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Context

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1 Executive summary

This deliverable describes the evaluation methodology proposed to evaluate the AIISM-PBL methodology and also the evaluation of the skills and knowledge of the students who participate in this course.

The main idea for the methodology is to use a continuous evaluation along the course that can give the instructors a lot of information in order to determine the real progress of each student. Part of the evaluation will measure the work in groups and other part at individual level.

The methodology also evaluates important skills for engineers as competition, working in teams, cooperation, oral presentations, budget management, report redaction, etc.

A section about assessment of the system is included in order to evaluate how this methodology is working around the academic year and the benefits for students and lecturers. This evaluation of the system is performed from the students point of view and also from the lectures point of view.

2 Introduction

Evaluation is a very important aspect of the learning process as it will allow to determine the level of assimilation of knowledge and skills by the students [5][6].

Evaluation should not only be focused to the technical knowledge of the subject but should also include assessment of those skills and competencies that students must acquire [1]. So the evaluation should pay attention to how they have developed cognitive skills (analysis, synthesis, application, evaluation, and critique) and action skills (organizing time, resources, coordination, negotiating, tolerating) [4].

Most students are not satisfied with the evaluation process followed in the different subjects, and that often is not focused on assessing the actual progress in student learning. The assessment must take into account how students are acquiring the knowledge, skills and competencies and ensure that those who pass the course have appropriate capabilities [8].

Problem solving related to real world problems is motivating for students as they see direct application and better assimilate concepts [2]. Students identify the problem, research on how to solve it applying concepts and principles. If they work in teams, develop communication skills and collaborative work, developing analytic skills [10].

During the evaluation process large amount of information will be collected, that will reveal whether the student has achieved the required objectives. This is for a process of continuous assessment throughout the course, collecting a wealth of information that allows at the end to put the student an overall rating. This will allow the teachers to know how students are learning the concepts and in the case of deviations from expected are detected may take corrective action [7].

3 Formation of teams

For students to work better the PBL methodology will need to form teams of 2 or 3 students. These groups should remain invariant throughout the course.

For students to get the most out of the course, it is important that students who form a team have a similar level of knowledge. This will prevent one student take an overly active role against another student will not participate enough with the loss of content assimilation [13].

To determine each stundent’s initial level, on the first day of class an objective type test will be performed. This test will have approximately 25 questions, each one with 3 possible answers (multiple-choice) and only one answer will be correct. This test should contain questions on microprocessor-based hardware, electronic circuits, basic programming knowledge and basic knowledge on process control systems.

Questions should be aimed to evaluate general aspects of the concepts required as prerequisites to begin the microcontroller based module. For example:

- Basic Electrical Engineering concepts: we must determine the level that provides the student with respect to microprocessor based systems, as well as basic electrical engineering laws (signal propagation, electrical circuit analysis, digital vs analog signals, etc.). It should also be assessed which concepts of control theory are provided, differentiate the concepts of open and closed loop control. We should also know the level of knowledge of analog and digital electronics and the differences between analog and digital signals.

- In regards to programming (Software) the test will determine the student's programming level. The questions will evaluate whether the student is comfortable with the C programming language, as well as procedural programming, and modular organization of code. Other aspects to be assessed are the concept of operating systems (timer, interrupts, realtime aspects) and the standard C language library functions, as well as the programming of microcontrollers.

Once we know the initial level of knowledge of the students, we will proceed by proposing groups of students whose members have similar knowledge level. This will make the groups being balanced and performance is greater.

Students demonstrating insufficient knowledge in a specific area will be provided with recommended reading material in order to allow them to come up to speed in the coruse prerequisites.

4 Student evaluation methodology

In this section we will address the evaluation strategy to be followed in the matter. To properly address the evaluation system will be structured in three levels [9].

4.1 Level One: Attitude (Student engagement)

At this level, we pay special attention to the motivation that students have within the course. It is important for them to perceive the usefulness of the matter and how important it is for their future career [12][15].

Obtaining information on this level we should keep an ongoing dialogue with different student groups of the course, this should be maintained by the lecturer throughout the entire course.

We should also pay special attention to students delivering activities in time and manner agreed as it is a clear indicator of student motivation. If different groups meet the deadlines will mean that they are working well and are motivated and think that the subject is useful for training.

