LANGUAGE COMMUNICATION COMPETENCIES IN ENGINEERING EDUCATION REVISITED

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Abstract: *The ability to learn languages and adapt communication competencies to the changing needs and situations of a global knowledge society and the European Higher Education area is becoming a necessity for future engineers. This article first discusses the demand for communication skills in Engineering Education in general. Secondly, it describes the present state of the Bologna process in Spanish higher education, which calls for a change in focus from an input model to an output one, in which learning outcomes are central. Finally, it summarizes the proposal of developing a "bank" of language learning outcomes for Engineering Education studies framed within the European Language Portfolio. This bank of learning outcomes, expressed as "can do" statements, will serve three purposes: curricula guidance for teachers, guidelines for student life-long learning and autonomous learning.*

Key words: *engineering communication competencies, learning outcomes, second language acquisition, European Higher Education area, ESP.*

1. LANGUAGE COMMUNICATION SKILLS WITHIN A GLOBAL COMMUNITY

Why is it so important to reconsider the need for engineering students to be trained in technical writing or speaking at this stage of European converging? In the first place, because of the reshaping of global tendencies in education that information and communication technologies are bringing about, as society not only realizes the importance of knowledge but also the importance of proper knowledge-sharing and distribution. Scientists, as members of a knowledge society with similar interests, aim to make effective use of their combined knowledge in scientific, economic and technical areas and in the process contribute to its development. A knowledge society is one in which knowledge becomes the major product and main raw material: we may say that knowledge and education are two of its vital elements because every knowledge society is formed around some shared concepts that give it shape. Consequently, there is a transformation of our society and our educational system to answer the needs of a global community with a shared knowledge of issues and possibilities. Within the context of this emerging society, no one considers writing and communication superfluous to a technical education (Durán, Aguado & Roldán, 2005). Thus, the change towards a knowledge-based society implies an increase as well as a broadening of communication skills and tasks.

Secondly, literacy practices change and learning goals need to be adapted to 'targeted linguistic change' in SLA, as Baynham (2003: 44) affirms. Engineers will have to acquire a wider range of diversified skills than their predecessors; they will have to take into account the dimensions of technology, be sensitive to cultural diversity, and know how to effectively communicate in society. To encompass these factors, engineering education must be focussed not only on technical knowledge but also on providing the students with the ability to learn, to analyse, to synthesise, and to creatively apply fundamental engineering principles to new problems, with

an aptitude for self-directed and life long learning (Bary and Rees, 2006); hence, the need for reconsideration of communication and language learning strategies as well.

Most engineers and researchers work in organizational spheres where team work is essential, and this is impossible without good communication. For many technical professionals, the ultimate product of their work is a written document. From this perspective, communication skills are critical tools for success, 'even survival', in real world environments, as Huckin and Olsen (1991: 3-10) affirm. These authors refer to a survey carried out by the American Society for Engineering Education, highlighting that, out of 4057 responses from working engineers, communication skills rank above any other type of skill, cornering five of the nine most needed categories out of thirty-five mentioned. These include technical writing, public speaking, working with groups, speed reading and talking with people.

Furthermore, according to Barton and Hamilton (2000) there are different language practices associated with different domains of life which should be taken into account in SLA. These practices are embedded in broader social goals and cultural practices but not totally fixed; they are rather adaptable to context and circumstances, the authors argue. Language practices change and new ones are frequently acquired through processes of informal learning and sense making as well as formal education and training. An example of this would be the differences in style between e-mail writing and letter writing in academic contexts, while being both formal situations. We may recall that "literacy encompasses both linguistic and socio-pragmatic dimensions of any language applied to reading, writing and speaking abilities, and, consequently, literacy evolves according to the needs and circumstances of the language user" (Durán and Pierce, 2007: 183). Moreover, applications of new genre studies to the classroom (Johns, 2002 and Bhatia, 2004) and the use of figurative language in teaching LSP (Littlemore, 2004; Littlemore and Low, 2006) are other cases of new developments that have been taken into account in our new proposal of language for academic purposes outcome descriptors, which we introduce in this paper.

