The Challenge of Implementing a Student-Centred Learning Approach in Large Engineering Classes

CRISTINA C. DANKO[1], ANTÓNIO A.L.S. DUARTE[2]
Department of Civil Engineering
University of Minho
Campus of Azurém, 4800-058, Guimarães
PORTUGAL
[1]ccdanko@civil.uminho.pt, [2]aduarte@civil.uminho.pt

Abstract: - The renovation of teaching and learning methodologies, promoted by the onset of the Bologna Declaration, is leading to shifting perceptions of roles and responsibilities of both teachers and students. Particularly in large engineering classes, certain subjects benefit from more active approaches to learning, namely those associated with team work and tutorial practices, rather than traditional lecture/teacher-driven presentations. Project-led education (PLE) and Project/problem-based learning (PBL) are successful student-centred teaching strategies by directing team work towards independent learning. These new approaches transfer the teacher's role from a mere transmitter of knowledge to that of advisor and facilitator of the learning process, by providing guidance and suggestions designed to encourage students to find their own solutions for proposed problems.

This paper describes a methodology for promoting and encouraging independent team work using tutorial techniques for the practical sessions of the Environmental Impact Assessment course (mandatory and elective) included in the Civil Engineering programme at the University of Minho. The authors were faced with a multi-faceted problem: managing and motivating a large class of civil engineering students in a transdisciplinary and non-traditional civil engineering setting. So, they decided to implement a project-based strategy aiming to foster the development and enhancement of student ´skills and aptitudes. The learning objectives were well-defined, as well as a set of pre-scheduled tutorial meetings for team work monitoring and assessment.

The overall project goal was to conduct a critical analysis of one or more cases concerning environmental impact assessment, in view of the concepts apprehended in lecture and through literature review of pertinent documents and applicable regulations. The students were pleased with the requirement to use and critically analyse procedural documents and regulations, favouring a broader understanding of the subject. The opportunity to study and analyse real cases was referred as a particularly positive aspect of this methodology, which allowed for another learning dimension towards the development of professional competencies. At the end of the semester and upon submitting the final written report, each student was required to conduct a simple exercise of self and peer-assessment.

The results of the *Teaching/Learning Evaluation* institutional survey were used to determine how successful the implementation of the new EIA course design had been, and, overall, both instructors and students considered the implemented methodology to be positive and suitable. The ability to conduct independent work and the freedom to manage their own work schedules were particularly appreciated, especially by students with heavier workloads from other courses. The experience described represents a significant move towards innovative approaches for handling and motivating large engineering classes in a transdisciplinary context, by encouraging active and collaborative learning activities, and by leading with real-world problems.

Key-Words: PLE, PBL, team work, large engineering classes, active and collaborative learning, self and peer-assessment, teaching evaluation, tutorial and monitoring meetings.

1 Introduction

Newer approaches to teaching are being promoted by the onset of the Bologna Declaration. In its aim to deepen the understanding of higher education topics, it is fostering a series of transformations, namely in the manner teachers are required to approach traditional and new materials and the way students are expected to learn from them [1].

This renovation in methodologies is bringing about a shift in perception of roles and responsibilities for both teachers and students. Whereas teachers were once seen as the ultimate class controller, the students were seen as no more than pupils eager (or not) to learn the presented material. Mauri and Marin-Garcia (2008) [2] provide a compelling description of a lecture conducted within the pattern of traditional teaching. Teachers were required to present the materials and evaluate the students over a written test of some sort. Depending on the subject's nature and constraints, a practical component would be added to the syllabus. The students would then have the opportunity to study, test and apply theoretical concepts, while possibly debating and discussing observations and results. Nevertheless, these practical sessions would still require a traditional managing approach from the instructor's standpoint and would not be considered more than a "practical lecture" of sorts. Consequently, the vast majority of the students would hardly move beyond a type of learning that is superficial and focused on the development of exam-passing competencies as the ultimate goal [2, 3].

Due to their complexity and interdisciplinarity, engineering themes warrant an equally complex form of learning that is fundamentally based upon the apprehension, comprehension and application of concepts, leading to the ability to synthesise knowledge and critically analyse information. These activities require the active participation of the students in their learning process. By mandating more autonomy and organisation in the handling of information, learning can be more effective [3] and lead to longer lasting knowledge retention [2].

Having proven their broad applicability and effectiveness, revised strategies to teaching and learning are becoming increasingly popular. More creativity and flexibility in teaching, as well as self-teaching through collaborative learning [1, 4], while perceived as recent trends, have been the focus of several education experiments and studies since the 1960s.

