ALTERNATIVE FORMS OF EVALUATION IN EXPERIMENTAL DISCIPLINES FOR ENGINEERING COURSES

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Abstract : *In this work, we present and discuss alternative methods to evaluate the student learning process in experimental courses for engineering. These methods comprise individual and group tests, class and extra-class work. Individual and group tests in classroom – the students are required to build up an experimental setup based in previously studied experimental configurations. Extra-class projects – the class is divided into groups and each one has to plan and execute all the steps in order to accomplish a pre-established goal (choose the appropriate materials and prepare the setup which they will test before presenting it to the other groups). In both cases, the student is evaluated during the entire process. The teacher is able to evaluate the student performance on carrying out measurements and interpreting the results with the appropriate statistical data analysis. In traditional teaching methods, exams and classes represent two different experiences, especially for the students. The teacher spends much extra-class time in the correction, and an additional amount of time to expose the expected answers to the class. Unlike these traditional forms of evaluation, the alternatives presented here provide the students with a real time feedback. This new examination system limits cheating problems, and the exams can be used to complement the topics studied in the classroom. The projects develop the ability of working in groups, promoting an increase in the motivation of the students, with the development of their criticism. Evaluating students through the proposed alternative practices allows the teacher to better follow the students knowledge evolution. We expect to improve the students' performance with a more dynamic teaching process.*

Key-words: *Evaluation, Experimental Courses, Extra-class, Projects.*

1. INTRODUCTION

1.1 The context

Different characters from the academic scenario surely defend different conceptions about education and science. The first one has been discussed by many publications, once the subject is extensive and affects the most different human social actions. At the same time, the conceptions about science have been the object of controversies since long ago and maybe it

is not exaggerated to say that they are getting deeper recently (DELIZOICOV, 1991; SHAPIRO, 1994; HARLEN, 1989).

Traditionally, teachers in Brazil present Physics and Chemistry to the students as a finished and unchangeable science. Science teaching is normally based on expositive classes, with few or no experimental activities. Theoretical disciplines are followed by the resolution of exercises that evaluate only the students' mathematical skills, not their comprehension and ability to apply the concepts (that must be) under analysis.

When there are experimental activities, they consist in the reproduction of a predetermined list of secular procedures that must be strictly followed by the students, leaving little or no space for questions and discussions. This may be a consequence of an education method based on the transmission of information through expositive classes, without experimental activities.

For many students, *to learn* means *to repeat the correct*. Considering the learning process of science, this conception becomes *to repeat the difficult words* (BIZZO, 1998). Of course it isn't our goal to convince the reader that the technical words should be abandoned. On the contrary, they should be valued. The problem is that, frequently, the theoretical knowledge acquired is not related to the students' reality. This is followed by the fact that students are not trained to perceive any connection between planned experiments and *the truth that is out there*. As the students never learned how to be critical about the topics that they are learning, they can not see by themselves, beyond the *recipes*, the connections between experiment and reality.

For a traditional subject, a traditional test. When the teacher does not succeed in relating the teaching subjects with the day-to-day reality, the tests can not evaluate anything beyond the memorized lessons. Actually, students are used (they get used) to receive and execute orders, instead of proposing and planning an experiment. In this context, lack of motivation of the student is not a surprise.

Blocking the creativity of the students does not seem to be a good practice. First of all, the classes get monotonous (a collection of old recipes already tested). As a consequence, the students lose their motivation. This, in turn, affects the teacher itself. The fact that there is no challenge at all (for both teacher and students) diminishes the learning process. In this context, ethics loses its relevancy to the students that tend to cheat. The students feel that the memorized lessons can be forgotten, and the insecurity brings them to prepare their *back-ups* (to cheat) for the moment of the test. One can say that, in this way, the students are lead to exercise their creativity - but developing cheating methods.

2. THE PROCESS

The idea presented in this work is best described as the advantages of an evaluation of the students performance on carrying out measurements and interpreting results of specified experiments in physics and chemistry during their experimental subjects.

2.1. Individual and group experimental tests

In this system, the students are required to perform an experiment as a test, collecting and analyzing its referent data. They have a predetermined period of time to complete the task when the teacher will approach the system for final analysis. The preparation of the experimental setup, the data collected, the results obtained and the experiment conclusions can be analyzed to define the evolution of the students' knowledge on that chosen topic.

For instance, in a basic electricity subject, the student builds up a required circuit. From its resistance's values, the voltage and the current for each circuit's bench can be calculated and also directly measured from the setup. This way, the student can confirm through the experimental system the theoretical results obtained.

Another example is the stoichiometry analysis for an experimental inorganic chemistry subject. If the class understands the reactions under study they will correctly define the experimental procedures to be followed. However, if any substance is wrongly replaced, quickly the new reaction will denounce the mistake. In this case, the teacher can evaluate the student even without a direct interaction.

2.2. Extra-class projects

In this system, the class is divided into groups and each group has to plan and execute all the steps in order to accomplish a pre-established goal, like developing a new experimental setup or performing a demonstration of physics principles. In an experimental optics subject, for instance, a group of students had to build a projector of slides, another one developed a homemade overhead projector (much cheaper than the commercial ones).

This method is an adaptation of the PBL (Problem Based Learning) method (FENWICK, 1997), not usually applied in Brazilian engineering courses. Each group of (three to five) students proposes a problem to be solved within the scope of the discipline. This opportunity to choose the experimental problem motivates the students. As they work on the experimental setup, they are faced with non-expected problems that must be solved in order to the project to be completed. Even receiving some orientation from the teacher, they must discover experimental solutions by themselves. This practice prepares the students to post-graduation and professional work. Here, teaching and learning represent two faces of the same changing experience.

3. CONCLUSION

We must admit that there is no perfect way to evaluate learning. However, we believe that the proposed practices are more representative. Additionally, these methods stimulate learning even during the evaluation process itself. Finally, a more challenging process brings motivation even to the traditional forms of evaluation, which can play their role – now, as an alternative evaluation method.

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