FACILITATING THE ADOPTION AND DISSEMINATION OF ACTIVE AND COOPERATIVE LEARNING METHODOLOGIES IN ENGINEERING EDUCATION USING A LEARNER ACTIVITY INDEX APPROACH.

ISABEL S CARVALHO
Department of Mechanical Engineering
Instituto Superior de Engenharia de Lisboa
Lisboa
PORTUGAL
icarvalho@dem.isel.ipl.pt

BILL WILLIAMS
Escola Superior de Tecnologia do Barreiro
Setubal Polytechnic
Barreiro
PORTUGAL
bill.williams@estbarreiro.ips.pt
http://www.estbarreiro.ips.pt

CONTEXT

The overall aims of the project are centred on the adoption and dissemination in engineering education at institutional and inter-institutional level in Portugal of good practice with regard to Active and Cooperative Learning (ACL).
We aim to achieve this over a three-year project lifetime through a two-phase strategy:
i) Initial implementation of ACL techniques in formal teaching contexts at departmental level in two engineering colleges through the use of self and peer observation using a semi-quantitative tool to measure a Learner Activity Index;
ii) Subsequent dissemination of the approach to other departments and colleges using online Community of Practice (CoP) cultivation strategies and Web 2.0 tools.

Background

As the implementation of the Bologna Process in European Higher Education by 2010 will require higher education courses to accommodate competence-based and learner-centred curricula, for those involved in engineering education in Portugal this would seem to present an ideal opportunity to ally the competence-based and active and cooperative learning approaches being developed in engineering education at international level (particularly that in the US associated with the ABET adherence to outcome-based education in 2000) with the general philosophy of Bologna and the associated Tuning Methodology for developing and assessing learner competences in the European context.
At institutional level, high failure and drop-out rates for students on engineering courses have been a matter of concern for many Portuguese higher education institutions as evidenced from external evaluations carried out by the European University Association and internal quality reports compiled by institutions.

Engineering Faculty and Education Sciences

The majority of engineering lecturers have not had specific training in Education Sciences and the provision of "pedagogical training" is often mooted as a way to tackle perceived skill gaps in this area. Such training typically takes the form of short-duration

workshops run by staff from educational rather than engineering fields and in many cases may not lead to significant change in the faculty practice at the "coalface" of the lecture hall/classroom/laboratory or in course design.
Furthermore, many lecturers, although keen to improve their teaching do not feel completely comfortable with the language and concepts of pedagogy and this may lead them to put their faith in technological solutions (e.g. e-learning platforms) rather than analysing the learning process itself and adopting approaches which have grown out of the considerable body of work related to the Scholarship of Teaching and Learning in Engineering Education. To date there has been relatively little work in this field in the context of Portuguese engineering education and most teaching tends to follow a fairly traditional knowledge transmission model in which the role of the learner is largely that of passive receptor.

Significant findings from other research studies
Although there is no published work to date demonstrating the value of these techniques within the specific context of Portuguese engineering education, given the existence of a large and credible body of research showing the value of ALC techniques in engineering education in other countries, particularly in the US (Springer et al, 1998; Felder et al, 1998), we believe one can be confident of the qualitative benefits of employing these techniques in the Portuguese context.

RESEARCH QUESTIONS

Can a semi-quantitative approach to measuring learner activity in a traditional lecture setting be effective in achieving the adoption of new pedagogical techniques in the context of Portuguese engineering education?
Can effective dissemination of good practice be achieved using a CoP cultivation approach based around Web 2.0 tools?

Objectives
To motivate engineering faculty to introduce established active and cooperative learning techniques in their lectures ("theory classes" in the Portuguese system) and semi-lectures ("theory-practice classes") over a three-year period.
To cultivate a community of practice approach which will encourage the dissemination and development of this approach at institutional and national level in Portugal.

METHODOLOGY

Although the project is centred on the implementation of both Active Learning and Cooperative Learning techniques, the intention is not to introduce the approaches simultaneously in the two participating schools. Our own experience and personal contacts with R. Felder lead us to believe that Active Learning (AL) techniques are initially more easily taken up by teaching staff who are accustomed to more traditional approaches and also are more immediately accepted by students ("Cooperative Learning tends to be the hardest student-centred method to sell immediately", R. Felder).
For this reason, in the first two years of the project, we propose to introduce Active Learning methods via a core group of lecturers, mostly new to this approach, who are teaching students at the ESTBarreiro Engineering College. The Cooperative Learning approach, on the other hand, will be implemented with 4th year students at ISEL Engineering College.
Assuming that engineering staff are often more comfortable with quantifiable results and a pragmatic approach, rather than one involving an immersion in unfamiliar

education science theory, we have been developing a simple semi-quantitative tool (Learner Activity Monitor Matrix - LAMM) which uses in-classroom observation or post-class video observation to monitor the degree of student activity before and after the implementation of ACL techniques in their classes. This allows an individual lecturer or team to focus on the question of learner activity during class contact time and develop efficient techniques to increase it.
Thus, the first year of the project has involved using self and peer observation of lectures to allow each participating lecturer in the pilot group (8 in all) to first of all establish a baseline level for the Learner Activity Index of students in his/her subject curriculum unit before the implementation of AL techniques and then introduce tried and tested AL techniques (Paulson, 2008; Felder and Brent, 2006) with the intention of increasing their activity index.
The second year aims to build on this experience by involving more faculties at the original participating colleges and two other local Portuguese engineering colleges who have expressed interest in participating. In the final year we expect to broaden our community of practitioners to include more distant participants at national and international level. During the first year we are operating our online community spaces in Portuguese but expect to evolve to a bilingual English-Portuguese environment at a later stage to facilitate international participation.

