Teaching Strategies to Promote Active Learning in Higher Education

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Quality of teaching, particularly in Higher Education, is a subject of increasing importance and attention by public opinion in general. We can support this statement both by consulting the literature related with this subject and by looking at several governments' measures, namely the Bologna Process. It is known that the lack of motivation and the number of failure, in particular in Physics, is a problem that teachers are facing nowadays. Current research in Science Education indicates that the levels of interaction between teachers and learners in formal instructional settings can be very low. In this study we analyse the effects that some strategies and instruments have had in changing the classroom environment. Through active learning techniques and modelling by the teacher, students shed the traditional role as passive receptors and learn and practice how to apprehend knowledge and skills and use them meaningfully. We have used a variety of strategies, namely conceptual questions, group projects, reading tasks, assignments with tutorial review, problem solving and a platform of e-learning. These strategies have been used in the first year of an introductory physics course for civil engineers. Although the study is in its early stages the results are promising. It appears that students are more engaged in the classroom, more interested in the subjects that are taught. However some strategies had not been well understood by the students and so it will be necessary to reformulate them. But, in general, the results indicate that the reactions of the students about those innovative strategies are quite positive.

Keywords Teaching Strategies, Active Learning, Physics in Higher Education.

1. Introduction

In Portugal the number of students in higher education has rapidly increased in the last 30 years: starting from around "*30 000 students in the sixties, to nearly 400 000 students by the end of the 20th century"* [1]. Also, the number of Higher Education Institutions has increased, existing, nowadays, more than 150 [1]. With this huge massification two phenomena has emerged: the need to look at the quality of higher education and the increase percentage of students who enter higher education and dropout without gaining a qualification. With respect to the first phenomena one can notice the increase amount of research studies which tackle the problem of quality, in particular the quality of teaching in higher education [2, 3]. With respect to the second, many studies have been also developed in order to understand the factors which may contribute to the high percentage of students who fail in higher education and also to develop approaches to diminish such failure. Physics, namely introductory physics for engineering degrees, is one area which appears to be quite problematic in terms of the failure of students[4] and, therefore, research is needed to improve this situation. It is in this context that the present study has been conducted.

2. Active Learning

It is well known that passive learners lose attention quickly in lectures and tutorials. Even if one assumes that our lectures possess goods and necessary characteristics, research suggests that "*the exclusive use of the lectures in the classroom constrains students learning*" [5]. Some researchers have analysed how

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effectively are students attention in 50 minute lectures. They show that after 10 to 20 minutes the attention and assimilation fall rapidly, however many teachers ignore such [6].

For many educators, the term active learning has more an intuitive connotation than a well established definition. As a consequence of this they consider that all the learning is inherently active, that the students are actively involved while they listen to a formal presentation in classroom. However, literature suggests that students must make more than simply listening: they must read, write, argue, ask questions, or be involved in problem solving.

Although there are many approaches to the concept of active learning, they all contain some common characteristics[7]. Bonwell & Eison [5], for example, consider five characteristics for an active learning:
i) Students are involved in more than listening;
ii) Less emphasis is placed on transmitting information and more on developing students skills;
iii) Students are involved in higher-order thinking (analysis, synthesis, evaluation);
iv) Students are engaged in activities (e.g., reading, discussing, writing);
v) Emphasis is placed on students' exploration of their own attitudes and values.

In this context, it is important to promote learning strategies and instruments where students are actively involved in making things and reflecting in what they are doing. The use of these strategies in classroom is vital to have a positive impact on the quality of the students learning process and outcomes. Some studies [3, 8, 9] point out that students prefer more the strategies that promote active learning than traditional lessons

To modify the traditional lectures is one way to incorporate active learning in classrooms. For example, Bonwell & Eison [5] suggest pauses during the lectures so to that the students can consolidate their notes and thereby enhanced retention and comprehension, or, as applied by Pedrosa de Jesus [10] and Neri de Souza [11] in their research, pauses so that students can write questions about the issues under discussion [12]. Other strategies are used to involve students in the lectures, such as: demonstrations, writing tasks, small work groups (collaborative/cooperative work projects), problem solving, asking oral questions. Lammers & Murphy [13] also present a set of strategies to enhance students' involvement in their own learning: "*Active learning techniques focus on the direct involvement of the student with the learning material and can include short writes, brainstorming, quick surveys, think-pair-share, formative quizzes, debate, role playing, cooperative learning, collaborative learning, and student presentations to name a few*".