2. THE EUROPEAN AREA OF HIGHER EDUCATION

2.1. Key Concepts
The main purpose of the Bologna process is to create the European higher education area by making degree standards and academic quality assurance more comparable throughout Europe. Although the Bologna Declaration of June 1999 was not based on a European Union institutional initiative, it constitutes an intergovernmental agreement signed by more than 45 state members, which have engaged themselves to accomplish this voluntary convergence in the field of education. Spain has been one of the first signatory members since 1999.

One of the main objectives of the Bologna Declaration is to implement the European Credit Transfer System (ECTS) in higher education, at European level, thus enhancing the quality and volume of student mobility throughout the territory of the state members. The ECTS is a student-centred system based on the student workload required to achieve the objectives of a programme, preferably specified in terms of the learning outcomes and competences to be

acquired. Credits in ECTS can only be obtained after successful completion of the work requi-red and assessment of the learning outcomes achieved, thus fostering transparency.

The European Commission plays an increasingly important role in the implementation of the Bologna process, supporting important European projects. The process is being implemented concurrently with other reforms and projects, such as the European Language Portfolio (ELP), as far as language learning is concerned. The ELP is a document based on the *Common European Framework of Reference for Languages* (Council of Europe, 2001), in which learners can record and reflect on their language learning and cultural experiences. It was developed and piloted by the Language Policy Division of the Council of Europe from 1998 until 2000, and it was launched on a pan-European level in 2001. Among its objectives we can also find the enhancement of student mobility, transparency in the formulation of language levels following a common framework of reference, and the description of language learning outcomes using "can do statements", as we shall discuss in the coming sections.

2.2. Brief over-view of learning outcomes usage in Europe

Traditional teaching has generally suffered from separating off the lecture and seminar room from the social dialogue and engagements of a concrete world; where human intellect functions within the rich and substantial context of social relationships and personal conceptions of who we are and what we want to be. These broader issues of personal and occupational identity can dramatically affect our learning in all contexts. /.../ They frequently become the most important and relevant components to student success (Light and Cox, 2001).

Learning outcomes have been described as a basic educational building block. They have a direct relationship to levels and level indicators. "Learning Outcomes are a set of competences expressing what the student will know, understand or be able to do after completion of a process of learning whether long or short" (Council of Europe, 2004). They are concerned with the learner's achievement rather than the teacher's intentions. The majority of education systems in Spain does not use learning outcomes in any systematic or comprehensive way but rely on tra-ditional approaches for explanation and expression of their syllabi and the courses that consti-tute them, even in L2 teaching (González and Wagenaar, 2003). The present system could be labelled as an "input focus approach", where learning is viewed as a process of transmission of knowledge from the teacher to the student. The teacher's role is to control the learning process by making decisions about what information to transmit and how to sequence it. The student's role is to acquire the information and demonstrate adequate knowledge acquisition. Assess-ment is summative with students demonstrating that they have reached an adequate level. Knowledge and learning are viewed as measurable and clearly defined products (Huba and Freed, 2000). Therefore, the courses are described in terms of what will be covered, emphasi-zing the length of a programme, its access requirements, and number of teacher contact hours.

At the other extreme, can be placed the "output focus approach" or student-centred appro-ach where learning is viewed not as a product but as a process. Both the ECTS and the ELP emphasise this student-centred approach. The acquisition of knowledge is then under the stu-dent's control. This implies that students should be actively involved in the planning and mana-gement of their own learning and take more responsibility for it as they progressively develop as independent learners. The introduction of learning outcomes into the curricula can promote this paradigm shift.

The Scottish Government (www.scotland.gov.uk/Publications) has recently carried out a research project to find out the level of implementation of learning outcomes in current higher education programmes in Europe. For this study, more than 100 European Commission ECTS/DS counsellors were contacted, as well as the 40 members of the Bologna follow-up group (BFUG). Learning outcomes were defined as: "precise statements of what the learner is expected to know, understand and be able to demonstrate at the end of a period of learning – involving the exact identification of the skills and abilities that a student will have on the successful completion of a module or unit…". Respondents were just asked to report on the situation of their country, without any further involvement.

