Active Learning as a Methodology for Motivating Team Work in Large Civil Engineering Classes

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Abstract

The renovation of teaching methodologies is leading to shifting perceptions of roles and responsibilities of both teachers and students concerning the way traditional and new materials are presented and learnt. While teachers strive to be creative and flexible and provide students with practical means for "self-teaching", students recognise the need for more responsibility and discipline. This paper describes a methodology for managing and motivating independent group work for students taking the Environmental Impact Assessment course included in the Civil Engineering programme at the University of Minho, either as a requirement or an elective. Though not agreeing on the overall level of difficulty of the course, the students were encouraged to complete their project assignments based on the critical analysis of real projects subject to EIA. The results indicate a significant move towards innovative approaches for motivating large classes of engineering students in a transdisciplinary context, through collaborative learning activities.

Keywords: civil engineering; active learning; independent work; self and peer-assessment.

1 Introduction

In recognising the generalised need for a more active approach to learning, the Bologna Declaration has driven a series of transformations designed to foster the deeper understanding of higher education topics by promoting newer approaches to teaching. The renovation of teaching methodologies is leading to a shift in perception of roles and responsibilities of both teachers and students, with regards to the way traditional and new materials are presented and learnt. While teachers are encouraged to be creative and flexible in their approaches and, above all, provide students with practical means for "self-teaching" through collaborative and active learning (Guedes *et al*., 2007; Oakley *et al.*, 2004), students recognise the need for more responsibility and discipline on their part. By being allowed and encouraged to interact with their peers during and class time, posing questions and debating issues, students are able to benefit from an enhanced collaborative environment, where active learning takes a central role (Beichner *et al.*, 2007).

This appears to be a particularly adequate strategy for teaching large engineering classes whose students tend to favour more active approaches to learning, however diverse in learning styles and apprenticeship they may be (Felder & Silverman, 1988). These are particularly desired in engineering, where the call for more practical and tutorial approaches instead of the traditional lecture-types is largely preferred.

2 Scope

This paper describes a methodology for managing and motivating independent group work, using tutorial techniques for the practical sessions of the Environmental Impact Assessment (EIA) course included in the undergraduate Civil Engineering programme at the University of Minho.

3 Background

In the past, this second semester course was offered to fifth-year students as an elective course for which registration and attendance was traditionally kept to an average of 30 students. The small group of students lent itself to teaching and learning strategies centred on frequent instructor-mediated debates and discussions around the course's programme themes. The students were also required to conduct group projects around suggested topics and give a presentation at the end of the semester. The course was offered as an elective to fifth-year students for the last time in 2007-2008. Also in 2007-2008 and pursuant to the recommendations made by an

external and international evaluation panel, the course became a requirement for fourth-year students, a move that resulted in the need to teach, support and evaluate a universe of approximately 150 undergraduates. Already familiar with the challenges of teaching large classes, the authors were, nonetheless, faced with the challenge of re-designing a course that neither had taught before.

The complexity and all-encompassing nature of the subject further emphasised the necessity of a particularly well-organised and well-defined curriculum in terms of aim, content, teaching strategy and evaluation methodology. This was not a conventional engineering course in the sense that it did not necessarily require students to solve numerical problems or learn and apply calculation and design procedures. It mostly versed on concepts, laws and regulations, evaluation processes and documental procedures within the Portuguese system for EIA and SEA (Strategic Environmental Assessment), matters that are traditionally perceived as important but nonetheless dull, tedious, often frustrating, and not meeting the typical expectations of engineering students in what practical classes are concerned.

4 Methodology

The methodology described herein concerns the practical sessions of the course. The lecture classes followed a more traditional approach, where the instructor presented the learning subject using overhead presentations while encouraging the participation of the students and discussion of the topics under study.

4.1 Work assignment and monitoring

The course was organised in 2-hour long weekly lectures, for which attendance was recommended but not mandatory and 2-hour long weekly practical sessions, during which the students were required to work in groups of 3 to 5 elements and perform a series of tasks leading up to a final report for turning in at the end of the semester. The groups were required to conduct a critical analysis of one or more actual environmental impact assessment situations using case-file databases that are available to the public in institutional websites and offices. The goal was to expose the students to so-called “real-world” case studies by encouraging the research and review of relevant material and literature, namely documentation pertaining to complete EIA case-files as mandated by Portuguese regulations and guidelines. While providing a broad understanding of the field of study, the students were able to observe and discuss the limitations of bringing theory (regulations and guidelines) to practice (real projects).

