

Integrating Linguistics into STEM Education

Emily J. Thompson, Liam M. Reed

Brown University, Providence, USA

Abstract—Teaching English to Engineers is part of English for Specific Purposes, a domain which is under the attention of English students especially under the current conditions of finding jobs and establishing partnerships outside Romania. The paper will analyse the existing textbooks together with the teaching strategies they adopt. Teaching English to Engineering students can intersect with domains such as psychology and cultural studies in order to teach them efficiently. Textbooks for students of ESP, ranging from those at the Faculty of Economics to those at the Faculty of Engineers, have shifted away from using specialized vocabulary, drills for grammar and reading comprehension questions and toward communicative methods and the practical use of language. At present, in Romania, grammar is neglected in favour of communicative methods. The current interest in translation studies may indicate a return to this type of method, since only translation specialists can distinguish among specialized terms and determine which are most suitable in a translation. Engineers are currently encouraged to learn English in order to do their own translations in their own field. This paper will analyse the issue of the extent to which it is useful to teach Engineering students to do translations in their field using cognitive psychology applied to language teaching, including issues such as motivation and social psychology. Teaching general English to engineering students can result in lack of interest, but they can be motivated by practical aspects which will help them in their field. This is why this paper needs to take into account an interdisciplinary approach to teaching English to Engineers.

Keywords—Cognition, ESP, motivation, psychology.

I. INTRODUCTION

WITH today's interdisciplinary approaches, it is natural to think of the teaching process in an interdisciplinary manner. Teaching a foreign language cannot be thought of as separate from fields such as language acquisition, translation studies, cognitive approaches, psychology, and cultural studies.

By looking at language acquisition, we could take into account what types of exercises are most efficient for learners of various ages. "How is a language taught and learned in a most efficient manner?" is a question for language acquisition. Grammar-translation, direct methods, audio-lingualism, communicative language teaching, humanistic approaches, and task-based teaching were suggested by Shengxi, Lei, Huan, and Min [1] in their paper *Second/Foreign Language Teaching Methodologies*, MA 03. Teaching English for Specific Purposes, namely for Engineers, can begin with these methods of teaching general English. We can take useful

aspects from each method. From the grammar-translation method we could use short and direct explanations of grammar.

Translating drills can be a starting point for further language learning. The direct method involves students using the language in everyday situations and in encouraging them to use the language for speaking. The audiolingual method uses visual and audio materials to stimulate learning. Learning vocabulary items in context furthers the motivation of engineering students when it comes to using terms in their specialized fields. Communicative language teaching is learner-centred and focuses on real-life situations. It can be very practical for Engineering students and a means to motivate them by teaching that a language can become useful right away in any given situation, work-related or more familiar. The humanist method can be used as an exercise for learners to produce meaning for themselves from the use of pointers and producing shapes. The task-based approach is centred on the abilities of the learners to think about solving tasks rather than focusing on form. A combination of various existing teaching methods could keep engineering students learning English as a second language constantly alert and motivated. What is more, language and the way we use it is complex, and each method helps develop different abilities: of problem solving, thinking, speaking, understanding words from context, staying actively involved, etc.

II. MOTIVATION STRATEGIES

The area of English language teaching for engineers is much larger than English Language Teaching and English for Specific Purposes, since when we teach these students we have in mind theories that relate to several other fields as well, such as psychology, language acquisition, or cultural studies. This is because we need to focus on the way we can motivate our students based on the psychology of their age, on the way a learner psychologically perceives the use of language and on the way a second language is acquired. What is more, current cultural trends in teaching need to be taken into account in order to respond to the current learners' needs. The fields of cultural studies and translation studies are usually linked to teaching English as a foreign language. The curricula of universities always include tasks related to translations as well as notions related to the culture and civilization of English-speaking countries. For instance, the curricula for Engineering in Foreign Languages at the Technical University of Bucharest includes a course called *Culture: An Awareness-Raising Approach* written by Professor Sorin Baciu. The book consists, as the author tells us in the foreword, of "basic theoretical information and concepts related to the topic of culture and civilization" [2] – such as culture, human nature, personality, society, state, nation, globalization, culture shock, etc. – and it is "meant to enable a proper understanding and, hopefully, an easier and smoother access to the study of cultures and civilisations in general, or as separate entities, in particular," [2]. The subtitle, the author further explains, shows that this book is "meant to offer an understanding 'toolkit' to anyone interested to go deeper into the

study of a culture and civilisation, without necessarily being a specialist in the field.” [2] At the end of the book (Chapter XVI – Research and Assignment Topics) there are some questions proposed for discussion in the seminars, related to the notions discussed in each chapter. They are designed to teach students to organize their ideas and arguments for and against an issue, to compare and contrast various notions discussed in the book and, last but not least, to improve their language proficiency. Thus, even in this course, language use and notions of culture and civilization are intertwined. What is more, the author has also published a Romanian version of this course book, in an attempt to help students and teachers with tasks related to translation.

