing with residual problems (e.g. a well known text incorporating those errors, which has to be corrected as homework).
8. Group work again.
9. Teacher correction with more grammar drills on few significant points, if necessary.
10. Students write their own composition focusing on accuracy. They are given time to recheck for errors and the teacher pays special attention to that specific grammar problem in grading compositions.

To ensure effectiveness of such procedures, students must complete their written exercises before coming to class. The teacher should quickly check for completion of work and penalize those who have come unprepared, before organising the group work. The groups are set up in advance, and each group should have an assigned leader and recorder/spokesman; the assignment changes each time, so that all learners do these jobs. Furthermore, it is best if group members rotate from one session to another, so that students have optimum exposure to each other in small, cordial groups. By judiciously assigning membership in the groups, the teacher can keep certain students apart from each other if this should be desirable.
2.3 Advantages of group work in developing critical thinking and problem solving skills

The teacher must be careful to pace group work so that it might not drag. A reasonable amount of time for completion of group tasks should be set before work starts. The teacher should move around the class to see how various groups are progressing and should urge them to speed up if they are too slow. Thus the teacher keeps any student alert and ensures a definite time and a certain rhythm for the creative exercises that follow. Learners enjoy such an interactive approach to learning grammar and the teacher corrects 4/5 exercises instead of 25. The most convincing argument, nevertheless, is that most students demonstrate marked improvement in later compositions and exams.

However, there are some disadvantages that should be mentioned. It requires a lot of preparation and the teacher has to work in a much more organized manner. In addition to this, each class has some students who do not like group work and will not fit into a collaborative atmosphere (loners or people reluctant to learn from peers because of social, cultural or temperamental reasons). Last but not least, group work may hide and protect slow learners, who do not make much progress despite all the work they do. However, there is no evidence that such students would do better in the conventional classroom setting. If overused, group work may cause students to get annoyed or bored, and then all advantages associated with this activity vanish. This technique is only one among others, which are just as useful: the interaction of the teacher with the whole class, independent student work, one or more students in charge of the whole class, pair work etc.

2.4 Cultivating creativity in grammar acquisition

At first sight, grammar teaching seemed to exclude creativity and focus only on rules and drills. Fortunately, this is an approach of the past, and nowadays education in engineering concentrates on synonyms, rephrasing and cloze exercises, creative self-expression and learning, trying to explore all varieties of English, and attempting at identifying the linguistic trend. Students creatively implement the patterns they learn about. Memorization of rules, drill exercises and tons of practice for developing language habits are forgotten much sooner than a composition or a presentation in which students express themselves by means of the communication patterns previously acquired. Thus grammar lessons become an adequate context for developing thinking and creativity, balancing memorization.

2.5 Enriching the vocabulary for specialized fields in engineering

Science textbooks and science texts are complicated documents for native-speakers and the student learning the same amount of data in a second language perceives it all even more so. Complexity and difficulty come from three closely connected variables: linguistic, rhetorical and conceptual.

Each section of science and every technical area are characterized by a particular and specific store of words they use regularly. Many of them have been purposefully coined by practitioners in the subjects. In recent years, work has been done in quantifying scientific texts vocabulary. A computer-aided frequency count produced an estimation of 114,000 words. The text samples were randomly selected from physics, mathematics and engineering. A statistical analysis showed that about 21% of the words were specialist, about 70% were sub-technical and the remaining 9% were functional words. Critics of the usefulness of word counts have pointed out that words occur in a syntactic context and that their frequency of occurrence is no true guide to the difficulties encountered by a student attempting to read and understand scientific texts. Clearly, therefore, it is also important to consider the syntax used in scientific texts. Occasionally, words from the specialist vocabulary are found in newspapers or in other non-specialist publications; usually, though, their place is between the covers of a science book or in a research paper. In many cases, only the teachers, practitioners or students of a subject will be familiar with such lexical units, and it may lead to the mistaken belief that acquisition of such vocabulary is the key to successful reading and communication, but there is far more involved in EST than learning words.

Apart from these technical terms there is a body of sub-technical lexis that can be described as context-independent, occurring with high frequency across disciplines. These sub-technical words are not as exclusive in use or application as the specialist vocabulary, and can be found in more general contexts. In addition to the technical and sub-technical words, there is also what might be called the general lexis of formal written English.

Although there is a scientific lexis, there is no scientific syntax. The syntax used in scientific texts is exactly the same syntax as that used in other contexts. Many writers, however, have described the special linguistic features of scientific texts, which are not exclusive to such texts, yet are widely used in them – a situation similar to the one of the sub-technical vocabulary.
3 Problem Solution

After explaining the categories of vocabulary in scientific texts, this section discusses features of syntax present in scientific approaches, rhetorical components in such discourses, means of enriching students’ vocabulary (teacher input, reading/practice from textbooks/dictionaries) and setting for learning.