The proposed approach brought a number of issues that were addressed early on during the planning stages of the course. Primarily, there was the imperative for providing project topics that would be adequately diverse so that work would not be replicated between different groups. Given the multidisciplinary nature of the field, each group was allowed to choose and rank, by order of preference, three thematic areas from a pre-determined list. Also, each group was given three options as to what type of study to conduct. Most groups were assigned their first or second preference of thematic area.

The need for an effective evaluation of each group’s ability to manage their own study and work effectively as a team led to a work progress monitoring plan, established to assist the instructors in this task. This monitoring plan included a series of progress meetings scheduled at predetermined dates and times within the class schedule, since the students were given the class time for conducting their research and writing and allowed to do so outside the assigned classroom. Each group sent a representative to meet with the instructor and deliver – along with any other written materials if and when requested – a written and oral progress report on the objectives accomplished thus far, goals to meet and tasks to be performed by the following meeting (Figure 1).

ENVIRONMENTAL IMPACT ASSESSMENT

Practical Sessions: Group work monitoring

School year: 2007 - 2008

PROGRESS REPORT

Date:	Group:	Representative:
Title:		
Accomplished objectives:		**Goals for the next work period:**
(…)		(...)
Difficulties:		**Other issues:**
(…)		(…)

Figure 1: Progress Report Template

Each group also reported on obstacles, difficulties and any other issues deemed important, for which they sought and obtained the instructor's advice and guidance. The role of group representative rotated among the team members and insure that the instructor talked to each student at least once during the semester (Figure 2).

ENVIRONMENTAL IMPACT ASSESSMENT

PRACTICAL SESSIONS: Progress meetings

School year: 2007 - 2008

GROUP ID	THEME / TITLE	ELEMENTS		(Date 1)	(Date 2)	(Date 3)	(Date 4)	(Date 5)
1.1		(ID Number)	(Full Name)					
1.2								

Figure 2: Progress Meetings Log

The instructor was also available during office hours, 2 hours per week and by appointment via e-mail for additional guidance to the groups that requested it. Thus designed, the practical sessions of the EIA course provided the time and space for the students to carry out independent work and devise working strategies that suited them best, while benefiting from guidance as needed. Exceptionally, the instructor presented a pre-scheduled class on an EIA software tool that was required as part of the work.

4.2 Evaluation

The final grade of the course resulted from a weighted average of the theoretical grade (worth 65%) – in the form of two written-tests administered during the semester at predefined dates and designed to appraise the theoretical knowledge derived from the lecture classes – and practical grade (worth 35%). The practical evaluation was amply supported by the regular monitoring of the work. The final reading and evaluation of the reports was aided by the knowledge on each project's history and team performance gathered throughout the semester.

Since it was necessary to evaluate each individual within the group, the authors resorted to a simplified form of self and peer-assessment to help differentiate between individual contributions and assign project grades. Accordingly, and upon submittal of the work, each student was required to email a private evaluation of his/her individual performance as well as an assessment of the remaining students in the group, in the form of percentage

contribution towards the total work effort. The final course grade was complemented by those obtained in the two written evaluation tests designed to appraise the theoretical knowledge derived from the lecture classes.

At the end of the semester, both students and teachers were also required to fill out an anonymous questionnaire as part of the Teaching/Learning Evaluation survey conducted by the University, in which both parties are given the opportunity to provide a quantified qualitative evaluation of the teaching and learning performances. The survey included a total of 37 parameters which were rated on a 6-point scale – 1 for "Strongly Disagree" through 6, for "Strongly Agree". This survey also included as self-assessment section. A list of 25 parameters and rating scale used for evaluating the teacher are presented in Appendix.

4.3 Resources

The progressive use of a wide and balanced variety of strategies for effective teaching and learning benefits from the support and is advanced by new electronic educational tools. Taking advantage of the existing resources, the authors decided to use the institutional e-learning platform (Blackboard Academic Suite®, BAS) in a variety of tasks such as sharing of class notes and study materials, and course managing tasks (posting of notices, rules and guidelines meeting schedules, etc.). The students were able to easily access the platform to view and obtain posted materials and also to post their own work for evaluation. The use of this additional interface proved to be a valuable enhancement to the authors' teaching and evaluation strategies. For instance, the availability of a "safe assignment" tool offered by the BAS platform allowed the teacher to verify plagiarised content in the submitted reports. Aware of this functionality, students were more likely to produce original text and carefully identify and list sources of information.