The engineering field has been fertile ground for the successful implementation of such methodologies. Particularly in large engineering classes, certain subjects have benefitted from these approaches. In general, engineering students, though diverse in learning styles and apprenticeship, tend to favour more active approaches to learning [5, 6], particularly those associated with tutorial practices, rather than traditional lecture/teacher-driven presentations. These strategies meet the needs of the main student types, active, sensing, visual and global learners. Active learners benefit from problem-solving assignments to carry out within a team. Sensing students are particularly mindful of the teacher's tutoring, taking in information, data, and the theoretical support for conducting their work. Visual learners' needs are addressed when these tutorial and verbal feedbacks are supported by visual presentations including schematics and pictures. Finally, global learners welcome the opportunity to tackle open-ended problems through brainstorming and discussing possible solutions with their team mates. Also, they are particularly apt for seeing the "big picture" and critically synthesise the key aspects of the problem [5, 6].

A clear benefit of being exposed to more active and cooperative learning environments is that students are encouraged to collaborate with their peers, questioning and teaching one another [7]. Additionally, though autonomous in their problem-solving towards project-completion, the students are required to actively interact with their teachers/tutors be it for guidance or for reporting on the progress of their work. This establishes a clear departure from the passive behaviour observed in more traditional settings. As Mauri and Marin-Garcia (2008) [2] put it: "When the lecturer asks a question to the students, usually a student from the first file answers that question, while many others avoid looking to the lecturer at that moment.".

The implementation of student-centred teaching/learning methodologies is certainly challenging to both teachers and students. On one hand, in adapting the curricula, teachers are required to adopt whole new approaches that are more practical and undoubtedly creative; on the other hand, students are called to recognise the necessity of more responsibility and discipline on their part. Furthermore, there are challenges that extend beyond matters of the curricula, teaching and learning aspects of engineering education [8]. As engineering programmes strive to effectively adapt to the precepts of the Bologna Declaration, critical matters such as ensuring the availability of adequate resources – namely human, financial, material and technological – must be addressed and resolved.

This paper describes an application of project-led education (PLE) and problem-based learning (PBL) principles through the implementation of a methodology for promoting independent learning through team work, with scheduled tutorial and monitoring meetings, in the context of the Environmental Impact Assessment (EIA) course (mandatory or elective) included in the undergraduate Civil Engineering programme at the University of Minho.

2 Background

Prior to the implementation of the Bologna Process, the EIA course was offered as an elective secondsemester class to fifth-year students, which averaged a total of 30 individuals per school year. In line with the on-going adaptation of curricula to the requirements of the Bologna Declaration and simultaneously pursuant to the specific recommendations made by an external and international panel of evaluators, the course became a required subject for fourth-year undergraduates in the school year of 2007-2008. This meant an increase from 30 to approximately 150 students, and a necessary shift in teaching strategy, which was further complicated by the fact that the authors were called to re-design and manage a course that neither had taught before.

An additional obstacle was that the course is not a conventional civil engineering course in the sense that it does not necessarily require students to solve numerical problems or learn and apply calculation and design procedures. The course mostly verses on concepts, laws and regulations, evaluation processes and documental procedures within the Portuguese system for EIA and strategic environmental assessment, matters that are perceived as important but nonetheless dull, tedious, often frustrating, and not meeting the typical expectations of engineering students, particularly in what practical classes are concerned.

The authors were faced with the multi-faceted problem of finding a way to manage and motivate a large class of civil engineering students in a transdisciplinary and non-traditional civil engineering setting. A carefully-organised and defined curriculum was critical to address the complexity and all-encompassing nature of the subject. Fully aware of the obstacles that lay ahead, the course's requirements, content, and teaching/learning and evaluation strategies were steered towards the fundamental aim of keeping the students engaged.

3 Methodology

The course was organised into lecture and practical sessions, each type following different but complementary strategies and aims.

The lecture sessions followed a more traditional approach, using overheads and multimedia presentations, through which the lecturer would present the learning topics, always supported by case studies for better conveying the complex issues under study. Though the debate and discussion of topics was encouraged, these were essentially classes where students would take notes and generally adopt a more passive behaviour.

The practical sessions were divided into four sub-classes meeting at different times during the week. Since these would not be devoted to traditional numerical problem-solving exercises typical of the majority of the classes in the civil engineering programme, the authors decided to implement a project-based strategy aiming to foster the development and enhancement of competencies and aptitudes. This consisted in having the students set up as teams and carry out the work necessary for the completion of a project assignment.

