

# **PEER INSTRUCTION: SIGNALS AND SYSTEMS CLASS, A CASE OF STUDY.**

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## **ABSTRACT**

Several universities around the world have in their syllabus in the electronic engineer programs, the Signals and Systems assignment, as part of the basis for their fundamental formation. Even though its importance, this class has been taught for a long time with traditional teaching methodologies, a teacher giving lectures to their students. This could be explained, due to the topics that are been taught in class and that involve great amount of mathematics, with a huge amount of complex equations and previous knowledge of different concepts involving various areas. Additionally, in this class several theoretical concepts are been treated, that will be used in the following courses, with a more practical component, due to its applied knowledge nature. To be able to overcome these challenges and increases the commitment and motivation of the students that take this class, the Peer Instruction methodology has been implemented since two years ago, it was inspired by the Professor Eric Mazur in the realization of courses of Introduction to Physics in the Harvard University. This methodology has not been adapted literally from the one used by the Professor Mazur, but has been adapted to the conditions and requirements of the Signals and Systems class.

This document shows the obtained results until the moment, including characteristics, achievements and details of the implemented methodology.

The modifications and adaptations from the original model have been made according to budget adjustment, to the available resources and some technological restrictions, but opportunities that have aroused during the development of the class have been seized.

Standard 8 in CDIO (active learning), is the key element of our project, that include self-study modules, individual tests and exams, group work, group evaluations, oral presentations, workshops and project realizations, but also the increase in the commitment and motivation from the students when they are taking the assignment. [4]

Finally, in this experience several tools have been used, some economic or of easy access and other a bit more expensive or of greater technological complexity. So the teacher that wants to duplicate this experience, may be able to do it, without taking too much into account the budget or access to technological tools.

## **KEYWORDS**

Peer instruction, self-learning, methodology, Standard 8

## **BACKGROUND**

In several Engineer Schools, especially in Latin America, the university teachers are professionals in the same area in which they teach, that have passion for teaching, but their professional preparations were not focused for education or pedagogy. When they are asked about the process or teaching methodology, some answer, remember and use some good practices that their teachers had with them during their student's life and try to avoid or repeat those bad experiences that they lived with their teachers. This phenomenon has led that a big part of the way that engineering is taught has been maintained without big changes despite the generational change in the students.

One of the biggest concerns that have taken place in the engineer programs from several years ago, (with some specific geographical exceptions or individual programs) is the decrease in the number of people interested in studying this disciplines. This phenomenon may have several causes and explanations that go further the objective of this document, nevertheless, one of the causes may be the permanent use of the traditional teaching methodology inside the classroom, because according to some studies made, the students mention that one of the causes in the decreasing numbers is the low quality of the teachers. [1]

Peer Instruction methodology has been implemented since 2013 in the Signals and Systems class that belongs to the third year of Electronics Engineer. In the past two years, this class has showed improvement and successful results in terms of acceptance and quality knowledge from the students. On the other hand has showed aspects and situations that must keep improving with the objective of maintaining or making better the students competitions, without the need of increasing in a great manner the amount of work and time from the teacher, exceeding the budget or the institution's resources.

All this methodology is inspired in the teaching models used by the Professor Mazur [2] [3], but also uses tools and models that have been adapted in a different way according to the cultural and technological differences or the program needs

## **APPLYING THE METHODOLOGY OF TEACHING & LEARNING**

At the moment of beginning with the methodology implementation, certain resistance from the students was found, fact that is contradictory, because they are the ones that wish some changes in the traditional methodology, but at the moment of offering changes in the classes methodology the students are sceptic and contradictory to these changes.

It has to be clarified, that any student was forced to assist to the group in which the Peer Instruction was used, another group also existed, where the traditional methodology was still used, the students were able to change from the group it they wanted. None student wanted to change to the other group, the one of the traditional methodology.

For the application of this methodology there was support from the Directives of the Program, where they were told that the methodology's objective was to achieve that the students were able to develop and improve in different abilities (for example, group work, argumentative skills, critical thinking) without losing the principal learning objectives of the course.

The way in which the class is structured, involves several components that may be given by the university (physical space, furniture and software) and others that the teacher may develop as supplementary educational material.