Despite the limitations of the study, it was found that out of the 30 countries that volunteered information, 29 (97%) indicated some activity with learning outcomes implementation, including small-scale institutional initiatives on all sectors of higher education. Among the countries that reported to be using learning outcomes as their main gauge of higher education quality enhancement, Belgium, Denmark, Hungary, Ireland, Italy, Slovak Republic, Spain, Sweden and the UK were mentioned. However, in no case were learning outcome initiatives directly linked with the adoption of student-centred learning practices. Nor were learning outcomes understood in the exact same way by all respondents; possible confusions between learning outcomes, objectives and aims were detected. More detailed studies are needed.

As we can see, basing new programmes on learning outcomes and competences is a complex issue, especially in SLA at tertiary level. Competence can broadly refer to aptitude, proficiency, capability, skills and understanding. It can represent a combination of attributes and be used to describe the level or extent to which a person is capable of performing them. A competence or set of competences means that a person can demonstrate a certain capacity or skill and perform a task in a way that allows evaluation of the level of achievement.

Although learning outcomes and competences may be at the forefront of educational change, they are only the first step in educational reform. In order to identify and define course learning objectives, within the context of languages for academic and professional purposes, our research decided to go further by developing a bank of language communication competence descriptors for future engineers, to be used within the framework of an ELP for curricular subjects as well as for student independent work.

3. DEVELOPING A BANK OF LANGUAGE COMMUNICATION COMPETENCES AND OUTCOMES FOR ACADEMIC PURPOSES

3.1. Pedagogical aims

The research group DISCYT[1] is made up of Technical English teaching staff and researchers from the following degree programmes at Universidad Politécnica de Madrid: Architecture, Aeronautical Engineering, Agricultural Engineering, Civil Engineering, Mining Engineering, and Telecommunications. This wide range of teaching content areas motivated us to develop a

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bank of language competence descriptors, i.e. learning outcomes, covering all skills, to be used in defining specific course objectives for university language courses. In this way teachers may choose the learning outcomes that are appropriate for their own language syllabi depending on the course objectives and competencies to be emphasized. The bank of competence descriptors can serve two major pedagogical purposes. Primarily, a detailed list of language competencies can be used for student self assessment: to guide them through their learning process, to identify and set goals and to assess their learning progressively, inside and outside the educational framework, thus promoting self directed learning.

A second rationale for developing the bank was to provide an interface between language learning, teaching and assessment. Learning outcomes can be a pedagogical resource for teachers to determine the key purposes of the course and a practical tool for students to take control of their learning processes under the teacher's guidance. Students do not become self-directed learners instantaneously; rather they need opportunities as well as clear directions and careful planning in many instances (Alha, 2004; Bary and Rees, 2006). Another function of the detailed descriptors of language competencies is their use in reporting language level proficiency for other educational contexts or future employers, thus, promoting mobility throughout Europe, and internationally. This should be done in the context of external reference points (qualification descriptors, level descriptors, benchmark statements). The Common European Framework of Reference for Languages (Council of Europe 2001) was chosen as our external reference point. The CEFRL provides a practical tool for setting clear standards to be attained at successive learning stages and for evaluating outcomes in an internationally comparable manner. It is divided into 6 levels clustering into 3 bands: A1-A2 (basic user), B1-B2 (independent user), and C1-C2 (proficient user).

3.2. The process of development and piloting the descriptors

Our first task was to determine the target communication areas needed by future engineers. By looking at the Spanish engineering degree syllabi and our students' professional perspectives, we had a good approximation to their specific academic and professional field of action. The range of competencies required of these students includes fundamental academic skills, such as reading, writing and speaking in an adequate register, as well as mastering specific terminology and the strategies required to consult sources and solve technical problems. Table 1 specifies the targeted communicative skills that belong to B1, B2 and C1 levels of reference most applicable to our engineering students, which have been taken from the CEFRL and will help teachers to select those applied to their courses.