It is important that a deadline for delivery of the different activities is set and that the student meet deadlines. This should be evaluated.

In order to improve the motivation of students, this level of evaluation should be a part of the final mark. This part can be 10% of the final overall rating.

As well students with a special motivation for the subject should identified because their attitude is above average and this good predisposition can be used to achieve higher goals.

It is important that students meet requirements of work deadlines in the subject. This will facilitate the professional future of the graduates in order to work in environments with strict deadlines.

4.2 Level Two: Learning

This level of evaluation is very important and significant. At this level the acquisition of knowledge and skills that students have acquired throughout the course is determined. The proposed methodology suggests that we are going to address the evaluation to [11]:

- Lecture: Lecturer presents main ideas of lecture contents and proposes some application problems which students solve individually. The teachers throughout the course individually assess how the student has solved different problems. Those problems of particular interest will be evaluated. For example, through the problems we can assess how students interpret a transfer function of a sensor/actuator. How to interpret the voltage as a physical quantity. The analytical representation by an equation. We can see if the student can interpret the current temperature if the input value is X volts, etc. For the evaluation of the problem we must take into account: Approach resolution procedures, steps followed in the resolution, final result, method, clarity of presentation and approach, inclusion of units of measure, focus on the important issues facing superfluous. In the event that the final result is not correct, will be important to evaluate the procedure and see where the error occurred and evaluate the approach undertaken.
- Laboratory: A practical problem previously presented during lecture. Students work by teams of two/three students. During the lab sessions students will show the teacher how they are solving the proposed activities and the teacher will make questions about how is the resolution of the activity [3]. At the end of each lab session the teacher will rate each group based on the work done and the objectives achieved. For evaluation can take into account:
    - Introduction phase: will reflect 20% of the grade. Aspects to be evaluated for example are clearness and structure in the developed code, comments included, code legibility. Check that the exercises have been completed and the results are as expected. The answers of the questions on the exercise will be reviewed and ensure that students understand what has been done.
    - Reinforcement Phase: will reflect 40% of the grade. Some aspects will assess like the level of achievement of the exercises, check whether results are consistent. The answers on the exercise will be reviewed to ensure that students understoodd what they have done.
    - Advanced stage: Will represent a 40% of the grade. The aspects to be evaluated are the robustness of the solution, the degree of integration of parts, the provided documentation, the integration the solution with the results from previous laboratory work, and quality of the solution presented, as well as the capacity of the students to analyse and explain the results of the experiments that were made during the validation phase.

- Seminars: A panel discussion with student teams (around six students) is proposed, consisting generally of solving a problem by means of PBL. The teachers will meet with each of the groups who will present how they have raised the issue, what options for the resolution are viable and which ones have been taken. It is important that the teacher dialogues with all members of the group to identify how well they attended and have acquired the relevant knowledge. Some aspects to be taken into account for the assessment:
    - Level of responsibility among group members.
    - Number of studied solutions and analysis in terms of advantages and disadvantages of each possible solution.
    - Quality of the written technical report explaining the work done
    - Level of confidence in their solution, and capacity of defending it against constructive criticism
    - Capacity of comparing the proposed solution with knowledge obtained in other courses
    - Management of bibliographic sources
    - Amount of work done beyond that which was requested
    - Robustness of the proposed solution
- Mini-project: Dedicated to planning, design and development of the control system of a real problem design. The developed project will presented publicly to a jury composed of three lecturers. The jury assesses the following aspects including some transversal skills:
    - Report: Maximum score of this part is 25% of the total mark. Quality of technical writing will be assessed, clarity in presentation of ideas, document structure, figures and tables included, the references, the precision in the wording, paragraph numbering and index, etc.
    - Oral presentation: The score of this part is 10% maximum. The team presents the work during maximum of 20 minutes. Aspects considered in the presentation are: description of the problem specification, design and provided solution, overall architecture of the solution, coordination amongst team members, participation of all members of the group, explanation coherence, language style, quality of slides or any other supporting material used during the presentation, the quality of responses to different questions, time spent in the presentation, gestures and staging, etc.
    - Implementation: The score assigned to this part is 65% of total mark. After the oral presentation, the team shows the project application. The evaluators assess how it works, such as: experimental set-up, code structure and clarity of implementation, prototype robustness, quality of user interface, robustness of design, fault tolerance, level of detail, ease of future expansion, developed additional aspects concerning requested, participation of each member of the group, connection between hardware and software, modularity, innovative ideas, economic assessment of the proposal, etc.