3.1 PBL principles and models

Project-led education (PLE) is a successful strategy that was pioneered in Denmark, at the universities of Aalborg and Roskilde in the early 1980s [9]. It consists on directing team-work towards independent learning through solving large scale problems leading to the completion of a project. Supported by regular lecture sessions and tutorial meetings, the team is required to produce and deliver a solution – a prototype, a report, etc. – by a pre-set deadline. This student-centred approach transfers the teacher's role from a mere transmitter of knowledge to that of advisor and facilitator of the learning process, by providing guidance and suggestions designed to encourage students to find their own solutions and strategies for problem-solving [3, 9].

In PLE approaches, the level of difficulty required is tailored to the students' abilities and competencies, while designed to increase the level of knowledge, skills and aptitudes towards the ability to successfully handle the challenges of future professional practice.

Problem-based learning (PBL) is an approach based on a similar philosophy. First introduced at McMaster University in Canada in the late 1960s [9, 10], it is another student-centred teaching strategy that focuses mainly on smaller scale problems designed to be solved in considerably shorter periods of time (one or two weeks versus the typical semester-long PLE assignments) [9] As such, a project can be seen as a series of problems to be solved, providing the means for cognitive learning within a broader and more complex set of conditions.

However, PBL also stands for project-based learning, a designation that has been favoured for the past ten years, as more universities and higher education institutions get involved in the application of these active-learning strategies.

Regardless of the chosen meaning, the learning principles supporting either and both are the same and overlapping with those defined for PLE [9, 10, 11]. The common aspects focus on the cognitive, collaborative (or social) and contents-learning principles (Fig. 1, adapted from [10]).

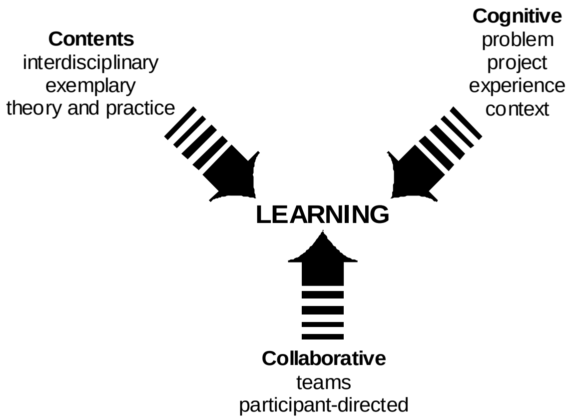

Fig. 1: Overlapping learning principles

The definition of sub-components to each of the categories allows each programme and/or institution to develop and tailor their own models to the needs and goals set forth. Accordingly, several authors have proposed a series of PBL sub-models based on how aspects such as perception of knowledge, learning, problems, students, teacher roles and assessment are valued. The combination of all of these dimensions demonstrates that such learning methodologies lead to more than the gathering and retention of knowledge, carrying impacts in terms of scientific research, since students are, in fact, applying research methodologies in their quest for solutions to the proposed problems [10].
Kolmos et al. (2009) [10] have defined a comprehensive model for PBL-based curricula, stressing the importance of the alignment between seven major elements (Fig. 2, adapted from [10]).

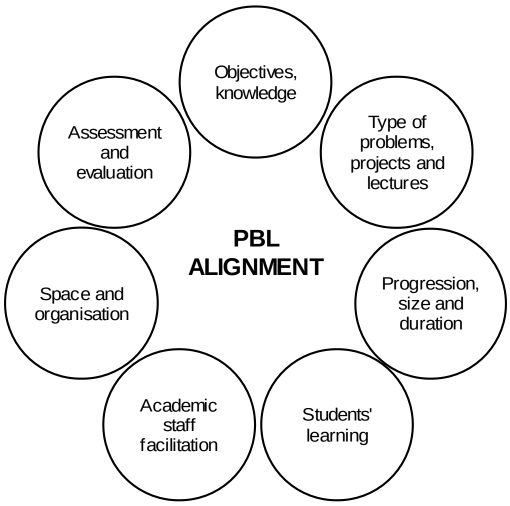

Fig. 2: A PBL curriculum design

As described in the following section, the reformulation the EIA course's programme encompasses the elements defined above.
Given the newness of the course's programme, a great concern was to provide the students with clear guidelines regarding the work they would be expected to accomplish, both in terms of deliverables (product) and performance throughout the semester (process) [12, 13]. A series of rules was established, presented, discussed and agreed by both teachers and students. However, the clear definition of boundaries did not equate with loss of flexibility, namely in what the project assignment was concerned. The students were given ample opportunity to find and suggest other thematic areas for exploring if the ones provided did not suit their interests. These decisions were aimed at promoting more active learning and participation, enabling the students to complement the exposure to the traditional transmission of facts and data with learning tools capable of moving them beyond the "I hear it, I forget it" and even the "I see it, I remember it" paradigm to the ultimate "I do it, I learn it" goal.
In addition, and aiming to stress the usefulness of interdisciplinary information, the students were encouraged to use knowledge derived from other fields and courses, as well as their own experiences.