3.1 Linguistic characteristics of scientific texts
A list of such features would include the following:
- passive voice → used to depersonalize texts and to direct the focus of attention towards facts, not people
- present simple → used to state rules and general truths, and to describe processes
- past tense and present perfect → used to refer to previous research, implying its relevance to present activities by an appropriate choice between tenses
- modal verbs → used to make predictions
- complex subjects and simple verbs forms (unlike conversational or literary English)
- Latin and Greek affixes (many scientific words are taken or derived from these languages)
- definite use of pronouns, articles, modifiers
- clear relativization
- specific intention, topic and conclusion sentences
- wide use of comparative and temporal structures

3.2 Discourse and rhetorical components
Apart from specific lexis and particular features of syntax, scientific texts also contain a rhetorical component worth taking into account. Unlike novels, for instance, which exclusively employ continuous texts, science (text)books also contain captions, diagrams, tables, photographs, and mathematical formulae. The writer of a science book presents subject knowledge in wide, shared contexts, which involve making assumptions about the reader. These assumptions affect the way of presenting data and the language employed. A study of the rhetoric of scientific texts must be concerned with language organization, presentation techniques and both readers’ and authors’ expectations or purposes. A brief list of characteristic features would include:
- careful and systematic observation
- minute recording and collection of data
- systematic procedures for evaluating information
- production of explanations, hypotheses, laws and theories to account for phenomena
- predictions based on hypotheses, theories and laws
- classification of data, knowledge, hypotheses, laws and theories, creating a logically coherent system
- production of hierarchies of knowledge leading to general laws of nature
- clear concern with precise descriptions, accurate measurements and standard units of quantification
- use of lab controlled conditions to eliminate variables and determine causal connections thereby
- use of mathematics to describe, quantify, analyze and predict phenomena
- rational approach seeking to discover, describe, measure and explain the world in natural terms.

Therefore the rhetoric of scientific texts is characterized by precise and accurate descriptions, by formal definitions, by emphasis on careful control of meaning, by minutely describing and defining things within an interlocking system, by constant reference to data and, last but not least, by creation of logically coherent approaches whose pattern can be extrapolated to further demonstrations.

Experience has shown that in such contexts students face increasing difficulties mainly in distinguishing between the conceptual paragraph and the physical paragraph as bearers of meaning. There are instances in which students have failed to understand a text (even when familiar with the language used) because of not being able to recognize the rhetorical features in that text – for example the inability of following ideas and logical deductions which took more than one paragraph. In their turn, maps, diagrams, graphs, tables, formulae, photographs, captions, charts and drawings are widely used features of scientific texts. Each of these devices is used to convey information to the reader, and may be a potential obstacle in understanding the subject area. In addition to these ways of presenting information, there is also the physical organization of the material in chapters or sections, the use of footnotes and references, the use of an index or a table of contents. Hence, the rhetoric of scientific texts is more involved in conveying the meaning than the rhetoric of an ordinary text.

3.3 Reading competence for research skills, in view of future career and adult education

Enriching students’ vocabulary is not an end in itself. It aims at achieving reading competence as an instrument for facilitating further professional development. An important linguistic assumption made by writers of scientific texts concerns this supposed reading competence of the audience. English language science (text)books, research papers and technical publications assume, in general, a high level of reading competence. As well as this, they assume a satisfactory knowledge of English syntax and proficiency in the general vocabulary and the sub-technical lexis. Only for a specific readership – the students – there could be an attempt to simplify the discourse during certain learning stages.
Vocabulary is mainly enriched by means of reading. Listening, speaking and writing may be additional opportunities for improving the use of an already acquired lexis, but they play a reduced part in actually learning new words. To the difficulties in reading and in enriching vocabulary enumerated so far, yet another one has to be added: the language of science is informative rather than emotional, therefore it is not appealing in itself. In very few cases (classics of modern scientific writing) the writer’s personality and vision are an integral and attractive part of the text. In most cases, the factual style of scientific writing is a result of a conscious choice on the part of the writer and it is the result of a rhetorical decision to depersonalize knowledge.

Learning to use any aspect of a foreign language is a lengthy and often difficult process, and learners are bound to make mistakes in using a system they have not completely mastered. But, in this particular area of vocabulary, there seem to be additional difficulties, arising both from the structure of the language itself (any language for that matter) and from incomplete understanding. With adult students, teachers’ efforts focus on emphasizing the restrictions on words that can occur together (whether these apply to whole semantic classes or to lists of individual words) on the one hand, and, on the other hand, on rules for the grammatical marking of various noun phrases that occur with certain verbs or adjectives. All languages have constraints and rules that determine which words can go together in sentences. Some are similar across languages, many others are not, and there are instances in which it is impossible for second language learners to predict how certain grammatical or lexical relations will function, on the basis of general principles or on the basis of their experience with their native language. It so happens that they often cannot tell whether a given noun will become the subject, object, or indirect object, and they do not know if it will be marked by a preposition or inflection. This causes many learners to wonder about what they can do with a word as soon as they have learnt it.