The methodology application has got the same structure, but has got some differences in each cohort in order to evaluate the different alternatives, that are based on the following aspects:

- **Motivation and Autonomy:** It is told to the students that they will develop the easy part at home (previous preparation) and the teacher will make the difficult part in class (will focus on the concepts and more complex exercises)
- **Course formalization:** The program content of the course must be defined, to be able to divide the topic each week, so the student can prepare the lectures previously. This program must be handled to the students from the beginning of the academic period.
- **Bibliography quality:** Additional to the literature, the students will receive a series of workshops and tests, so they can evaluate themselves and feel challenged to solve them.
- **Continuous evaluation:** During the time class the teacher will evaluate (no need of grades) asking questions to answer in individual or group way, in one or several attempts. Once the students give the answers to the teacher, he will evaluate such solution and give a direct feedback, solving questions or doubts that may have the students. At this point is very important to highlight the importance of the previous class preparation by the student.
- **Projects:** The realization of projects made by groups and that must be showed to the whole group. Depending on the complexity of the project, between three to five projects can be done by semester. It is recommended to change the group members in each project.

#### **SUGGESTED RESOURCES NEEDED:**

- **Bibliographic material:** The teacher must prepare in advance the bibliographic material, workshops, projects and literature that will be handled in to the students. No matter if the material is produced by the teacher or other references are used. All of these increases the class preparation time from the teacher.
- **Variety and number of questions:** The teacher must prepare in advance the questions and problems that will be used in each session of every topic that builds the program. All of these involve greater amount of work for the teacher than in a traditional class methodology.
- **Physical or virtual space to share information:** There must exist a common space to share the material that is used in class. This space may be physical or virtual. Paid platforms have been used, as Blackboard, but free tools can also be used as Dropbox, Slideshare and even Facebook.
- **Classroom and furniture:** It is desirable a classroom with available space and reorganization capacity for furniture (for individual or group work). It is also recommended to have several mobile blackboards, in case each group needs to access one of them. (Figure 1).



Figure 1. A classroom with reorganization capacity for furniture.

- Test tools and real time feedback: Several evaluating and feedback tools in real time have been used. One is the use of online tests, in this case Blackboard. Other cheaper tools had been used too (acrylic erasable palettes, multiple choice answers formats that should be scrape) that will maintain the capacity of obtaining information in real time and give immediate feedback to the students.
- Tools for projects realization: In the specific case of Signals and Systems, the use of Matlab is emphasize, which is a powerful tool in the projects realization, though it is not the only tool used.

## DESCRIPTION OF THE METHODOLOGY.

The students are responsible for the previous study and autonomy preparations of the class, according to the detailed program that has been given at the beginning of the academic period.

Weekly evaluations are done, that are not necessary graded, about the topic that the student must have prepared for the class. For the preparations of these topics, the students have the following tool:

- Specific bibliographic references: (Usually taken from the book or the assignment guide books)
- Teacher Class notes, that must fulfill the weekly topic completely. It is recommended to include examples and exercises.
- Workshops based on the weekly topics. Must be uploaded online with the option of choosing the answer, but if does not have this option, the workshop answers can be post it. In any case, the student must have the possibility to know what is wrong if necessary, so it can make the respective corrections.
- Attention schedule, defined hours for doubt solving.

The following were strategies used during class:

- Class assessments, no graded. A series of questions are made in each class, one at a time and must be answered by the student (could be individually) and later on depending on the answer given it can be answered by groups; or from the beginning could be answered by the group, all according to the teacher's intention and decision. Both cases, the teacher should have a way to know the answers in real time, in order

to take decisions, for example, explain any concept to solve the question, expand a topic explanation or just valid the answer and continue.

These answers can be given online, so the student can make a choice and later the teacher may have access to the statistics of the answer, so the teacher can decide how to continue with the teaching.

If there is not an online answers platform, acrylic erasable palettes (or something similar) can be used, so the students can write on it their answers and show them to the teacher.[5]

This option has the advantage that the teachers knows the exact answer that each student gave, without knowing the other students. In the case of having answers no so similar, the students can be organized into groups were they had different answers, therefore they can reach an agreement, with this the students are encouraged to discuss and argument between them.

- Exams. Two different type of graded exams were used; one was of keeping the exams as the traditional method and the other of having one every week. In the weekly exams, they could do several attempts to have the correct answer. Each new attempt lowered the percentage of the question value:  
Correct answer in the first attempt: 100%  
Correct answer in the second attempt: 50%  
Correct answer in the third attempt: 25%  
Correct answer in the fourth attempt: 0%  
This kind of exam was made for both individual and group exams.