3.2 Active learning and team work in large civil engineering classes

The course was designed to include two-hour long weekly lectures, for which attendance was strongly recommended but not mandatory. These sessions were devoted to the presentation of the course's contents, as well as provide the support to the practical sessions.
The practical classes also consisted of two-hour long weekly sessions, during which the students were asked to carry out the proposed practical work. No attendance was taken.

3.2.1 Learning objectives

By the end of the semester and after completion of the project, the students were expected to have met the six learning objectives defined for the practical sessions. These included the ability to describe EIA processes and procedures, to critically review existing case studies, to perform analyses and verify compliance with regulations, to use suggested software tools, and to write technical reports. Furthermore, the students were also required to develop and demonstrate project management abilities, namely regarding task definition and assignment, scheduling and progress reporting.

3.2.2 Project assignment

The project was designed to promote the use of file-databases publicly available in institutional websites and offices. The overall goal was to conduct a critical analysis of one or more cases concerning environmental impact assessment, in view of the concepts apprehended in lecture and through literature review of pertinent documents and applicable regulations, while promoting the contact with regulatory and pubic administration entities (central government, city halls, etc.) and real world situations.

The students were required to set up as teams of 3 to 5 elements. There were initial concerns about providing thematic areas that would be adequately diverse and deterrent of work replication amongst the teams. In order to prevent this possibility, 3 project alternatives were provided, along with a list of 8 possible thematic areas to explore (Table 1).

Table 1: Project and thematic areas alternatives

Project Alternatives
A: Comparative analysis of at least two EIA processes within the same thematic areas, with particular emphasis on documental procedure aspects; **B:** Comparative analysis between case file documents and regulatory requirements; **C:** Elaboration of a non-technical report for a selected EIA case study, according to the requisites stated in the Law and applicable regulations;
Thematic Areas
1. Intensive animal farming; **2.** Intensive aquiculture; **3.** Hydroelectric power; **4.** Wastewater treatment; **5.** Transportation infrastructure (roads, railways or airports); **6.** Solid waste treatment and valorisation; **7.** Electrical power production (fossil fuel, nuclear, wind farms,…); **8.** Mining and transformation industry.

This technique helped ensure a varied distribution of themes, though some were repeated between sub-classes. However, each and every team was able to find different case studies. More importantly, the students were also given the opportunity to propose other thematic areas and/or case studies – national and international – provided they were better suited for the team's interests without compromising the courses' requirements. Also, the teams were required to use a particular software tool designed for assisting the analysis of potential and established environmental impact situations.

The process of setting-up the teams, selecting and assigning projects took approximately 2 weeks. Armed with the rules and guidelines for project and report writing right from the start, this period gave willing students the opportunity to conduct a preliminary review of the information available and make a better theme selection.

3.2.3 Schedules and resources

Although the practical sessions were scheduled to take place every week (a necessary subterfuge for securing a classroom), teacher and students only got together on 5 pre-scheduled meetings. Except for these meetings, the students were free to use the scheduled time and classroom to carry out the work however they saw fit. During these sessions, the teacher was available for tutoring, answering questions and providing guidance as requested. Exceptionally, the teacher presented a pre-scheduled class on the software tool that the teams were required to use. Both teachers (lecturer and practical) were also available on a weekly basis for a period of 2 hours during pre-defined times for office attendance and additional support. Trivial matters and quick "consults" were often handled through short e-mails between instructors and students.

The advent of new electronic educational tools has brought additional challenges that, nonetheless, present both teachers and students with numerous and valuable opportunities for improving the teaching and learning experience. Striving to apply and implement new and effective teaching resources, capable of fostering motivated and effective learning, the course was designed to use the institutional e-learning platform (Blackboard Academic Suite®, BAS), available at the University, in a variety of tasks such as sharing of class notes and study materials, and other tasks concerning class management (posting of notices, rules, etc.).

The students were able to access this platform for viewing and obtaining posted materials and also to post their own work for evaluation. The use of this technique for interfacing with the students proved to be an enhancement to the authors' teaching and evaluation strategy. For instance, the availability of a safe assignment tool offered by BAS platform allowed the teacher to verify plagiarism potential in the submitted reports. Aware of this functionality, students were encouraged to produce original text and carefully identify sources of information.