III. TRANSLATIONS

Part of adapting to Engineering students’ needs involves choosing the right methods and techniques for them. Here cognitive theories can help. Translations can be approached as problem-solving tasks, which are generally used for teaching English to Engineering students. Cognitive theories have been applied to both the process of translation and to the process of language learning. Foreign language learning is treated by cognitive theorists as a mental process which is different from other types of learning.

The process of translation involves problem-solving and decision making which, coupled with texts from the Engineering students’ fields of study and specialized terms can increase their motivation to learn English, according to Kairong:

“Wilss (1996) [3] argues that problem-solving and decision-making are the most relevant elements in translation. He takes a cognitive psychological perspective to view translation as a decision-making process involving knowledge-based intelligent activities. It requires the acquisition of organized knowledge. As schema is the representation of knowledge in mind, the central task of cognitive approaches to translation process is to investigate the way schemas operate. In problemsolving, the translator needs both declarative knowledge and procedural knowledge, and six phases are listed in problem-solving: identification of problems; clarification of problems; search and retrieval of relevant information; problem-solving strategies; choice of solution; and evaluation of solution. There is also the cognitive simplification to reduce inaccuracies in specific translators’ acts.” [4]

By focusing on translations, students can also memorize various grammatical structures with minimal effort. Since they are motivated by the text which is of interest to them, they can be more receptive to various language structures.

IV. LEARNERS’ NEEDS AND THE SOCIAL CONTEXT

As Engineering students are adult learners, they learn language differently than young children, as they are motivated by other factors such as age and field of interest, merging more general English language learning with that of English for specific purposes.

In Romania, the teaching of English gained wide popularity after the fall of communism in 1989. The current problem in

teaching English in Romania has to do with an over-reliance on Communicative methods, which leads to a neglect of grammar and grammar-translation methods. The current interest in translation studies, though, paves the way for a return to this type of method, as translation is a very large field which requires specialists to distinguish among similar terms in order to determine which is most suitable. Engineers are currently encouraged to learn English so that they can do their own translations in their own field. Engineering students can thus be motivated by a practical aspect related to their field of study. Teaching general English to them can result in lack of interest, as they usually feel they know enough from their previous years of study. However, we can rely on their interest in learning English to continue to inspire them. For the present moment, they can be interested in learning English to pass Erasmus scholarship tests which they need to study abroad, or simply for travelling purposes, so that they can use the language in various social situations. For the future, they can be interested in establishing professional connections, business communication, and writing English-language academic papers in their field of study for international database journals.

Sociological factors relating to the current trends and needs of foreign language learners has led to a greater focus on cultural studies, as learners need to adapt to what society asks of employees in their fields. Professional adaptation to a multicultural society forms a culture of its own. The groups of teachers of foreign languages establish cultures in their own right, for example the communities, online or physical established by the British Council and various teachers associations.

Nowadays, Romanian society expects everyone to know English. This also holds true for Engineering students who will eventually end up translating their own research papers from Romanian into English in order to reach a wider audience in scientific journals in international databases. Having this goal in mind, teachers tend to focus more on this type of students’ need and adapt their teaching methods to them. Teaching with translations has not lost its utility and popularity despite the widely popular communicative methods of teaching a foreign language at any level and age. We could say that interdisciplinarity also influences teaching methods. The grammar-translation method has not been kept as such but adapted. Translations are still given as tasks and they form the large basis of Practical Courses in philological and nonphilological universities. Translations are taught on the basis of discussing text genre and its specificities. A literary text and a scientific text have different features and as such the translator needs to adapt to them. From here we can work on teaching engineering students the features of their technical texts and the way they need to approach them in translation. Perhaps with engineers the teachers need to work more on grammar, yet the kind of grammar and vocabulary needs to be carefully planned and differentiated from those taught to philology students.

V. TEXTBOOKS

The teacher-student relationship for engineering students learning a foreign language should be approached through psychological theories. Psychoanalysts state that the