3. Description of the study in the classroom: the implemented active learning strategies

The research we report here is in its early stages. A pilot study was conducted, during the academic year 2005-2006, involving four teachers (one of them is the first author of this work) and a group of 80 first year undergraduate students, drawn from the 300 students attending an introductory physic course (Física I) given to Civil Engineering at the Instituto Superior de Engenharia do Porto (Portugal). This course had three kinds of classes: theoretical (2 h/week), practical (2 h/week) and laboratory (2 h/week). The age range of students is very wide as this course is given to full and part time students (75% full time students). In spite of this 60% of the students have less than 20 years old. In terms of gender 65% of students are male.

The principal active learning strategies used are described below.

3.1 Blended-learning (b-learning)

Blended learning is the combination of multiple approaches to pedagogy or teaching. Driscoll[14] defines b-learning as a meaning "*to combine or mix modes of Web-based technology (e.g., live virtual classroom, self-paced instruction, collaborative learning, streaming video, audio, and text) to accomplish an educational goal*". The platform LMS used was the Moodle. There the students had all the information about the Course (the lectures notes, problems to be solved in practical classes, grading system, interested web sites, bibliography and finally multiple choice questions).

3.2. Reading Tasks and Conceptual Questions in Lectures

Before each lecture some reading material were given to students with the subjects that were taught in that lecture (physics concepts, theorems and expression deduction) Reading task were introduced aiming that students could do a previous preparation on the topic and so they would be able to discuss it in class [7]. To motivate the students to read the "reading tasks" multiple choice questions were created in the platform LMS. The students had to answer these questions before each lecture to achieve bonus points in their final classification. To promote and improve class discussions conceptual questions were also used[15]. Two types of conceptual questions were implemented. The first aiming to introduce some topic and the second to verify if the concepts were understood by the students. See, in Figure 1, an example of a typical conceptual question used in class[16].

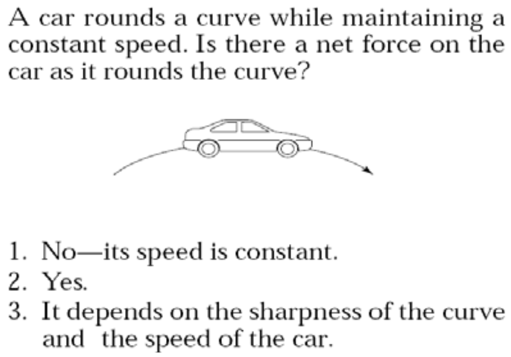

Fig. 1 Typical Conceptual Question (addapted: Mazur [16])

3.3 Work Group in Practical and Laboratory Classes

In classrooms students were invited to work in group solving problems and exercises. In each lesson they discussed a "real world" problem (for example: *Estimate the speed of a car before it crashes, given the brake traces in the road and the damage done in the car*). This kind of problems are in contrast with textbook problems which typically use idealized objects and events that have little or no connection to the real world. Solutions to real world problems are, in general, more interesting to the solver as s/he wants to know something about actual objects or events with which s/he is familiar. Before doing any calculations the solver had to decide which quantities are useful for solving the question, which physics concepts and principles are relevant, what additional information is needed, and specify which information can be determined and which must be estimated [9, 17].
In the laboratory students work in groups on laboratory problems where they must decide on what measurements to make and how to analyze the data they collect to answer the problem. They had to follow the following suggested steps:

- Visualize the problem (make a physical representation of the situation);
- Describe the problem in physics terms;
- Plan a solution;
- Execute the plan;
- Check and evaluate.

3.4 Assignments with tutorial review

In each practical class an assignment was given to students. Then the teachers evaluated and comment those assignments. This kind of action helps students to overcome their difficulties[18]. In some cases, if the difficulties encountered justified students were advised to attend individual tutorial.