Writing competence for independent learning

Eight areas should be taken into account in describing the characteristics of effective writing:
1. Student edited to correct misspellings and other mechanical errors (capitals, apostrophes, mechanics of documentation, punctuation of quotations)
2. Student followed standard conventions of grammar/usage (grammatical rules, punctuation, possessives, tenses, modifiers, correct word choice)
3. Student omitted needless words and demonstrated concise expression, correct use of idioms, adequately constructed sentences, appropriate use of quotations
4. Student developed coherent paragraphs
5. Student used evidence effectively (sufficient and relevant, clear identification and attribution of sources, analyzed evidence, logically related arguments and claims, multiple points of view)
6. Student clearly communicated the purpose, design, and major points of the paper
7. Student developed an interesting theme/argument
8. Student demonstrated complexity of intellectual approach (critical thinking, insight, originality)

3.5 Help from professors
The mere acquisition of new words and their possible meanings is not enough: the student must also learn how to use them appropriately. Logical sources to help with this knowledge are the teachers themselves, the textbooks in use, and reference materials such as dictionaries and grammar books. The most powerful and adaptable influence on what learners acquire is provided by teachers – they recognize exactly students’ problems and give useful explanations followed by adequate practice. However, many professors, especially the ones teaching their native language, are not fully aware of restrictions on word usage, which is largely unconscious, and they fail to explain a large set of arbitrary but highly specific language constraints.

3.6 Help from textbooks
Any textbook includes a limited amount of material and it would be impractical to expect complete coverage of patterns of usage for all common words. Some of them are presented as idioms, some are labeled as useful expressions and the bulk are found in dialogues, reading passages or other materials. Therefore, foreign language text books convey information on patterns of usage, but it seldom is what students expect or need, as most lexically determined syntactic behavior is left for the individual student to pick up on his own. The learner simply has to build up a feeling of language derived from the examples he is exposed to.

3.7 Help from dictionaries
When faced with specific problems, dictionaries are probably the first place most learners turn to for help. Unfortunately, however, the type and amount of data do not meet language learners’ needs. In English for engineering it is not enough to give information such as: co-occurrence with a direct object, common combinations with other
words or extended idiomatic meanings, clichés and proverbs. Dictionaries present syntactic information in two forms: examples and translations. Practice has proved that it is hard for students to apply and learn from examples if they lack language experience or knowledge that would enable them to guess the type of generalization those examples represent.

### 3.8 Help from translations

Translations are no better. The unaware learner is often led into the trap of assuming that if the meaning of a foreign word is similar to that of a word in his own language, its syntactic properties are probably similar, too. The reduced number of sample sentences in dictionaries may make the entries misleading in that they abandon the student to draw his own conclusions regarding the general principles of vocabulary usage and regarding the way rules apply in specific cases: they may have the vague impression that the examples illustrating the syntactic behavior of a word are just optional constructions and that, perhaps, other ways innovated by them and tailored according to the native tongue are alright, as well. Even if examples are good in dictionaries, there should be some control mechanisms ready to prevent or even correct inaccurate generalizations and predictable misinterpretations.

### 3.9 The setting for learning

Setting may help or hinder learners. Many engineering students complain about the insufficient real / realistic lexical practice that takes place in the university, about the lack of training in particular social and communication skills, and about the obvious barrier existing between the (old-fashioned) classroom and the (modern) outside world. On the other hand, students themselves have preferences dictated by their culture, temperament, age or education: they may feel more at home with one setting than with another, which will be visible in their language use, accordingly. But learners of nearly all cultures, irrespective of age, have some classroom stereotypes deeply rooted in their minds: a passive attitude (they come only to listen and have their knowledge organized by somebody else) and high expectations (the teacher knows all the answers and censors all student productions). Therefore, in the classroom, everything is anticipated and safe – unlike outside this protective environment, where interlocutors may seem to be hunting for mistakes (another damaging prejudice). In order to avoid stereotypes and prejudices and in order to be effective, professors should make language teaching as realistic as possible Realistic practice is provided through role-plays in imaginary situations, photos and other visual aids, information transfer and information gap conversations, group and pair work, video, and authentic tapes. It all is very necessary, but the point is that it is not actual and real life communication, so it should be alternated with real practice (if and as much as possible), in order to avoid the negative impact of overprotective aids and distorted motivations, which focus on form and not on communication.

### 4 Conclusion

Integrating group work with the teaching of grammar is an effective modality of developing thinking within foreign language grammar lessons in engineering. This technique helps to establish a good classroom climate and stimulates communication centred on problem solving role-plays. It can also be used as a pre-writing activity, or for peer correction. Enriching students’ vocabulary is a constant concern for teachers and learners alike, as it facilitates professional development. It is difficult to achieve, being in permanent connection with syntax patterns and rhetoric features. Enriching vocabulary is not a matter of memorization, but a matter of flexible, adaptative and creative intelligence, involving perseverance and responsibility in self-improvement.

### References: