# Communication outcomes and Bologna: an approach to Professional English for engineering students

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*Abstract:* This is a report on work in progress involving the design and implementation of a new Professional English curriculum unit for Portuguese engineering students to achieve an effective adaptation of successful existing engineering courses to meet the challenges of the Bologna Process by incorporating elements of life-long learning and employing Active Learning elements in the teaching approach.

*Keywords*: Bologna, lifelong learning, active learning.

## 1. Introduction:

### 1.1 Active and Collaborative Learning

Since the appearance in 1988 of Felder's paper on Learning and Teaching Styles in Engineering Education [1] which concluded that there was a mismatch between most engineering education and the learning styles of most engineering students, there has been an increasing interest in developing teaching techniques to address all learning styles with a particular emphasis on the importance of active learning supported by pedagogies of engagement, often involving a cooperative or problem-based approach, with the aim of improving the outcome of Engineering Education in Europe, the US and Asia.

Examples can be found at subject level such as Krezel and Pocknee's [2] with project-based learning on a first year Civil Engineering course and Braga's [3] use of computer-enhanced learning to study Heat-Transfer on a Mechanical Engineering course. Vos [4] describes the implementation of active learning organisation at departmental level in the area of Electrical Engineering Other institutions have implemented an active learning approach at a broader curriculum level: INSA-Lyon [5] offers a two-year curriculum in Technology Science and Innovation using active learning while the Amsterdam University of Professional Education provides a competency-based program leading to a primary degree in Engineering Design and Education in the belief this approach leads to active-learning and will produce technical engineers better equipped to meet the needs of industrial enterprises [6].

In parallel with these developments in engineering education and the increasing interest in Outcome Based Education in the ABET guidelines in the US, the emergence of the Bologna Process in European Higher Education has led to a growing interest in developing new ways of promoting learning from a competence-based perspective in all areas of higher education. The Tuning Methodology [7] has been developed at European level to establish reference points for common curricula on the basis of agreed competences and learning outcomes. This approach considered two broad types of competence: generic and subject-specific and attempted to identify such competences across the higher education curriculum. From 2000 to 2004, nine subject areas were studied, including Chemistry, Physics, Earth Sciences and Maths and subject specific competences were presented for each.

As the implementation of the Bologna Process in European Higher Education over the next four years will require higher education courses to accommodate competence-based and learner - centred curricula, this would seem to present a good opportunity to ally the competence-based and active learning approaches being developed in Engineering Education with the philosophy of Bologna and the Tuning Methodology.

In the US it has been noted that rates of attrition from the curriculum are dramatic considering the strong academic records of most students who choose to go into engineering. In a monumental study of nearly 25,000 students at over 300 institutions, Astin [8] found that only 43% of the first-year engineering students in his population went on to graduate in engineering. A common but incorrect explanation of high student attrition rates from engineering is that most of those who leave lack the academic ability to cope with the rigors of the discipline. In fact, studies have shown little difference in academic status between students staying in engineering and students leaving [9, 10]. The true explanation appears to involve a complex set of factors including students' attitudes toward engineering, their self-confidence levels, and the quality of their interactions with instructors and peers, along with their aptitude for engineering [8, 11,12].

Felder carried out a longitudinal study following the effect of active and cooperative learning methodology on a cohort of students over 5 semesters [13] and found that an experimental group using these techniques in chemical engineering subjects outperformed a comparison group on a number of measures, including retention and graduation, and many more of the graduates in this group chose to pursue advanced study in field. He also notes that academic performance in other course subjects was better in the groups studied.

A study by Ramirez and Velasques at the Univ. of Puerto Rico also found significantly higher academic grades were earned in cooperatively-taught offerings [14] while Paulson claims the overall pass rate in organic chemistry classes using these techniques was 20-30% higher than those in the traditional lecture model [15].

Various authors have described studies which show the effectiveness of active and cooperative learning in engineering education as an important element of course design in encouraging engagement of undergraduate students and contributing to active learning [16, 17].

Felder uses the term Active Learning to describe a number of techniques which can be incorporated in the conventional classroom/lecture hall context so as to give the learner a more active role in the learning process while he uses the term Cooperative Learning in accord with the definition originally proposed by Johnson, Johnson and Smith [18] that: Cooperative Learning is the instructional use of small groups so that students work together to maximize their own and each others' learning.

Smith et al. [16] propose that effective implementation of formal cooperative learning groups in a well-structured learning environment requires the following elements: positive interdependence;

- face-to-face promotive interaction
- individual accountability
- teamwork skills
- group processing.

A measure of the importance currently given to the Active and Cooperative Learning methodologies at international level can be seen from the fact that applied research in this area has been supported in a variety of projects funded by the US National Science Foundation [13, 24].

## 1.2 Lifelong Learning

Just as the Bologna Process in Europe has focussed attention on Active and Collaborative Learning technique in Engineering education, it has also been instrumental in initiating awareness of the importance of Lifelong Learning. Due to increasingly rapid technological change, with correspondingly shorter design and development cycles, the engineer needs to be constantly learning. To achieve a high-level performance, engineering professionals need to be able to change their learning focus, and smoothly adapt to change.

## 2 Background

The academic year 2006-07 was the first year in which new ministry-approved Bologna Process courses were run in Portuguese higher education institutions. As part of this new approach the Instituto Superior Técnico (IST), Lisbon, one of the country's leading engineering colleges, introduced Professional English for the first time as a soft skill core first-year subject in two of its engineering courses so as to "better prepare its engineers for professional life" in the words of Professor Pedro Lourtie, one of the signatories of the Bologna Declaration in 1999 and a senior IST academic [19]. In addition, IST has recently adopted an operating model in which the 2nd cycle of Bologna Masters degrees is run in English when there is one or more foreign student attending classes. This policy will be in operation from 2008/09.

This paper describes the initial implementation of this course in the first semester of 2006-07 for 45 Industrial Engineering Management students. As part of the IST response to the challenge of implementing the Bologna Process, there was a desire that in addition to developing student professional communication skills in English (at present engineering courses at IST as in other Portuguese universities and polytechnics are normally taught in Portuguese) this course would be designed to meet three additional objectives:

- contribute to student life-long learning;
- include Active Learning (AL) techniques during lecture contact-time;
- integrate language learning with the development of competences in areas which would be studied in other engineering subjects (in Portuguese).

## 3 Procedure

### 3.1 Life-long learning

Although it has been common practice for language lecturers and teachers to exhort students to create their own "vocabulary lists" (usually a form of a personal dictionary) it is generally noted in the literature that the majority of students tend not to do so. [20] In this case, students were recommended to create a Personal Learning Organiser (PLO) which goes beyond the vocabulary list model in that it contains English expressions and word-partnerships recorded within a professional engineering context rather than isolated words.

As an incentive to invest the time and effort in creating this resource, students are told that the PLO would not in itself be evaluated or compulsory but it could be consulted during their Professional English written tests and exams.

It is hoped that the PLO will serve as a resource for autonomous learning, not only for Professional English, but also during the specialized subjects of their course, which although taught in Portuguese typically feature extensive support bibliography in English. In addition there is a more long-term aim of encouraging students to continue using the PLO approach in their professional life after graduation.

Students were surveyed at the end of the semester as to their adoption and opinion of the PLO. Subsequently they will be re-surveyed at the end of the following semester (when they no longer have English). Likewise, other subject lecturers will be surveyed to get their feedback on student PLO usage and to receive suggestions to help in designing the PLO as an ongoing learner resource.

### 3.2 Active Learning

A number of specific AL techniques were employed based on the work of Felder and Paulson and which are said to increase student learning and performance in assessment on engineering courses [21, 22]

### 3.3 Content

The following content areas are included in the curriculum unit: Career Management, Innovation, Entrepreneurism, Environmental Ethics and Management Styles and specialist staff are encouraged to sit in and participate in the evaluation of student oral presentations.

## 4 Results

### 4.1 Life-long learning

Although 66% of students believed the PLO to be a very useful resource for preparing for their English assessment when surveyed, less than 50% anticipated that they would continue to consult it for their other subjects or in their future professional life. As both the course and the PLO are new to the institution and the students this is not altogether surprising but it clearly indicates the scale of the challenge which this approach to lifelong learning represents.

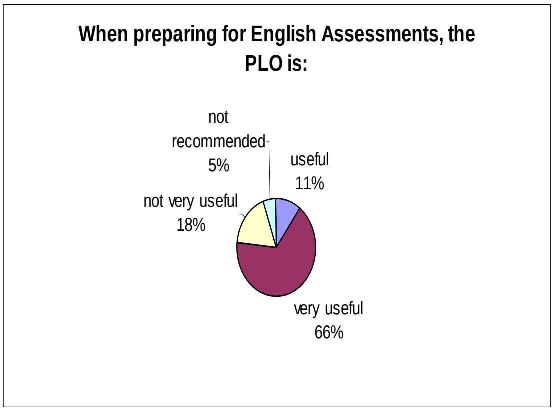


Chart 1.1 Evaluation of PLO to prepare for English Assessment

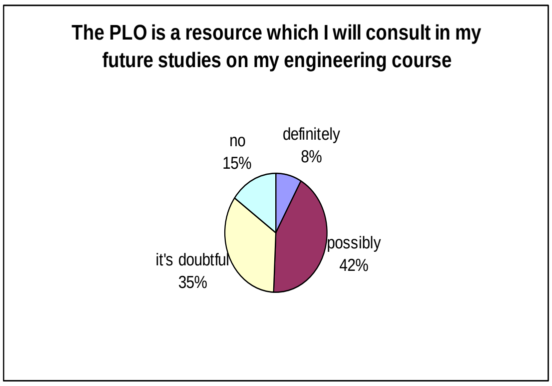


Chart 1.2 Evaluation of PLO for future studies

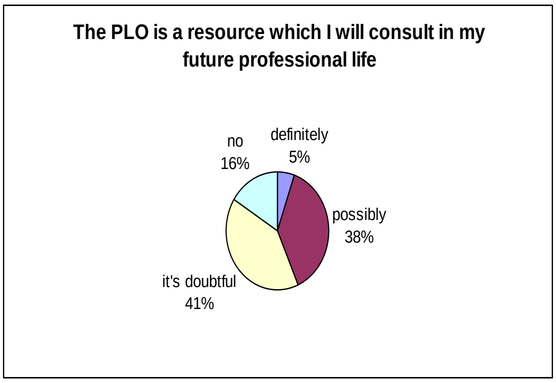


Chart 1.3 Evaluation of PLO for future professional life

### 4.2 Active Learning

The following elements were employed during scheduled lecture classes:

| | | |
|---|---|---|
| Affective Response | Student Summary | Students create quizzes |
| Active Review Sessions | Visual Lists | Jig-saw group activities |
| Puzzles/paradoxes | Reciprocal pair questioning | |
| Think-Pair-Share | Cooperative note-taking | |

Table 1.1 Active Learning elements

Although no measure of student activity during class was carried out in this particular case, future work will include this element

## 5. Conclusion

With regard to lifelong learning objective, we feel that the PLO represents a promising and innovative approach but will require ongoing study and follow-up with students and staff over a number of years to establish the best way to guide engineering students in this area.
Due to the methodological difficulties involved and the fact that the curriculum unit had not been offered previously, it was not our objective to establish that AL techniques resulted in improved learning for these particular students: the generation of credible data would imply a timescale, number of participating students and scale of project we are not in a position to undertake at this stage but given the results from other countries mentioned above and of a US meta-analysis involving results from over 30 published quantitative studies [23] and our own impressions of this first implementation, we are confident that this has an important role to play in bringing significant improvements in the learning of education students and better preparing them for professional life.

## 6. Future development

We are preparing a semi-quantitative Activity Monitoring Matrix which will allow lecturers to register the activity levels of students attending their classes and verify the extent to which their implementation of AL techniques is moving students from being passive receptors to being active agents in their own learning process.

*References*

[1] Felder, RM, Silverman, LK, Learning and

Teaching Styles in Engineering Education. J Engineering Education. Vol.78, No.7, 1988, pp.674-681. Preceded by the Author's Preface of June 2002: http://www.ncsu.edu/felderpublic/Papers/LS-1988.pdf, retrieved 29/5/2006

[2] Krezel, ZA, Pocknee, C, Moving Towards Project-Based Learning: A Case Study Looking at a First Year Civil Engineering Subject, 4th Intl Workshop on Active Learning in Engineering Education (ALE), 6 – 9 June, 2004, Nantes,France

[3] Braga, W, Evaluating Students on Internet Enhanced Engineering Courses. 32nd ASEE/IEEE Frontiers in Education Conference, 6-9 November, 2002, Boston, USA

[4] Vos, H, An Active Learning Organisation: Teaching Projects in Electrical Engineering Education, Fourth International Workshop on Active Learning in Engineering Education (ALE), 6 – 9 June, 2004, Nantes, France

[5] Freud N, Hillion S, Dias D, Bastide J, Gallet, J, A Two-Year Curriculum Using Active Learning for Technical Students at INSA-Lyon, 4th Intl Workshop on Active Learning in Engineering Education (ALE), 6 – 9 June, 2004, Nantes, France

[6] Schat-Zeckendorf A, Nieweg, M, Does Competency-Based Education Lead to Active Learning? 4th Intl Workshop on Active Learning in Engineering Education (ALE), 6 – 9 June, 2004, Nantes, France

[7] Tuning Educational Structure in Europe, Report on Pilot Project Phase II (2005), http://www.tuning.unideusto.org/tuningeu/index.php?option=content&task=view&id=173, retrieved 29/5/2006

[8] Astin, AW, What Matters in College: Four Critical Years Revisited, San Francisco, Jossey-Bass, 1993

[9] Besterfield-Sacre, M, Atman, CJ and Shuman, LJ. Characteristics of Freshman Engineering Students: Models for Determining Student Attrition in Engineering, J. Engineering Education, 86(2), 1997, pp.139-149

[10] Seymour, E. and Hewitt, NM. Talking About Leaving-Factors Contributing to High Attrition Rates Among Science, Mathematics and Engineering Undergraduate Majors, Final Report to the Alfred P. Sloan Foundation on an Ethnographic Inquiry at Seven Institutions, Bureau of Sociological Research, University of Colorado: Boulder, April 1994

[11] Acker, JC, Hughes, W Fendley, WR, Implementing a Recursive Retention Assessment System for Engineering Programs, 2001 Southern Association for Institutional Research Conference, Panama City Florida, retrieved 29/5/2006 from https://oira.auburn.edu/sair/4-7400-PP.pdf

[12] Cross, KP. On College Teaching, J. Engineering Education, 82(1), 1993, pp.9-14

[13] Felder, RM, Felder, GN and Deitz E J. A Longitudinal Study of Engineering Student Performance and Retention, V. Comparisons with Traditionally-Taught Students J. Engineering Education, 87(4), 469-480, 1998

[14] Morell de Ramirez, L and Velazquez, C. Enhancing Student Success in an Introductory Chemical Engineering Course: Impact of the Cooperative Learning Strategy, Proceedings Annual ASEE Conference, ASEE, 1996

[15] Paulson, DR. Active Learning and Cooperative Learning in the Organic Chemistry Lecture Class. J. Chem. Educ. 1999, vol. 76, 1136

[16] Smith, KA, Sheppard, SD, Johnson, DW, Johnson, RT. Pedagogies of Engagement: Classroom-Based Practices. J. Engineering Education, 2005, January, pp.87-101

[17] Felder RM, Brent, R. FAQs. Chemical Engineering Education, Vol.33, No.1, 1999, pp.32-33

[18] Johnson, DW, Johnson, RT, Smith, KA. Cooperative Learning: Increasing College Faculty Instructional Productivity, ASHE-ERIC Report on Higher Education, Washington, D.C.: The George Washington University, 1991, Retrieved 30/2/2007 from http://fc1.tamu.edu/index.html

[19] Interview (in Portuguese) with Prof. Pedro Lourtie on Rádio Europa-Lisboa 19/10/2006; Podcast retrieved 30/2/2007 from http://s-l-c-d.blogspot.com/

[20] Schmitt, N. 1997. 'Vocabulary Learning Strategies' in N. Schmitt and M. McCarthy (eds.). Vocabulary: Description, Acquisition and Pedagogy: Cambridge University Press

[21] R. M. Felder & R. Brent, Active Learning. Retrieved 30/2/2007 from www.uwf.edu/cutla/workshops/Active%20Handout.pdf

[22] D.R. Paulson & Faust J L, Active Learning for the College Classroom, Retrieved 30/2/2007 from http://www.calstatela.edu/dept/chem/chem2/Active/

[23] Springer, L., Stanne, M. E., and Donovan, S. (1998). "Effects of cooperative learning on undergraduates in science, mathematics,

engineering, and technology: A meta-analysis. Retrieved 30/2/2007 from http://www.wcer.wisc.edu/archive/cl1/cl/resource/scismet.pdf
[24] Goodson C, Ezelle S, Miertschin, Engineering Technology Education and the National Science Foundation: Results, Journal of Engineering Technology, Fall 2000