teacher-student relationship generally works similarly to the relationship of transference established between analyst and patient. The analyst takes care to work efficiently with the patient, taking into account the particularities of the respective patient. No psychoanalytical therapy session is completely identical to another, just as no case is perfectly the same as another one. Every individual is different. While working with students implies working with groups, no group of students is the same, even if they are all Engineers or all the same age. Usually groups tend to become homogenous and behave in a similar way in class, share the same interests, and be more active or less active in general. Seminars need to be structured according to what students ask of the teachers. Usually there is no set textbook and the teacher structures his own materials, even if he tends to use more materials from a certain textbook. The method of using no textbook, with the teacher structuring his own materials, is more difficult, according to a paper published on the British Council's site. Yet this method is more adaptable to the specific needs of a specific group of students. This works in the same way as a psychoanalyst adapts, by using his life experience and empathy, to relate to a specific patient. The same holds true for a teacher. The teaching materials and methods should be selected with his students in mind. For engineering students, he should select texts related to their field, with specific vocabulary, structure and means of expression. There are handbooks related to teaching technical English, yet they may only work at certain times and not for the entire semester or year. For instance, the curricula for the two years of studying English at the Technical University of Civil Engineering Bucharest includes real life situations such as answering direct questions or ordering from a menu in a restaurant, and then moves on to specialized situations such as dealing with types of construction, and, as for grammar, the curricula includes if conditionals, degrees of comparison, modal verbs, tenses, etc. The writing tasks focus on writing a cv or report, and other activities which they can put to practical use. The bibliography for the curricula includes several textbooks, among them are Evans, Virginia. *Successful Writing (Upper-Intermediate)*, Express Publishing, 2002 [5], and Sweeney, Simon. *English for Business Communication*, Cambridge University Press, 1997 [6]. The whole textbook by Evans focuses on writing tasks, while the textbook by Sweeney focuses on communication skills in business situations. One single textbook rarely meets the needs and expectations of any class at all times. Diversity is needed. Blandu's *English for Professional Communication*, published in 2004, is similar to Sweeney's and was created by the Polytechnic University of Bucharest, Department of Modern Languages [7]. It begins by examining cross cultural diversity and business companies, continues with units dealing with oral presentations and writing curriculum vitae, ending with a unit for grammar reference, with explanations and examples of issues such as the article, the sequence of tenses and so on.

There are textbooks that have been created with ESP in mind for science and technology and engineers. Such is *English for the Construction Industry* by Graham and Celia Waterhouse [8] which focuses on communication situations on construction sites. The focus is on pragmatic aspects such as giving orders,

requesting help, and so on, but there are also notions of grammar, relating to the position of an adverb, reading comprehension, and vocabulary. Dean Curry's textbook [9] *Science and Technology in Everyday Life* includes texts belonging to general aspects from these fields, with reading comprehension and grammatical notions such as adjective clauses, sentence patterns, etc.

An older textbook, from 1967, published at Editura Tehnica in Romania, by Viorica Danila [10], called *English for Engineers and Technicians*, focuses in each unit on a text, its related vocabulary, translation exercises from English to Romanian and from Romanian into English, and grammar drills. All grammar issues are adapted to the Engineers' and Technicians' fields of activity and interest. The English teacher can attract Engineering students by adding notions from their related fields of activity, showing them that he adapts to their interests and showing them that the English subject is complex and can be very different from their previous English classes. *English for Mechanical Engineering in Higher Education Studies* by Dunn, Howey and Ilic, Garnet Publishing Ltd., 2010 [11], focuses on skills students need for lectures and seminars in their field of study. The textbook includes listening comprehension, reading comprehension, fill-in exercises, etc. *Take-Off. Technical English for Engineering* by Morgan and Regan [12], Garnet Publishing Ltd., 2008, has in view vocabulary, grammar, listening, speaking, reading, and writing aimed for engineers and technicians that will work in the aeronautics industry. It uses a communicative methodology.

A psychological profile of engineering students could be beneficial to use for the teaching and learning process. They are said to enjoy problem-solving activities and translations could work very well for their mindset. Teaching them to work with language related to both grammar issues and vocabulary from their general field of activity and interest can work very well to establish a good relationship between teachers and students. The relationship of collaboration can prove beneficial for both the teaching and learning process. All textbooks have in common the use of a common context, related to the fields of science, technology, and engineering, around which the activities of communication are built.

The skills defined by cognitive approaches to learning focus on an active learner, able to memorize and organize information successfully. These skills go hand in hand with the skills needed by future engineers, and which are stressed by the description of the socio-psychological competence: future engineers should be able to successfully process information, solve conflict or problems, and manage others. The textbooks follow such skills with listening and reading comprehension exercises, understanding grammatical issues and matching exercises, drills and translations. The sociopsychological competence of future engineers is described as follows by Shageeva, Kraysman and Gorodetskaya in 2013

[13]:

“Socio-psychological competence of future engineers should be developed in the educational process at the university. Humanities, especially psychology and educational science as academic disciplines play an important role in developing socio-psychological competence. Psychological and pedagogical knowledge

and skills are necessary to solve problems in HR, management, conflict resolving, information processing, etc. Humanities in the engineering education allow students to evaluate significance of innovations, implement them and overcome obstacles and difficulties. Besides education in psychology and pedagogics reveals potential for personal growth, influences motivation, general outlook, values, and consciousness as a whole [3].