Computer rooms and wireless connectivity were available across the campus, supplying students with the necessary accessibility to the course's digital interface and the means to conduct on-line research.

3.2.4 Team work monitoring

The pre-scheduled meetings also served for progress monitoring, which was planned to assist the teacher in evaluating each group's performance throughout the semester.
As mentioned, 5 meetings were scheduled at pre-determined dates, during the scheduled class time (Fig. 3).

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)
		(ID Number)	(Full Name)					
1.1								
1.2								

Fig. 3: Progress meetings schedule form

The teacher would, at a minimum, meet with a single representative from each team. This was a role that rotated among the team members and allowed the teacher to talk to each individual student at least once during the semester. During the meetings, the team speaker was responsible for presenting a short written and oral progress report (Fig. 4) and answering any questions posed by the teacher.

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:
(...)		(...)

Fig. 4: Team work progress report form

In the progress report, the team was required to list and/or briefly describe the accomplished objectives, goals and tasks to be performed, along with obstacles and difficulties that were preventing a better performance. Other pertinent issues would also be addressed, for which the students would seek the instructor's advice and recommendations.

3.2.5 Learning through project management

The implemented methodology allowed for another dimension towards the development of professional competencies. By holding the students responsible for meeting intermediate and final deadlines (progress and final reports), by requiring that they adhered to the set rules, and by essentially controlling the performance of each team member, the students were given the means to experiment with simple project management concepts [14], which were more or less intuitively applied in relation to the successful and timely completion of the tasks at hand. Consequently, personal responsibility, interpersonal relations, collaborative interaction and self-regulating performance were some of the targeted aspects of individual growth.
These were furthered by the demands of working in a team (*Together Everyone Achieves More*) whose member had rotating responsibilities. The alternating nature of the team speaker role drew the majority of the students out of their passive comfort-zone. Whereas talkative and more participative students had no problem fulfilling the duties of the position, quieter and shy students visibly struggled and had a more difficult time expressing themselves. Anticipating this, the remaining team members were allowed to participate in the progress meetings but their intervention was only permitted after the speaker had had the chance to present the progress report.
The flexibility imparted to the methodology gave it an aura of informality that was welcomed by the students. Given the preference of emotional and interpersonal relationship aspects over cognitive ones, this helped keep the students motivated throughout the semester, particularly when faced with stressful obstacles.

3.2.6 Self and peer-assessment

At the end of the semester and upon submitting the final written report, each student was required to conduct a simple exercise of self and peer-assessment. Each team element was asked to send, in a private e-mail, an assessment of his/her and peer contribution (in percentage) to the total team effort. This exercise was useful in determining the individual performance within the group, as work distribution is not always uniform and equitable. The goal was to assist the teacher in grading the elements in the team and to assign different individual scores, if warranted.

3.2.7 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.
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.

3.2.8 The Teaching/Learning Evaluation survey
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 (TLE) 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 a self-assessment section. A list of 25 parameters and rating scale used for evaluating the teachers are presented in Appendix.

4 Results and Discussion
The results of the TLE survey were used to determine the success of the implementation of the new EIA course design. Instead of focusing on passing/fail statistics, the authors decided to focus on the assessment of perceptions provided by the survey.
Though not completely devoid of usefulness, pass/fail statistics cannot be reliably used in the context of the University's evaluation guidelines. Students that do not obtain a passing grade under the continuous evaluation system, in place throughout the semester, are normally allowed to take an exam on the course's materials. A passing grade in this exam means the student passed the course. However, the students that get an approving grade in the exam are typically the individuals with lowest average grades and many of them do not even bother to attend classes if attendance is not mandatory. Also, but depending on the course, they can be significantly fewer that the number of students that passes under the continuous evaluation. For these reasons, these groups are not comparable and thus, an analysis that tries to devise possible measures of success from the confrontation between these passing and failing students is corrupted right at its inception.
By establishing implementation success as a function of student perceptions, participation, motivation and level of commitment, the authors can obtain a more truthful snapshot of the real situation.

4.1 Global results
Of the 149 students enrolled in the course, 132 formed 31 teams. By the end of the semester, a total of 26 reports were handed in for evaluation, corresponding to a total of 109 students or a level of completion of approximately 83% (Fig. 5).