5 Results and Discussion

Of the 149 fourth-year students enrolled in the course, a total of 109 students in 26 groups actively participated and successfully completed the proposed practical assignment. Since the authors were also responsible for the elective course offered to fifth-year students (a total of 26 enrolled students, with 23 able to complete the project), the values in Figure 3 refer to the combined sets of students. Overall, they were able to demonstrate a satisfactory ability to carry out independent work and meet the goals set forth, with varying levels of enthusiasm and commitment to the duties and tasks assigned.

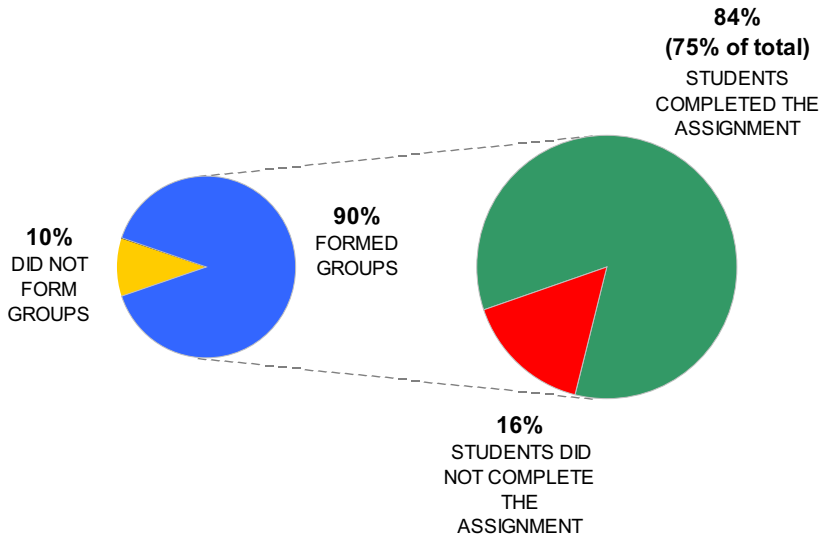

Figure 3: Student Participation

Fifth-year students were offered identical course requirements, class organization and practical methodology. In fact, both sets of students simultaneously attended the lectures and were offered the same course materials and notes. Fourth and fifth-year students were equally required to fill out the Teaching/Learning Evaluation survey for both lecture and practical classes. Since the methodology described herein concerns the practical sessions of the course, the results presented below exclude the students' assessment of the lecture sessions.

