QUALITY IMPROVEMNT OF TEACHING PHYSICS: AN EXPERIENCE ON ENGINIEERING COURSES

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Abstract. *the teaching-learning process has as its main goal the search for a balance among the components directly involved within it: teacher, student and content. Whereas the engineering learning is concerned, this process passes through constant changes in order to be up to date with the transformations that the world has gone into. Because of this, teachers are always looking for new methods and techniques. The Physics area is of great importance in the formation of the student of Engineering. From its concepts, it is possible for the student to understand an amount of applications in Engineering, which means that they must master those ideas in order to succeed when moving forward into their professional area of expertise.*
Having this in mind, the teachers of subject Experimental Physics II are developing a new learning approach, by the use of seminars as instrument of the teaching-learning process. The students are divided into groups and must present seminars on issues related to the experiments they have to undertake. While one group is presenting the seminar, the other students are asked in advance to develop questions about the subject which is going to be presented next in order to inquire them during the classmates' seminar. This activity was thought as a means of involving the student to research about the subjects along the academic term.
The experience has come up with interesting results, beginning with the need the teachers had to learn about the new tool, which was a way of updating their skills in teaching. On the other hand, the students discovered that it is not so simple to present new information and realized how much is asked of them when data exchange is requested during a class. Besides, to develop questions in advance showed them the need for mastering the content, which made all students coming to class with enough knowledge in order to develop complementary activities. In doing so, they were able to keep a larger amount of information as well as improved their attitude towards facing a group during their exposition of ideas and showing more security about the knowledge they have acquired.
This new approach has been developed in the last six months. The students involved in the activity undertook an evaluation in order to criticize the method and suggest some changes. Even though all the teachers of the subject are involved in the process, some questions not analyzed have aroused during its application, such as:
- *Is it possible to apply this technique to any kind of student?*
- *How must be the approach in order for the teachers master this new tool?*
- *Which alternatives may be applied to complement the learning?*
- *How are the teachers supposed to act in order to involve the students in the activity?*

The goal of this work is to show that the experience is being undertaken, the results are being collected and the difficulties are being subject of analysis.

Keywords*: Teaching, Physics, Methodology*

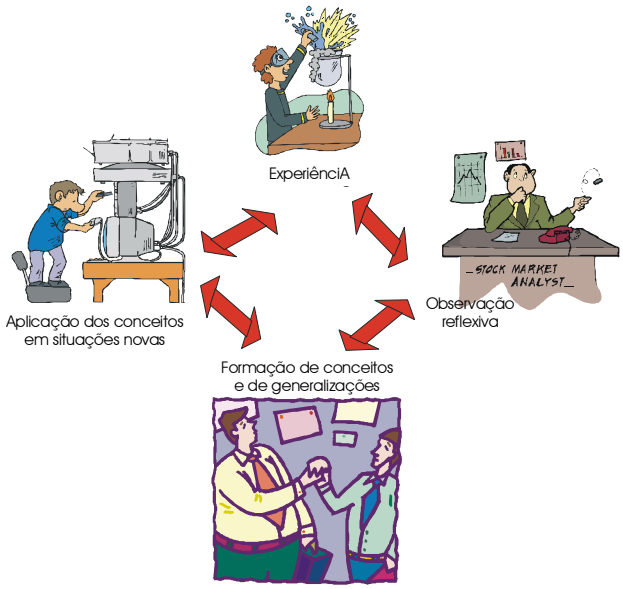
1. Introduction

Engineering is a science that has as beginning the curiosity and the analyses of the phenomenon. Each project developed by Engineering has many influences of several subjects. The technological development is intimately connected to the engineer search for new materials, new processes, new forms of analyses and new products. Engineering is a science that makes the individual to face new challenges in search of a better facility of life. The Engineer in order to surpass these challenges needs to have objectives and strategy that orients his way toward the realization of a new activity, a new project or a new challenge (Timm, 2004)
One of the important characteristics for the engineer who face challenges is the capacity of the cognitive abstraction. This characteristic is developed with the experience utilizing mathematics and physics. They are two fundamental sciences for the formation of the engineer. To develop this capacity of abstraction is not an easy task, because the initial subjects of the course of Engineering they are pure, to perceive the importance of these two subjects, and lose interest

because they do no understand how important those concept are and are going to be needed on the practical side of his profession. Some of them do not give the importance of a solid formation because they are too young and they do not have a vision of future necessities. This reality is faced by the great majority of the Universities of this country. It is also a fact on the University where this work is being done.
For the last three years it has happened discussions with the teachers of calculus and physics in search of a solution for the high rate of reprove of the two subjects on the first two years of those course in Engineering. Many works have been developed with positive results, and some with result below expectation. One of the subjects found on the first years is experimental physics. In the case of the University of this work, the subject of theory of physics has been separated from the Experimental in the hope of finding the students to learn through the knowledge of another teacher, and also to give greater importance in the experimental area what was not the same previously.
The present work presents a change made in the methodology on the subject of Experimental physics. This change has as an objective to stimulate the students in the search of knowledge and to challenge him to learn and face his own difficulties at the time to defend the contents of his research.
It will be presented as process of the application of the new methodology, some results already obtained and the considerations about the subject done with the professors on the area.

2. The present methodology of the subject of Experimental physics

The subject of Experimental physics is divided in three Experimental Physics I, II and III. It is taught in the first three semesters in the Engineering courses. This subject consists in presenting in a practical way contents of practical physics that are seen in another theoric subject (Moreira, 2004)
The idea of this subject appeared a way to facilitate the observation of the phenomenon. This phenomenon is based in the cycle of Kolb. Where the process of learning occurs with the observation of the phenomenon, after being understood and explained is studied conceptuality and applied to the situation of fixation of the concept acquired. The figure 1 shows the cycle of Kolb. The more the student observes the phenomenon the more he is capable to develop the abstraction. Besides having a concrete experience the student is capable to realize a mathematical analysis of processes observed practically.