Next, in order to gauge the level of learning outcomes, it was necessary to determine the students' English entry level. To do this, teacher members of the research group administered the Oxford placement test to their respective students, a total of 301 students enrolled in technical English courses. The majority of students fell into the A2 and B1 band so we targeted the learning outcomes at the B1 /B2 level of competence shown in table 1, applying them to our technical tertiary education engineering context. However, since some courses are geared towards lower level students, especially in three-year Technical Engineering degrees, descriptors for A1 and A2 were also included in our bank.

SKILL	B1* LEVEL OF REFERENCE	B2* LEVEL OF REFERENCE	C1* LEVEL OF REFERENCE
SPOKEN PRODUCTION AND INTERACTION	1 can connect phrases in a simple way in order to describe experiences and events. 1 can orally summarize a short experiment or a simple article in my field.	I can present clear, detailed descriptions on a wide range of subjects related to my field of interest. I can explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.	I can present clear, detailed descriptions of complex subjects integrating sub-themes, developing particular points and rounding off with an appropriate conclusion.
WRITTEN PRODUCTION AND INTERACTION	1 can write simple connected text on topics which are familiar or of personal interest. 1 can write personal letters describing experiences and impressions. I can write brief reports of experiments and summarize articles.	I can write clear, detailed text on a wide range of subjects related to my interests. I can write an essay or report, in support of or against a particular point of view, and write letters highlighting the personal significance of events and experiences.	I can write clear, well structured text, expressing points of view at some length. I can write about complex subjects in a letter, an essay or a report. I can select style appropriate to the reader in mind.
RECEPTION/ SPOKEN	1 can understand the main points of clear standard speech on familiar matters regularly encountered in work, school, leisure, etc. 1 can understand the main point of lectures or current affairs when the delivery is relatively slow and clear.	I can understand extended speech and lectures and follow even complex lines of argument provided the topic is reasonably familiar. I can understand most TV news and current affairs programmes, the majority of films in standard dialect.	I can understand extended speech even when it is not clearly structured and when relationships are only implied and not signalled explicitly. I can understand TV programmes and films without too much effort.
RECEPTION / WRITTEN	1 can understand texts that consist mainly of high frequency everyday or job- related language. 1 can understand articles in my field.	I can read articles and reports concerned with contemporary problems in which the writers adopt particular attitudes or viewpoints. I can understand contemporary prose.	I can understand long and complex factual texts, appreciating distinctions of style. I can understand specialised articles and longer technical instructions, even when they do not relate to my field.

Table 1. Target communicative skills. * Adapted from the CEFRL (2001).

Before the actual writing of the language competencies description was undertaken, existing descriptors such as the ones found in the European Language Portfolio for higher education (Foster Vosicki 2002) as well as in the 'A bank of descriptors for self-assessment in European Language Portfolios' (Lenz and Schneider 2004) were consulted. These self assessment checklists served as a good model for writing the descriptors, but they did not contemplate the specific needs of our engineering students (Pierce and Ubeda, 2006).

In teams of two, each team devoted to one skill, a series of learning outcomes was written following the domains detailed in Table 2 (Durán and Pierce, 2006). All the teachers involved in the project followed the same directives to actually write the new learning descriptors applied to architecture and engineering academic and professional environments. We took into account

CATEGORY/ SKILL	LANGUAGE COMPETENCE	DOMAINS
SPOKEN PRODUCTION AND INTERACTION	phonological control, sociolinguistic appropriateness, turn-taking, thematic development, fluency	overall oral production; sustained monologue: describing experience, putting a case; public announcements; addressing audiences: oral presentations; overall spoken interaction: formal discussion, meetings, telephoning.
WRITTEN PRODUCTION AND INTERACTION	general linguistic range and vocabulary range, grammatical accuracy, and orthographic control	overall written production, reports and essays, instructions, descriptions of mechanisms & processes, student applications (CV, cover letter and forms), abstract and research papers, overall written interaction, correspondence (letters and e-mails), notes & messages.
RECEPTION/ SPOKEN	general linguistic range and vocabulary range, identification of different registers, accents and popular sayings	overall listening comprehension, understanding conversation, listening as a member of a live audience, listening to announcements and instructions, listening to audio media and recordings
RECEPTION / WRITTEN	general linguistic range and vocabulary range, identification of different registers and styles	overall reading comprehension, reading correspondence, reading for orientation, reading for information, reading instructions, reading reports and articles
WORKING WITH ORAL AND WRITTEN TEXTS	general linguistic range and vocabulary control, sociolinguistic appropriateness, figurative language use, coherence and cohesion, propositional precision	note-taking (lectures, seminars, etc.), processing text (précis and summaries), translation l2 to l1 (written), translation l1 to l2 (written), interpretation (face to face interaction).

Table 2. Specific categories and domains for academic and professional environments.

that a good language competence descriptor, according to Lenz and Schneider, should be positive, definite, clear, brief and independent. That is, they should be formulated using positive descriptions of what the learner can do in describing concrete tasks or degrees of skill. They should be written in clear simple language, which does not require previous training. Finally, the descriptors should be independent of each other and be answerable with a clear "I can do this" or "I can't do this" (Lenz and Schneider, 2004: 13).

The drafts were revised by two or three other researchers involved in the *DISCYT* group project, different from the first authors and raters, in order to refine the wording and levels of the descriptors. Suggested improvements were discussed during several meetings of the entire research group in order to produce the final draft. Five sets of 50 to 90 detailed learning outcomes were developed, corresponding to the five categories: spoken production and interaction; written production and interaction; reception-spoken; reception-written; and working with oral and written texts. The next step was to pilot the outcome descriptors with our respective stu-

dents. The primary purpose of this study was to discover which descriptors were easily understood and interpreted. Another objective was to check if our scaling of the outcomes to the Common European six-level framework was accurate.

Each teacher/researcher chose a set of learning outcomes that best represented those of their course. For example, the set of spoken production outcomes was given to the students enrolled in the course of *Oral Presentations* at the Technical Aeronautical Engineering School. The learning outcomes for reading were distributed to first year mining students, where reading is a major component of the *Fundamentals of Technical English* course. A short explanation of our study was given. They understood that filling out the set of learning outcome questionnaires was voluntary. On the right of each learning outcome were four boxes, of which students were asked to mark only one. The outcomes were written in English but the instructions were in Spanish. The translation for column instructions is as follows:

Column 1. (?)   -don't understand the objective,

Column 2. (A) -can do this,

Column 3. (T)   -working on this but haven't reached it yet (either in class or personally),

Column 4. (N)   -not an objective at the moment.

Students were also asked to underline words or phrases that they did not understand to guide the researchers as to what part of the learning outcome was causing difficulty.

3.3. Initial Results of the Pilot study for the skill of writing

Although the whole back of learning outcomes were piloted, we comment on the results for the skill of writing whose descriptors were piloted at the several of the engineering schools. Eighty nine descriptors for written production were developed for the bank. Each teacher chose the learning outcomes appropriate for their course. Although the main purpose of the study was to target learning outcomes that were not clear to the students, another question posed for the study was to find out if there was a relationship between the descriptors marked "I can do this" and the students Oxford Placement level. If this correlation exists we can assume that the learning outcomes are scaled properly to the CEFR.

3.3.1. Participants

187 students from the five engineering schools volunteered to participate in the study from the Schools of Mining, Architecture, Agriculture, Aeronautical and Civil Engineering. All were given the Oxford Placement Test at the beginning of the course. The results are shown in Figure 1. The great majority of students placed in the A2 and B1 bands. Figure 2 shows the results of the students included in the whole project. We can see the pattern of results the students piloting the writing descriptors is very similar to the pattern of the total students with the exception of a slightly less numbers in the A2 category.
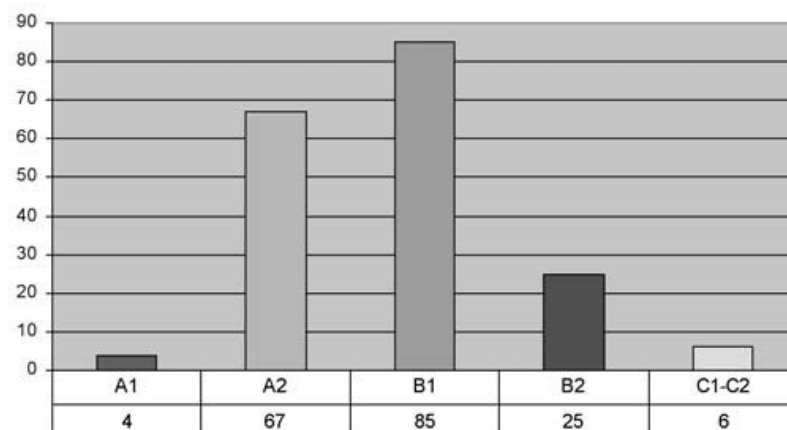
Figure 1. Results of Oxford placement exam for students included in this analysis

3.3.2. Results for Correspondence

As mentioned earlier, within the skill of written production, each instructor piloted the descriptors best representing their course. The School of Architecture piloted 75 descriptors, Mining 52, Civil Engineering 51, Technical architecture 40, and Agriculture 25. With the diversity of the descriptors piloted at each School the following results are presented in percentages. To answer the question whether there is a relationship between the number of descriptors marked as "reached" and the students' level of Oxford Placement test, the total number of descriptors marked as reached was calculated for each level. Figure 3 shows the results of this analysis.

As we can see, there is a close relationship between the percentage marked '*I can do this*' and the level of the students, except at the C1-C2. The explanation for the discrepancy in the CI-C2 band, we believe, is twofold. Since only 6 students fall into this band, the number of answers is too low to be significant. Secondly, 4 of 6 C1-C2 level students were from the School of Architecture, which piloted 75 written production descriptors. These descriptors included some very specific writing tasks pertaining to the course, hence a large percentage of descriptors were marked '*I am working on this*'.
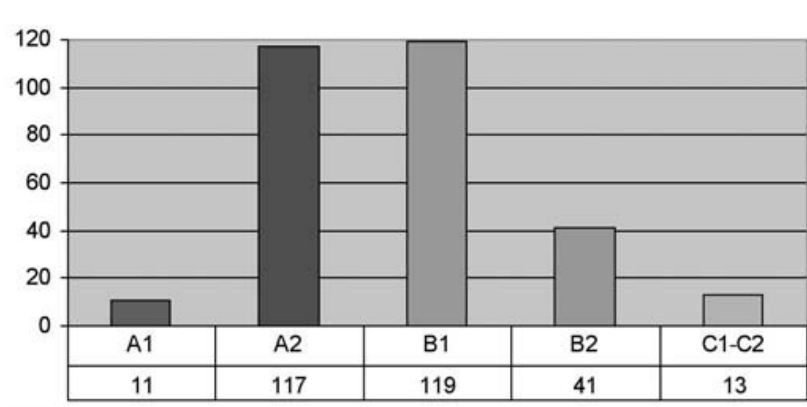

Figure 2. Results of the student Oxford placement exam for the whole study.

3.3.3. Results for Clarity

From an initial analysis of the results of the student questionnaires, we have found that even after thoroughly reviewing the outcome descriptors before presenting them to the students, many descriptions were still unclear to them.

