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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 to 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 competitiveness, working in teams, cooperation, oral presentations, budget management, report writing, 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 student point of view and also from the lectures.

2 Introduction

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

Evaluation should not only be focused on 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 the concepts [2]. Students identify the problem, research on how to solve them by applying concepts and principles. By working in teams they also develop communication, collaborative work, and analytic skills [10].

During the evaluation process a 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 give 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 the norm, to take corrective actions [7].

3 Formation of teams

To allow students to take full advantage of the PBL methodology, they will work in teams of 2 or 3 students. These groups should remain unchanged throughout the course.

It is also important that students in the same team have a similar level of knowledge. This will prevent one student to take an overly active role while other students will not participate enough, with the consequent loss of content assimilation [13].

To determine each student's initial level, in the first day of class an objective type test will be performed. This test will have approximately 25 questions, each with 3 possible answers of which only one will be correct. This test should contain questions on elementary electronics, microprocessor-based hardware, basic programming of microprocessors and on POSIX operating systems, knowledge of methodologies of designing industrial process control programs, as well as basic knowledge on networking.

Questions should be aimed to evaluate general aspects of the concepts required as prerequisites for the AINFM. For example:

- Basic Electrical Engineering concepts: we determine whether the student is able to identify the distinct components of an embeddable micro-processor, as well as basic electrical engineering laws (signal propagation, electrical circuit analysis, digital vs analog signals, etc.). Also to be assessed will be their capability of understanding the appropriate approach to develop state machine based control programs, as well as programs to control continuous processes. Another aspect to be determined is whether the students are capable of using common laboratory instruments (multimeter, oscilloscope, etc.).
- 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 system, and the standard C language and POSIX library functions, as well as the programming of micro-controllers. Basic networking concepts (OSI layers) will also be covered.

Once we know the initial level of each student, we will proceed by proposing groups whose members have similar knowledge level. This will make the groups are 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 that will be followed. 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 during the course. It is important for them to perceive the usefulness of the subject matter in the context of their future career [12][15].

Obtaining information on this level will be based on an ongoing dialogue with each group of students - this should be maintained by the lecturer throughout the entire course.

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

It is important that a deadline for delivery of the different activities that students set and meet deadlines. This should be something to evaluate.

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.

Also should identify those students with a special motivation for the subject because their attitude is above average, as his good predisposition can be made to work 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 crucial. At this level we determine the acquisition of knowledge and skills that students have acquired throughout the course. From our part, taking into account the proposed methodology, we are going to address the evaluation to [11]:

- 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 ask questions regarding this solution [3]. At the end of each lab session the teacher will rate each group based on the work done and the objectives achieved. The evaluation can take into account:
  - Introduction phase: will reflect 20% of the grade. Aspects to be evaluated are, for example, the structure of the produced code (that should implement a communication protocol, or a networked control application), quality of comments, and code legibility. The teacher will also check that the exercises have been completed and the results are as expected. The answers of the questions on the exercise will be reviewed to ensure that students understand what has been done.
  - Reinforcement Phase: will reflect 40% of the grade. Some aspects to assess will be the level of achievement of the exercises, and consistency of the results. The answers on the exercise will be reviewed to ensure that students understand what they have just done.
  - Advanced stage: Will represent 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, which may include an analyses of an existing industrial communication network (technologies used, protocols, etc.). The teachers will meet with each of the groups who will present how they have approached the problem in question, what options for the solution the students consider viable, and which options have been taken. It is important that the teacher dialogue with all members of the group to identify whether all students have achieve the desired aims. Some aspects to be taken into account for the assessment:
  - Level of responsibility among group members.

- Number of studied 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 is requested
- Robustness of the proposed solution

- Mini-project: Dedicated to planning, design and development of a networked control system. The developed project will be 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, overall architecture of the solution, coordination amongst team members, participation of all members of the group, coherence of the presentation, language style, quality of slides or any other supporting materials used during the presentation, the quality of responses to questions posed, 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 its execution: experimental set-up, code structure, robustness of architecture, clarity of implementation, fault tolerance, level of detail, ease of future expansion, any extra features not in initial requirements, participation of each member of the group, connection between hardware and software, modularity, innovative ideas, economic assessment of the proposal, evaluation of the timing properties of the control application and the network protocol, etc.

In each of these sections, in addition to the knowledge assessment, the teacher should take into consideration and evaluate all the skills that are transversally important to any engineer. Specifically we evaluate [15]:

- Cognitive skills: Analysis, synthesis, application, evaluation, critique, etc.
- Action skills: Time organizing, 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 throughout the continuous assessment along the course, and proceed to determine the final grade for the module.

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 mini-project represents (MP) a 45% of the final score.
- The evaluation of the Laboratory (L): 30% of the final score.
- The evaluation of the Seminars (S): 15% of the final score.

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

For the calculation of the final grade (FG) can be followed as the following equation:

$$FG = A*0.1 + MP*0.45 + L*0.3 + S*0.15$$

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 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 design a survey in a way that can be simple and easy to answer. For instance, can be made based on 6 questions with 5 possible answers (“A”: Strongly Agree; “B”: Agree; “C”: Unsure; “D”: Disagree; “E”: Strongly Disagree) for each, rated from A to E marks. 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 mini-project?
    - 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 viewpoint: 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 make the balance. 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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