ICT tools
The project team proposes to use web-based video-conferencing and Web 2.0 tools for knowledge sharing and community building within the research team itself and with the dissemination partners in the later stages of the three-year project. This involves the following use of ICT tools:

- video recording of lectures to a dedicated server followed by their analysis to determine Learner Activity Indices before and after the introduction of ACL techniques;
- use of a proprietary browser-based videoconferencing tool (Moonlight Conference) for synchronous meetings between faculty in the participating colleges;
- use of online groups (Google Groups) and wikis (pkWiki) for faculty Knowledge Sharing;
- use of social software (Ning) to facilitate community building between participating faculty in different institutions in the latter stages of the project.

Dissemination
Our approach to community building is based around the CoP conceptual approach developed by Etienne Wenger (Wenger et al, 2002) and our participation in the community building and mentoring activities of CP Square, the Community of Practice for Communities of Practice (CP Square, 2008).
We also aim to apply the insights of the Australian Flexible Learning Framework report on Embedding Innovative Practices which suggests that embedding an innovation requires uptake by a critical mass – i.e. by mainstream adopters rather than early adopters and that incremental innovations that complement existing practice are more likely to be adopted and embedded than more radical approaches that require significant change of practice (Jasinski, 2007).

Data gathering
The project having started in October 2007, we are still in the early stages of data gathering. The work so far has focussed on preparatory workshops for the eight

participating lecturers participating in the pilot group and on adapting the format and organization of the LAMM to best monitor existing teaching practice.

FINDINGS

- Preliminary conclusions suggest that registering learner activity every 5 minutes, as originally proposed, does not give a fine enough measurement and we settled on 2 minute intervals as giving a satisfactory balance between data registering and observer capability;
- In addition to the learner activity index calculation the LAMM has also been adapted to capture data on learner question and answer which is reflected in a Participation Parameter;
- Faculty in areas like civil engineering structures, maths and statistics, report that they have difficulty adapting the Active Learning techniques available online to their particular discipline specifics;
- Whilst lecturers readily adapted to using a Google Group to facilitate asynchronous communication between group members they still evince some reluctance in using the wiki.

CONCLUSIONS

It should be said that it is not our aim to attempt to demonstrate unequivocally that ACL techniques are as beneficial in the Portuguese engineering education context as they have been shown to be internationally, because the generation of valid, credible data on this aspect would imply a timescale, number of participating students and scale of project we believe we are not in a position to undertake at this stage.

Although we are satisfied we now have a satisfactory methodology and instrument to semi-quantitatively measure average learner activity in engineering lectures, lecturers report they need more preparation in terms of training workshops to feel confident in introducing Active Learning techniques. Although we have begun work on creating in-house resources and lesson-plans, there is a need for access to proven lesson plans in engineering and maths subjects

We are confident, that this approach can bring about significant improvements in the learning of engineering students in the participating colleges and provide a positive multiplier effect in other linked institutions, but feel we still have some ground to cover at local level before we have data to share with potential partners at national or international level.

ACKNOWLEDGEMENTS

Financial support has been partially provided by the (PTDC / CED / 69529 / 2006) of the Portuguese Ministry of Science and Technology and Higher Education. The authors also acknowledge the technical support from Moonlight, Portugal within the current Project.

REFERENCES CITED

CP Square community (2008), retrieved 30/1/2008 from http://www.cpsquare.org/.

Felder, R.M., Felder, G.N. and Deitz, E.J. (1998). A Longitudinal Study of Engineering Student Performance and Retention. V. Comparisons with Traditionally-Taught Students. *J. Engineering. Education, 87(4),* 469-480.

Felder, R.M. and Brent, R. (2006). Active Learning, retrieved 30/2/2007 from http://www.uwf.edu/cutla/workshops/Active%20Handout.pdf.
Jasinski, M. (2007). Innovate and Integrate: Embedding Innovative Practices Research. *Report of the Australian Flexible Learning Framework*, pg. 6, 8, retrieved 15/2/2008, http://www.flexiblelearning.net.au/flx/webdav/site/flxsite/shared/New%20Practices/Innovate_and_Integrate_Final_26Jun07.pdf .
Paulson R.M. and Faust, J.L. (2008). Active Learning for the College Classroom, retrieved 30/1/2008 from http://www.calstatela.edu/dept/chem/chem2/Active/.
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 30/1/2008 from http://www.wcer.wisc.edu/archive/cl1/cl/resource/scismet.pdf.
Wenger, E.C., McDermott, R. and Snyder, W.C. (2002). Cultivating Communities of Practice: A Guide to Managing Knowledge, Harvard Business School Press, Cambridge, USA, 304 pages (ISBN 1-5781-330-8).