The quote also stresses the use of humanity studies for Engineering students, which can help them find solutions and better develop their active thinking abilities as proposed by cognitive approaches to learning, as Horaničová [14] claims:

“Current cognitive approaches to learning stress that learning is an active, constructive, cumulative, and selfdirected process that is dependent on the mental activities of the learner [15]; [16]. Cognitive orientation focuses on the mental activities of the learner that lead to successful learning. This explicitly acknowledges the role of metacognitive processes and the use of various learning strategies. Memory and learning both require the learner to actively construct new knowledge and strategies, according to Rumelhart and Norman in 1981. Transfer of information into permanent storage is facilitated by rehearsal of the information (particularly if the information is elaborated meaningfully), by organization (e.g., categorization) of the information, by the use of metamemory strategies (e.g., writing lists or taking notes). Learners tend to remember better when knowledge is acquired through distributed practice across various study sessions, rather than through massed practise, although the distribution of time during any given study session does not seem to affect transfer into long-term storage (Anderson 1983 [17]; Sternberg 1996) [16].”

VI. CONCLUSIONS

The teacher himself can practice various abilities of problem solving and managing the way the English language should be taught to Engineering students, as a function of their level and of the way they need to exercise their thinking abilities. English seminars thus come to help the way students can present arguments, make decisions, solve problems, and process information, besides helping them use their language skills in given contexts. The idea of having a variety of methods at hand to teach English also functions as a strategy for motivation, as well as introducing students to various situations and types of exercises, to various textbooks, in order to make them adapt their language skills to various situations of understanding. The theories concerning how age affects acquiring a second language are currently controversial, so they were not treated here. However, they have been considered by the proponents of the various methods of language teaching. As a result, some methods focus on visual learning, and learning a language just as the first language is acquired, while other methods focus more on grammatical rules. Different learners have different learning styles and so do Engineering students. Exposing them to a variety of exercises from various textbooks can make them discover for

themselves the method that fits them best. However, the best results are received when explanations are short, to the point, and illustrated with examples. Afterwards, using the old method of drills can be effective for a while, but it should be alternated with other types of activities to create variety and make students feel they can use language for practical purposes. Some skills that remain important are: grammar, vocabulary, reading, listening, writing, and speaking, which are present in most language proficiency tests that most students will need to take. Teachers can vary the teaching methods for these skills, for reasons of variety or adaptation, but also for discovering which can be the most effective for which students. No two classes are the same.

REFERENCES

- [1] Baciu, Sorin, *Culture: An Awareness-Raising Approach*, Cavallioti, 2013.
- [2] Wills, Wolf, *Knowledge and Skills in Translator Behaviour*, Amsterdam and Philadelphia: John Benjamins.
- [3] Kairong, Xiao, *Cognitive Approaches to Translation Process: Current Trends, Challenges, and Future Development*, College of International Studies, Southwest University.
- [4] Evans, Virginia. *Successful Writing (Upper-Intermediate)*, Express Publishing, 2002, and Sweeney, Simon. *English for Business Communication*, Cambridge University Press, 1997.
- [5] Sweeney, Simon, *English for Business Communication*, Cambridge University Press, 1997.
- [6] Blandu, Mihaela, coord., *English for Professional Communication*, The Polytechnic University of Bucharest, Department of Modern Languages, Ed. Printech, 2004.
- [7] Waterhouse, Graham and Celia, *English for the Construction Industry*, Macmillan Publishers, 1981.
- [8] Curry, Dean, *Science and Technology in Everyday Life*, English Teaching Division, Educational and Affairs, USA, 1988.
- [9] Danila, Viorica, *Engleza pentru ingineri si tehnicieni*, Editura Technica, Bucuresti, 1967.
- [10] Dunn, Marian, Howey, David, Ilic, Amanda, Regan, Nicholas, *English for Mechanical Engineering in Higher Education Studies*, Garnet Publishing Ltd., 2010.
- [11] Morgan, David, Regan, Nicholas, *Take-Off. Technical English for Engineering*, Garnet Publishing Ltd., 2008.
- [12] Shageeva, Farida Tagirovna, Kraysman, Natalia Vladimirovna, *Sociopsychological competence of future engineers*, American Society for Engineering Education, 2013
- [13] Horaničová, Zuzana, *The influence of cognitive psychology in a second language instruction*, Department of Foreign Languages, P. J. Šafárik University, Košice, Slovakia
- [14] Shuell, T., *Cognitive Conceptions of Learning*, *Review of Educational Research*, 56: 411-436.
- [15] Sternberg, R. (1996) *Cognitive Psychology*. New York NY: Holt, Rinehart and Winston, Inc.
- [16] Anderson, J. (1985) *Cognitive Psychology and Its Implications*. New York: Freeman.