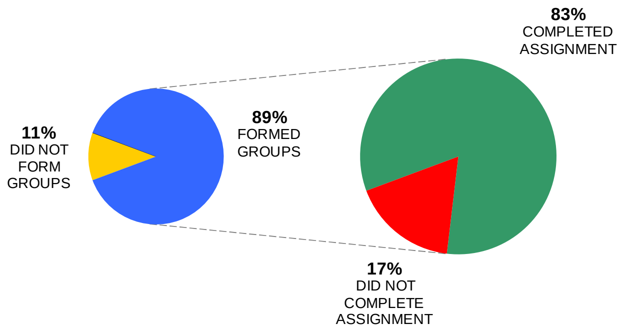

Fig. 5: Student participation levels

Overall, the students actively participated in the course's activities, generally demonstrating a satisfactory ability to carry out the tasks assigned, with varied levels of enthusiasm and commitment to the project.
The results of the Teaching/Learning Evaluation survey are encouraging and agree with information derived from casual conversations with random students throughout the semester.
The global evaluation of the course (Fig. 6) obtained an average grade of 3.20 out of possible 6, practically par with the perception of the importance of the course, which obtained an average score of 3.24.

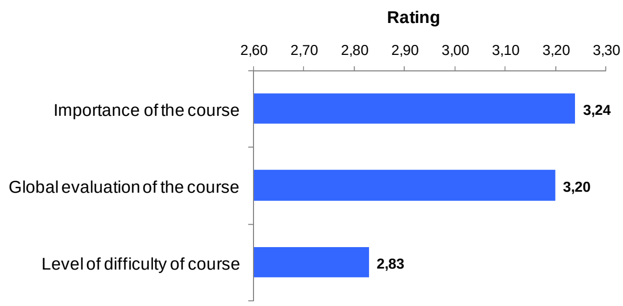

Fig. 6: Least-rated parameters of the Teaching/Learning Evaluation survey

The responses were practically split between the students, with a slightly higher fraction of agreeing rather than disagreeing students (51 to 55 over 45 to 49%, respectively).

In terms of the least rated parameters, the majority (72%) of the students found the course to be challenging and difficult, a perception that mirrors the initial concerns of the authors.

This assessment was supported by feelings of anxiety regarding the lecture-part of the course. When asked about the lecture classes, the students admitted a lack of enthusiasm for the materials and learning topics. 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".

When the rationale for the new approach was explained, the students understood it and accepted it but had a difficult time letting go of their pre-conceived notions regarding how demanding they thought then course would be, fostered by conversations with older classmates that had successfully taken EIA in previous years. Because they were based on the courses' historical record, these perceptions proved difficult to overcome emotionally, though intellectually, it was clear to the students that they should not have expected different teachers (past and present) to have the same approaches, particularly when the context of the course had changed as dramatically as it had.

As anticipated, the students were none too thrilled nor thrilling with their performance in the written tests. These feelings of frustration and apprehension compounded by a fear of failing the class altogether (even before the written test grades were known) overflowed into the practical sessions, hindering the teams motivation to go on working and finish the job they had set out to complete.

The scheduled progress meetings often became encouragement and pep talk sessions in order to keep the students focused and motivated. Despite the hardships, most groups persevered and managed to finish and submit the work with satisfactory results.

The results are illustrated in Fig. 7 correspond to the better-rated parameters in the survey. The vast majority of the students (94%) felt that they were encouraged to express their points of view and in doing so, question the teacher in her own opinions and perceptions. Also, there was a general agreement that schedules were met according to what had been initially planned. An overwhelming majority (98%) felt there was concern and interest about the students, an observation supported by a general perception of encouragement, by the teacher, of their participating in the course's activities (rated 4.71, not shown).

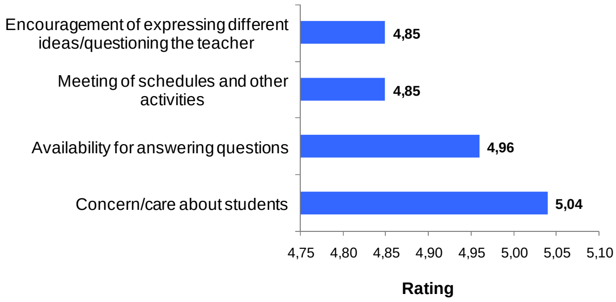

Fig. 7: Most-rated parameters of the Teaching/Learning Evaluation survey

Because the projects were centred on the analysis of case studies in light of topics covered in lecture, the practical sessions were 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 revealed 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, teams that participated more and were more critical and 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.

4.2 Elective versus mandatory course

The 2007-2008 school year was a transitional year with regards to the civil engineering programme. While new curricula were tested for the first time – as was the case for EIA – some of the old courses continued to be offered to accommodate the needs of older students enrolled in pre-Bologna programmes. Therefore, EIA was also offered to fifth-year students as an elective course and the authors were equally responsible for this class that included 26 enrolled students. Successful completion of the assigned project was achieved by 23 of them.