When the evaluation is done by groups, the teacher has the opportunity of listening their discussions and arguments, fact that is very useful in order to know the level of knowledge management and use of concepts by the students.

- Peer evaluation. For the group work, the commitment and work of each member of the group was evaluated. Secretly each one of the students had to give a qualitative grade of the work and contribution of his/her partner (outstanding, high, medium, low)
- Group project realization. To put in practice the learned concepts, the students should develop several projects in group (three or five by semester, depending on the complexity), the members of each group must change for each project.

In this methodology, some differences are appreciated from the one of Professor Mazur [3]. Perhaps the main difference is in the availability and use of tools. Both consist in the use of Blackboard for the online answer that does not allow showing question by question or changing the percentages of each one depending on the number of attempts done to answer them, depending on what the teacher wants. The other is the no use of the tool that allows the students to comment in the main text, so the teacher has the information previously to the class, about the topics in which they may have more difficulties.

## **METHODOLOGY DEVELOPMENT**

At the beginning of the academic period, the students are informed about the use of a different methodology from the traditional one. If they want they can change of group, but until the moment, none has done it.

It is told to the students on what consists the methodology, what is its main objective and the commitments the get in order to obtain successful results. In these aspects are mentioned: the use of technological tools, self-learning, group work, peer evaluation, projects development and presentation, improve in punctuality and class assistance, improve in communication skills, argumentation practice and the cooperation and adaptation promotion in different work groups. Additionally it is the improvement of self- criticism and the chance of knowing the mistakes and

misunderstandings and be able to correct them immediately, decreasing the frustration of having low grades.

## RESULTS

The first time the methodology was applied, a survey was made to the 29 students taking the course, to evaluate the implemented methodology in contrast to the traditional one, also there is data about the quantitative results and the class assistance.

For the survey, they were made 20 questions, divided into four areas: teaching strategies, use of contents, teacher-student relation, evaluations and grades.

The results are shown beyond:

Teaching strategies:

The 100% of the students felt useful the use of technology in the learning development, also 80% of them affirmed that the extra class work was suitable.

45% of the students felt more comfortable and confident with the evaluation methods, 30% prefer the traditional methodology and the other 25% it is indifferent.

Use of contents:

At the beginning, one of the main concerns the students had, was that the whole course program would not be covered using the new methodology. However at the end of the class 62% did not find the difference, but 32% think less themes were cover. This is one of the topics to correct.

Teacher- student relation:

It was thought at the beginning that it would be the weaker issue, nevertheless they felt more confident, with greater class participation. The weakest item was the one of critical thinking promotion, 50% of the students said that it is promoted with this new methodology, but 10% preferred the traditional methodology.

Evaluation and grades:

70% of the students prefer the new methodology evaluation rules and only 10% prefer the traditional evaluation.

When the weekly exams were made, the average was 20% greater in contrast to the traditional methodology. When only few (three) exams were made the average was 10% greater to the conventional methodology.

Although the results are better using weekly exams with grades, the students prefer few three evaluations with grade along the semester, because sometimes they do not have enough time to study, due to their other assignments works.

When they were asked if they would like to apply this methodology in other assignments, mostly answered affirmative, but they also said that could not be applied to all of the courses.

From the educational point of view, the methodology was really good, because allowed to appreciate the students' discussions and how they use the concepts with their partners, in the dialogues taken inside the group work.

The assistance and punctuality percentage was greater to the one found with the traditional methodology, even it was no graded. Nevertheless, as it was no graded, it lowered the percentage of previous reading by the students.

Although there were better results in the written exams, this was not part of the initial objectives of the project.

## CONCLUSIONS

The courses have taken place rotating both methodologies between semesters to evaluate constantly the results. When the traditional methodology is used, they ask if there will be at least some exercises or lectures with the alternative methodology.

Even though the results have been satisfactory and the objectives have been achieved, there are three topics that must be keep working on: self-confidence at the moment of taking tests, perception of the covered theme depending on the applied methodology and the perceptions of learning less as the teacher is not given the class directly.

The students have shown the use of previous reading skill, better than it was thought initially as they are not used to do it. This was motivated mainly for the great results obtained

The group projects have been of great motivation for the students, as they apply their knowledge, and there has not been many problems with the change of group members for each project, on the contrary, it has improved the relationships between students.

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