For example, the following C1 learning outcome was marked unclear by a significant number of students, even high level ones, with 'rounding off' being noted as the source; this was changed to *'ending with'*.
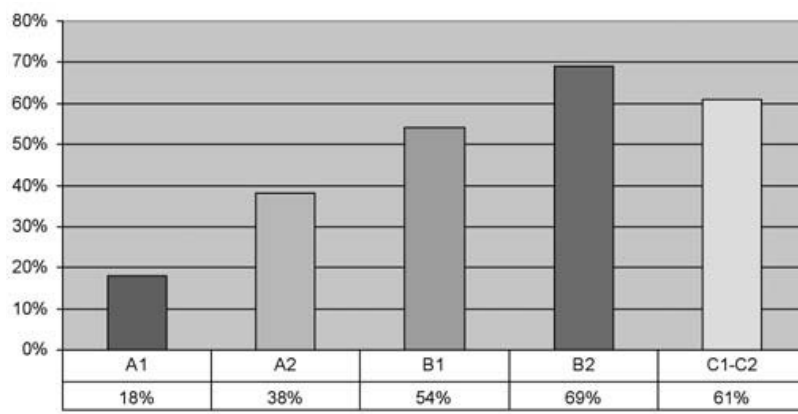

Figure 3. Percentage of descriptors marked as reached for each level

- *'I can write clear, well-structured texts on complex subjects related to my academic field, supporting my arguments, giving relevant examples and rounding off with an appropriate conclusion.*

An example of B1 writing descriptor marked as unclear is

- *'I can write simple instructions and safety guidelines related to my vocational field, which are clearly intelligible'.*

In this description, 'guidelines', a fairly common word in English, does not have a Spanish cognate equivalent, so *'advise'* was used instead.

This A2 learning outcome was also marked as unclear by 10 A2 students, which is especially important since the outcome is targeted to their level.

- *'I can write a brief and clear CV following the standard models'.*

The word brief was changed to 'short'.

The phrase *'reasonable level of accuracy'* was used in several learning outcomes with students consistently marking the phrase as unclear. This phrase had been adapted from the bank of descriptors for the European Language Portfolio gathered by Lenz (2004). What seemed to have presented no difficulty to adult learners from other nationalities, did present problems to

our engineering students. However, in this case, we decided to leave the phrase in the higher levels and introduced the word 'grammatical' at the lower levels, resulting in the phrase *'reasonable level of grammatical accuracy'.*

Unclear statements of learning outcomes do not serve the purpose of motivating the self-directed language learning process. It is important to note here that since one of the purposes of the learning outcomes bank is its use in student self-assessment, it is paramount that the students understand the description of the outcomes. The series of descriptors that were noted as unclear have been rewritten with the hope of implementing them in the course design this coming semester. The result has been a bank of 342 descriptors, ranging from A1 to C1 CEFRL levels, grouped under five skills: listening (57), reading (64), speaking (47), writing (91) and working with texts (83). In short, the development of clear, understandable learning outcomes is not an easy process and their testing, and scaling to an external reference point (the CEFRL) is a time-consuming process. However, students, teachers and researchers are finding that working with language learning outcomes can contribute clarity and transparency and serve as good resources in the language-learning process; therefore, our work has been a rewarding endeavour.

4. CONCLUSION

The emergence of the knowledge society and the European Higher Education Area are bringing about a reshaping of global tendencies in education, which imply a transformation of our society and our educational system. Engineers will have to acquire a wider range of diversified skills and academic literacies than their predecessors, especially communication skills. The traditional input-related curriculum, too teacher-focused, is turning into a student-centred learning outcome approach. The introduction of learning outcomes and competence descriptors into engineering language courses can promote change towards student self-directed learning. By focusing on the process aspect of language learning, we can help students to identify their learning goals, to design and modify their action plans, and monitor the processes. The academic and professional bank of descriptors developed has proved to be a useful and motivating tool for language teaching and learning. We have found that there is a close relationship between the percentage of language outcome descriptors level (scaled to CEFRL standards) marked by the students *'I can do this'*, and the language level of the students (according to the Oxford Placement Test) who marked them; this paper includes a sample of writing descriptors results to illustrate it.

Learning outcomes are not the universal panacea for all the problems faced by higher education language learners, and their varied complexity should not be underestimated. In spite of the difficulties encountered in calibrating them to the CEFRL, our research group DISCYT1 as well as our students have found that the knowledge of expected language learning outcomes at the beginning of the course is a motivating factor for self-directed language learning.

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