Fifth-year students were subjected to identical course requirements, class organisation and practical methodology. In fact, lectures were offered simultaneously to fifth and fourth-year students and the same course materials and notes were available. Fifth-year students were equally required to fill out the TLE survey. This allows the possibility to analyse the consequences of converting the course from elective to mandatory, assigning fifth-year students the role of control group. The graph in Fig. 8 illustrates the TLE survey results obtained for the practical sessions. The evaluation criteria key corresponds to the list of parameters presented in Appendix.

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.

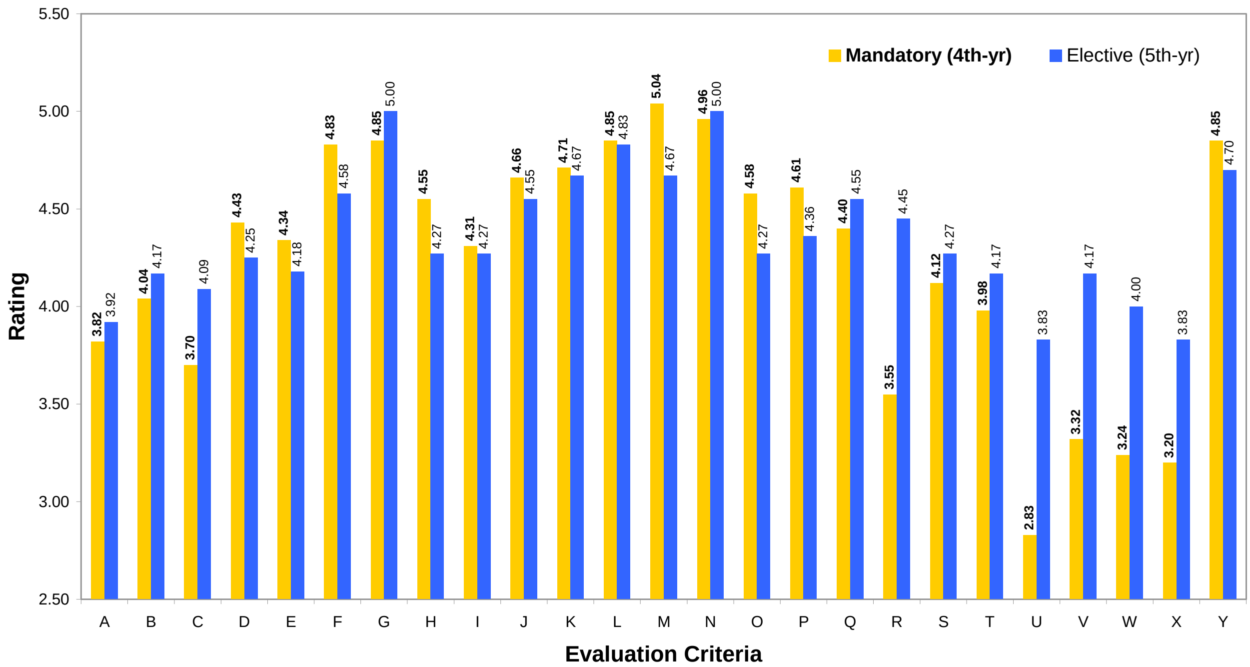

Fig. 8: Teaching/Learning Evaluation survey ratings (practical sessions) by fourth-year (mandatory) and fifth-year (elective) students

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 taken other courses with them in the past. 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 to make an 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 the factor that could have led to 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 other aspects of the course.

Fifth-year students also expressed the same negative feelings towards the increase in the level of difficulty of the course.

In terms of the better-rated parameters, fifth-year students selected the same as their fourth-year classmates, rating them similarly.

4 Conclusions

Having been traditionally offered as an elective course to fifth-year students, the Environmental Impact Assessment course became a requirement for fourth-year students in 2007-2008. Given the transitional nature of this school year, the course was offered one last time as an elective to fifth-year students. The authors were responsible for both fourth and fifth-year groups. The shift came as a consequence of the adaptation and reformulation of the Civil Engineering curriculum at eth University of Minho, in the context of the Bologna Declaration, a process that as brought many critical challenges to teachers and students alike.

Faced with the multi-faceted problem of managing and motivating a large class of civil engineering students in a transdisciplinary and non-traditional civil engineering setting, the authors decided to implement a project-based learning strategy, using well-defined learning objectives and pre-scheduled tutorial meetings for team work monitoring and assessment.