In each of these sections in addition to the assessment of knowledge, the teacher should take into consideration and evaluate all the important skills and transversal skills for engineers. Specifically we evaluate [15]:

- Cognitive skills: Analysis, synthesis, application, evaluation, critique, etc.
- Action skills: Organizing time, resources, coordination, negotiating, tolerating, etc.

The advantage of the methodology is that it allows the assessment of other skills that are important for a well-rounded engineer: competition, working in teams, cooperation, oral presentations, budget management, report writing, etc.

The rating of these skills should be included in the appropriate rating to each of the evaluation issues associated at this level.

4.3 Level Three: Grading (outcome)

At this level we will collect all grades earned along the continuous assessment developed along the course and proceed to obtain the final grade for the course.

We give a weight to each section that ensures a final grade which is fair, and that simultaneously differentiates the students amongst themselves, taking into account the individual acquisition of knowledge and acquired skills..

The proposal will be applied as follows:

- The evaluation of the student attitude (A) a 10% of the final score.
- The evaluation of the miniproject represents (MP) a 40% of the final score.
- The evaluation of the Laboratory (L): 20% of the final score.
- The evaluation of the Problems (P): 15% of the final score.
- The evaluation of the Seminars (S): 15% of the final score.

With all the information of ratings and percentages described a single grade for each student will be calculated.

$$FG = A*0.1+MP*0.4+L*0.2+P*0.15+S*0.15$$

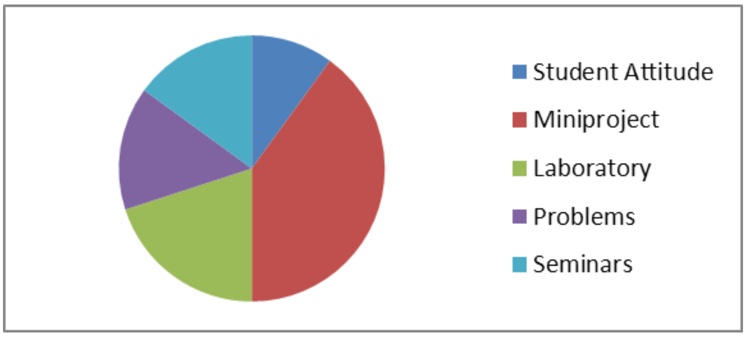

Figure 4.3-1 Distribution of percentages for final grade

5 Assessment of the methodology system

The last level in the evaluation methodology is the evaluation of the system used for teaching this subject. It is important to know the opinion of students and teachers involved to find out what has been done well and what parts could be improved [11].

In this sense the evaluation board system works from two points of view:

- Student point of view: Is important to conduct a survey among students to have information about the acceptance of the course [15]. Students can give their opinion at the end of the course and before obtaining their qualifications so they have a more objective well-formed opinion on the course system. The idea can be the design of a survey in a way that can be simple and easy answered. For instance it can be based on 6 questions with 5 possible answers (“A”: Strongly Agree; “B”: Agree; “C”: Unsure; “D”: Disagree; “E”: Strongly Disagree). The questions can be of the type:
    - Has the subject methodology facilitated your learning process?
    - Has every important concept of the subject been addressed in the miniproject?
    - Has the complexity level of every part of the subject been reasonable?
    - Has the activities promoted cooperation skills as in real work environments?
    - Have you felt motivated during the learning process?
    - Would you recommend taking this course to other students?
- Lecturer point of view: The opinion of teachers is important to make an overall assessment of how the course has worked and what aspects should be improved [14]. Teachers should maintain an open dialogue throughout the course and at the end draw conclusions. The aspects to be evaluated are for example the ratio of approved students, the quality of ratings, the amount of work done by teachers, problems that have arisen and how they have been resolved, possible updating of content, duplication and overlap with other subjects, etc.

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