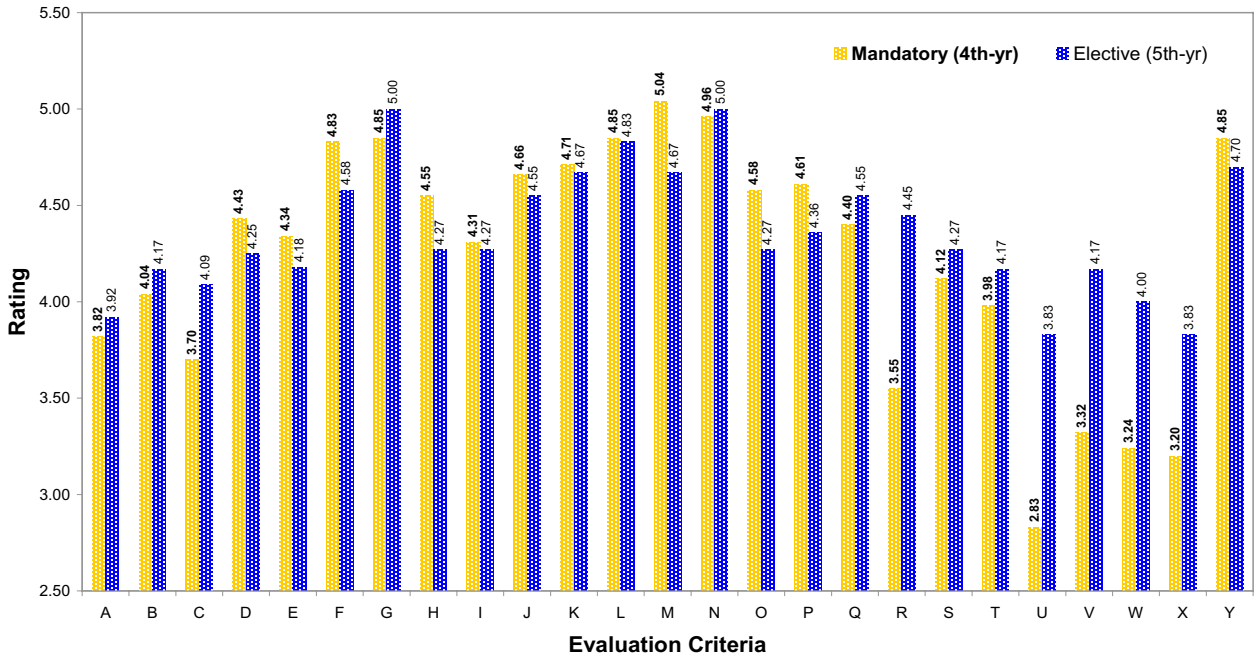

Figure 4: Teaching/Quality Evaluation Survey Ratings (Practical Sessions) by Fourth-Year Students (Mandatory) and Fifth-Year Students (Elective)

Overall, the ratings assigned by both groups of students are very similar and agree on most of the parameters, with few noteworthy exceptions. This is the case for parameter U, difficulty of the course. While both groups of students were least likely to agree with the level of difficulty, this was more evident for the students for whom the course was mandatory. In fact, fourth-year students assigned a full point less, corresponding to a total of 72% of disagreeing individuals. On the contrary, 67% of the fifth-years agreed with the degree of difficulty imposed. Likewise, the importance of the course (parameter W) received a lower rating from fourth-years. Not surprisingly, fifth-years were more likely to find the course more important. Fourth-year students were also more likely to disagree with the adequacy of the evaluation system (parameter R), assigning a significantly lower rating (a 0.9 difference) that their fifth-year colleagues. Fourth-year students were also less likely to agree with the work load demand (parameter V). In general, their assessment of the course warranted a 3.20 rating (parameter X), whereas the older students were a bit more agreeing, assigning a rating of 3.83.

These differences could be explained by two major distinctions between both sets of students. On one hand, fifth-year students were already familiar with both teachers, having had them in past courses. This may have allowed the older students to be feel more at ease and more focused on the subject because the teaching styles and personality traits of each teacher were already known. Fourth-years had little or no knowledge of the new teachers and thus, had the additional effort of getting to know them. However, the most important difference was the fact that fifth years chose to take the course, while fourth-years were given no such choice. This alone is a factor that could have led to some demotivation amongst the younger students, for not all of them were interested in pursuing the subject but were, nonetheless, required to do so. One may even speculate that this may have predisposed a significant number of students to agree on a poorer rating for certain aspects of the course.

The perception that the course was more difficult than expected was supported by feelings of anxiety regarding the lecture materials. When asked about these, the students admitted a lack of enthusiasm for the learning topics, describing them as complex and tedious. These observations were supported by feelings of bewilderment and incomprehension about the way the course was being managed this year, when "…it had been so differently done in the past". After being presented with the rationale for the new teaching approach, the students understood and accepted it but continued to have a difficult time letting go of their pre-conceived notions regarding how demanding they thought the course would be, an opinion built on conversations with older classmates that had successfully taken the course in previous years. These perceptions proved difficult to overcome emotionally, though intellectually it was clear to the students that they should not have expected identical approaches from different teachers (past and present), especially when the context of the course had changed as dramatically as it had. These feelings were expressed by both fourth and fifth-year students.

Consequently and regarding the written test performances, the students were neither thrilled nor thrilling. Their feelings of frustration and apprehension compounded by a fear of failing the class altogether (even before the written test grades were known) spilled into the practical sessions, hindering the motivation to go on working and get the job done. As a result, the scheduled progress meetings often became encouragement and pep talk sessions aimed at keeping the students focused and motivated. Despite the hardships, most groups persevered and managed to finish and submit the work, with satisfactory results.

Because the projects were centred on the analysis of case studies in light of topics covered in lecture, the practical sessions also served as a place for discussing some of the more theoretical aspects of the project, while assisting the students in cementing their knowledge of certain lecture materials. However, this was only carried out by some students that requested it, thus revealing more interest in the subject and more enthusiasm about their own project. The majority of the students, though given equal and ample opportunity to do so, both inside and outside the classroom, did not take advantage of this particular type of interaction with the teacher. In general and not surprisingly, groups that participated more and were more inquisitive about their work were also able to produce better reports. Nonetheless, the vast majority (94%) of the students easily obtained a passing grade on their projects.

In terms of the better-rated parameters, both sets of students selected concern and care about students, availability for answering questions and encouragement for expressing different ideas/questioning the teacher (parameters M, N and L, respectively). The vast majority (94% of the fourth and 100% of the fifth-year students) felt encouraged to express their points of view and in doing so, question the teacher in her own opinions and perceptions. An overwhelming majority (98% and 100%, respectively) felt there was concern and interest about them, an observation supported by the general perception of encouragement of participation in the course's activities (parameter K).