4. Results and Discussion

The results we present here were obtained from two different sources: questionnaires (two given to students and one to the teachers involved in the teaching) and information taken from the Moodle. The aim of the first questionnaire, given to students at the end of the scholar year, was to find out students' opinions about some of the strategies implemented in the course. The questionnaire had 29 questions with a likert scale (1-5). In the analysis we count as a positive opinion an answer equal or higher than 3 (middle of the likert scale). The second questionnaire given to students aimed to evaluate the general opinion about: good teaching; clearness of goals and standards defined; appropriated workload; appropriated assessment; appropriated interaction between teachers and students. Finally, the questionnaire given to teachers aimed to find out how they had implemented the teaching strategies and their opinion about the results achieved with them.

The average of participation of students in **b-learning questions** was 26%. Figure 2 shows the percentage of students' answer to each of the 19 questions proposed to them. The analysis about this low percentage made us change partially our strategy in the course we gave to students in the second semester (Física II). We believe that two main reasons justify the low percentage referred above: the short deadline students had to answer the questions (less than a week) and, so, many students did not answer in time; the high number of questions. Taking this into account in the second semester course we used a different strategy. Although we kept the same number of questions, we grouped them in five different chapters, according to the topic under study, and students had a larger deadline to answer. The capacity of adjusting strategies was an important factor, in this case, because the number of participation increased to 60%.

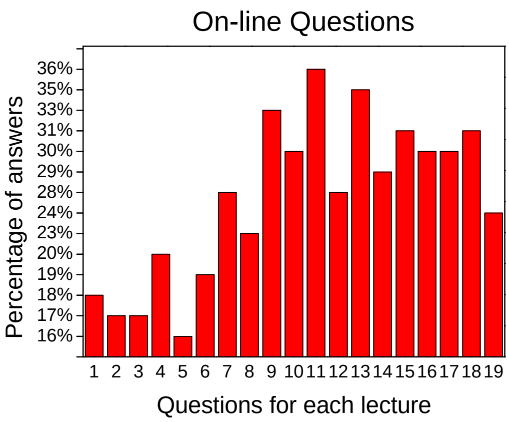

Fig. 2 Participation in b-learning question

For 80% of the students **conceptual questions** were a motivating factor to attend lectures. Also all of them said that the discussion in the class was helpful for their learning process. Teachers said that conceptual questions were used: (a) to stimulate the interaction student-student and student-teacher; (b) to verify if the concepts were apprehended and (c) to review the subjects. Therefore conceptual questions were an important strategy to engage and promote active learning

When students were asked about **group work**, 80% said that the discussing problems and exercises were very useful in their learning process. Referring to work group in the laboratory 75% said that having to find one experiment to measure something that they were asked to do was motivating. On the other hand, one of the teachers said "*discussion* [by the group] *in class had a very positive influence on students*" and all teachers were unanimous in saying that in lab classes the search that groups had to make to implement the lab work was very well accepted and made them think about physics in a different way.

All of the students said that the **assignments** helped them in the learning process and 80% said that tutorial review was important. However one of the teachers said that "*only 50% of student's did the assignments*" but she also added that "*those who did it had better final results*".

When students were asked about **teaching practices** 60% of them thought that teachers were good and tried to make the course appellative. For 57% of the students the evaluation system and the learning outcomes were clear. This result was in agreement with all of the teachers when they said that the evaluation system was well explained to students. When students were inquired about the contents of the course, 47% answered that they had not enough time to acquire the amount of information given. Finally 51% of students thought that the interaction between them and the teachers was good. It should be also noted that 85% of the students think that teachers tried to motivate them.

5. Concluding Remarks

The results found so far support the authors to pursue their work, namely in what concerns the promotion of active learning strategies in physics classrooms. However, some results suggest the need to introduce some changes in the strategies used. Also they suggest a need to look deeply in what is considered as factors for improving the quality of teaching physics in higher education. These are the main concerns of the PhD research projects which are being developed by the two first authors of this paper.

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