Despite the more traditional approach adopted for the lecture classes, the practical sessions were designed for teams of students to conduct their own work according to a defined set of objectives and rules, without the supervision of the instructor. A study of the perceptions expressed by the students in the University-sponsored Teaching/Learning Evaluation survey revealed a series of encouraging results.

The ability to conduct independent work was mentioned as an advantageous aspect of the methodology, particularly when the students were given the chance to select topics more agreeable to their interests. There was a general sense of acknowledgement of an increased need for more individual discipline and effort to remain committed to the work, since the teams were entirely responsible for managing schedules, assigning tasks and getting the job done. Most students were able to effectively meet these responsibilities. Nevertheless, the freedom to manage their own work schedules was particularly appreciated, especially by students with heavier workloads from other courses.

The exposure of students to real situations encouraged the search for additional material deemed relevant for the tasks at hand. In fact, by accessing a list of recommend institutional websites, all students had access to documentation pertaining to complete EIA processes as mandated by Portuguese Law, regulations and guidelines, allowing them a broader understanding of the field study in a “real-world” context. Also, by promoting the critical review of real cases, students were given the opportunity to observe and discuss some aspects of bringing theory (regulations and guidelines) to practice (real evaluation processes).

Another advantageous aspect of the methodology was that evaluating the written reports was positively supported by the regular student and teacher interaction during the progress meetings, weekly office hours and via e-mail, which kept the teacher informed and updated about the on-going work. Having previous knowledge of each project’s history and team performance definitely aided in the final reading and evaluation. From the students’ point of view, this interaction also translated into the encouragement for expressing their thoughts, question the teacher in her own opinions, seeking guidance and recommendations.

The purpose of the peer and self-assessment exercise was understood by all as an important, though not necessarily, essential task. Nonetheless, all students complied and turned in their assessments as required. The majority of the individual reports agreed in their effort distribution and not surprisingly, the most of the students assigned equal effort percentages to themselves and their group peers. Though not exactly corresponding to the truth – to the best of the teacher’s knowledge derived from observation throughout the semester – the decision to assign equal work loads demonstrated a sense of team unity. There were two separate instances that needed the mediation of the teachers, since the students within the two groups involved would not agree on how the work had been carried out. These occurrences point out to the need for additional reflexion with regards to the manner in which self and peer-assessment is required in future group projects.

There were many challenges throughout the course of the semester that were effectively addressed and dealt with. 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 recognised that the teachers were aware of their hardships and were actively trying to help them overcome this obstacle. Because they felt there was genuine concern and care for their performances, the students remained engaged and committed to the project-based learning process. In doing so, there was an enhanced ability to cope with demotivation and lack of interest towards particularly difficult aspects of the course's learning content.

As implemented, this methodology required different levels of effort from the practical sessions teacher throughout the semester, with moments of more intensity at the beginning and at the end. Since these peak activity moments were planned from the start, the more open schedule during the semester was refreshing and welcome, allowing the teacher 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 led to more focused and more productive moments in both areas of activity.

When asked whether they would recommend, to future school-year students, the methodology implemented in the practical sessions, the majority of the students would do so, despite the great effort that would be required. However, it was acknowledged that future students would benefit from this class' experiences and admonitions, in what would be a clear advantage over the 2007-2008 students. Accordingly, similar methodologies were implemented for additional courses of the 2008-2009 school-year.

The work described herein supports the notion that student-centred teaching methodologies are proving to be useful strategies for the adaptation of curricula under the guidelines of the Bologna Declaration. As teachers and students become aware of their new responsibilities and roles, it is critical that active learning is directed not only towards lasting knowledge retention but also towards having students effectively engaged and committed to autonomous learning processes. Project-led education and project/problem-based learning principles are particularly adequate for the demands of handling large civil engineering classes, where active approaches are favoured over more passive forms of learning. Also, they promote the harmonious balance between cognitive, context and collaborative learning principles, effectively reaching out to the different learning styles exhibited by students.

The experience described hints at the critical implications of moving towards further and renewed approaches to teaching and learning in transdisciplinary contexts. While traditional teaching roles placed the teacher and the students in opposite sides of the classroom, student-centred learning strategies imply that teachers and students make the journey towards knowledge together, providing students with the tools, motivation, guidance and support for the development of their own competencies, skills and aptitudes and the enhancement of their interpersonal and professional identities.

Appendix

	TLE Survey Parameters		Rating Scale
A	Interest in the subject	1	Strongly disagree
B	Usefulness of learning	2	Disagree
C	Understanding/Grasp of content	3	Somewhat disagree
D	Classroom dynamics	4	Somewhat agree
E	Classroom organisation	5	Agree
F	Commitment to teaching	6	Strongly agree
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		

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