The overall results are encouraging and seem to agree with information obtained from casual and sporadic conversations with some students throughout the semester. The methodology was welcomed by the majority of them and when asked whether they would recommend it to classmates from the following school year, the majority would do so. The students mostly appreciated the freedom to manage their own work schedules though recognising that more effort and discipline was required on their part to remain focused and committed to the assignment. For the most part, the students were able to effectively accomplish the objectives as initially proposed. As for the peer-assessment, everyone seemed to have understood the purpose and importance of the task. Not surprisingly, the majority of the groups distributed equal effort percentages amongst their elements. Though this may have not corresponded exactly to an equal distribution of workload, it does seem to indicate a sense of *team unity*, particularly in groups where the effort was perceived – to the best of the instructor's knowledge – as having been unevenly shared.

6 Conclusions

The Environmental Impact Assessment course became a requirement for 149 fourth-year students in 2007-2008, while this was the last time the course was offered as an elective to 26 fifth-year students. The authors were responsible for the two courses and offered both sets of students the identical course requirements, methodology and access to the same learning materials. Because of their pre-existing motivation to attend the course, fifth-year students were less likely to give it a lower rating than their fourth-year classmates. Also, the previous acquaintance with the instructors might have increased the level of comfort of the older students, allowing them to more actively focus on the course and not as much on getting to know the teachers, their teaching styles and personalities. Nevertheless, there was a common sense of disenchantment with the course's level of difficulty and importance.

Regardless of the enduring lack of enthusiasm towards the course's more tedious topics and concepts, the students were able to overcome this obstacle by using active learning strategies in the form of a practical project that required the application of theoretical concepts derived from lecture. In this context, active learning functioned as a means to resist and balance demotivation and lack of interest towards particularly difficult aspects of the course's learning content.

Because the groups were entirely responsible for managing their work, there was an overall recognition of the need for disciplined and responsible approaches in order to complete the assignment in a timely manner and according to the proposed objectives. This was effectively accomplished by most individuals.

The opportunity to study and analyse real cases was referred as a particularly positive aspect of the methodology. The students were pleased with the fact that they were required to use and critically analyse actual procedural documents and regulations, favouring a broader understanding of the subject.

Despite the fact that the purpose of the peer and self-assessment exercise was followed by all the students, there is a need for additional reflexion. Though perceived as important and useful, it was not considered essential by students.

The methodology allowed for the regular interaction between teacher and students and monitoring of the work progress, which facilitated the final evaluation of the written reports. Additionally, it allowed the teacher to devote different levels of effort throughout the semester, with the more labour intensive moments at the beginning and end (initial planning and final evaluation). Consequently, and throughout the semester, the instructor was able to devote more time and effort to other activities, namely research, without compromising the quality of her guidance and availability to the students. This flexibility in schedule was both welcome and refreshing, leading to more focused and more productive moments in both areas of activity.

Overall, both instructors and students considered the implemented methodology to be positive and successful. Consequently, similar approaches are currently being applied to other courses of the 2008-2009 school year.

The experience described herein represents a significant move towards innovative and adequate approaches for handling and motivating large classes of engineering students in a transdisciplinary context, by encouraging active and collaborative learning activities and strategies. More importantly, it provided students with an opportunity to enhance their individual personal and professional abilities.

Appendix

Teaching/Learning Evaluation Survey Parameters	
A	Interest in the subject
B	Usefulness of learning
C	Understanding/Grasp of content
D	Classroom dynamics
E	Classroom organisation
F	Commitment to teaching
G	Meeting schedules and other activities
H	Clarity of subjects taught
I	Organisation and availability of study materials
J	Ease of producing class notes
K	Encouragement of students participation
L	Encouragement for expressing different ideas/questioning the teacher
M	Concern/care about students
N	Availability for answering questions
O	Comparison of different theories and existing models
P	Presentation of different points of view
Q	Usefulness of information regarding projects
R	Adequacy of evaluation system
S	Usefulness of projects and/or reading assignments
T	Number of projects and/or reading assignments
U	Level of difficulty of course
V	Work demand/load of course
W	Importance of the course
X	Global evaluation of the course
Y	Global evaluation of the teacher

Rating Scale	
1	Strongly disagree
2	Disagree
3	Somewhat disagree
4	Somewhat agree
5	Agree
6	Strongly agree

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