Fígure 1 – Cycle de Kolb (source: Carvalho, 2002)

The methodology of the subject consists in two parts: one part experimental and one instrumental. In the instrumental part the teacher presents all of the theoric fundamentals necessaries for the practical development. The present instruments that are utilized and the care that are necessary to handle them; afterward the students take some measure to facilitate the understanding of the present theory. In the experimental part, the student should use the knowledge of the instrumental lecture to make an assessment of the data in the experiment calculate the results of the experiment and to make an analyses of what has been studied theoretically with what has been studied experimentally.
This procedure in two stages based on the idea of the cycle of Kolb. In each one of the experimental subject emphases is given to one of the physics. But the methodology is applied in the same way in all of them. This rule has been established in order for the students not detect difficulties when they pass from the Experimental Physics to the other one.
It was formed a group responsible for each one of Experimental Physics. Then the professors prepare a theoric material, they prepare the practical side and observe the difficulties during the presentation in laboratory according to the

difficulties felt by the students. The practical side may be modified of the didactic material or create new practices that will stimulate the student cognition.
The didactic material is at the disposal of the students, so that they can study or consult. Besides this material the student has available to him, films that show the execution and the experience, monitors may help in case of doubt and the didactic book of physics that contain the theorical contents of the subject.

3. Problems with the methodology actual

The course of Experimental Physics has been in use since 1990. There have been many discussions about the methodology, and it has been improved for some years. The changes, more recently, have been changed because of the necessity to awake the curiosity of the student about the phenomenon that is important in the professional practice.
The great majority of the students were not worried to learn the concepts and sometime to understand the concepts of the phenomenon that has been studied.
In some cases, has been observed solutions of problems copied, or students that effectively participate in the experimental activities.
The report of activities that should be made by the student at home was feeble and many times were not made by the student. This background of motivation and curiosity to describe the phenomenon and the concepts learned was the reason to search for new methodology and discussion about the instruments that should have been used in order to make the students devote more time to study and could create more interest on the subject matter.

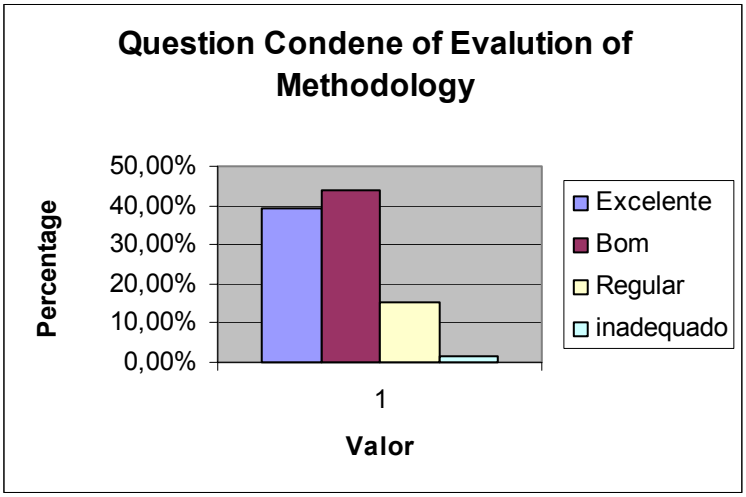
4. Seminary as a new methodology

Owed to the background of interest on the part of the students and also due to the background of study during the application of the methodology previously, it was necessary to think about alternatives that could bring a contribution in the structure cognitive of the future engineer. The suggestion to be used in seminary, as one of the activities, to be developed in the instrumental subject of experimental physics.
The choice of the seminary as a methodology had a motivation in its structure. According to Veiga apud Maia (2004) seminary is a technique usual to debate ideas in group. With the seminary a group of people or one person, presents ideas or contents that are discussed by the group that participate attending some care are important when we used that technique, as for example, the way how the material is prepared to be used; the form of presentation and the necessaries knowledge, and the disposition of the room where the seminary will be presented.
The seminary should be developed with the orientation of professor. He has as main advantage to give the student the opportunity to research about the subject matter, make analysis of the subject critically, and from this analysis the formulates a sequence to be presented to the group. An important step of this technique is that the teacher has predominance in the search of knowledge. The idea is that the teacher be just a mediator making the learning process in learning. This process that helps significantly in learning procedure which is defended by Ausubel (Moreira, 1982).
According to the vision of Ausubel has been thought about on methodology that could help the student to build his knowledge and attain to pass to the cycle of Kolb solidifying his knowledge and forming a cognitive process that could help in the abstract thinking. For these reasons the seminary was chosen as methodology.
The process consists in dividing the contents to be studied by the students. They choose what to study and with whom they are going to study. It is placed the didactic material to be used in the laboratory at the disposal of the student, and the monitor will he present to assist the student, plus the presence or the teacher for any orientation that may be necessary, then a sequence of presentation. The students should prepare the transparences to use the material at his disposal to orient the students during the presentation. The students that are attending should be stimulated to ask questions, and after the presentation they should give grade by what they saw and discuss with the other students.
This methodology is being used in the instrumental class as a stimulus in order for the students to study the subject before they come to class. At the end of the presentation the teacher may give further contents in case that it is necessary and make observation for mistakes that may appear again.
The new methodology is being taught in two semesters as test for a change in the other classes of experimental physics

5. Partial Results

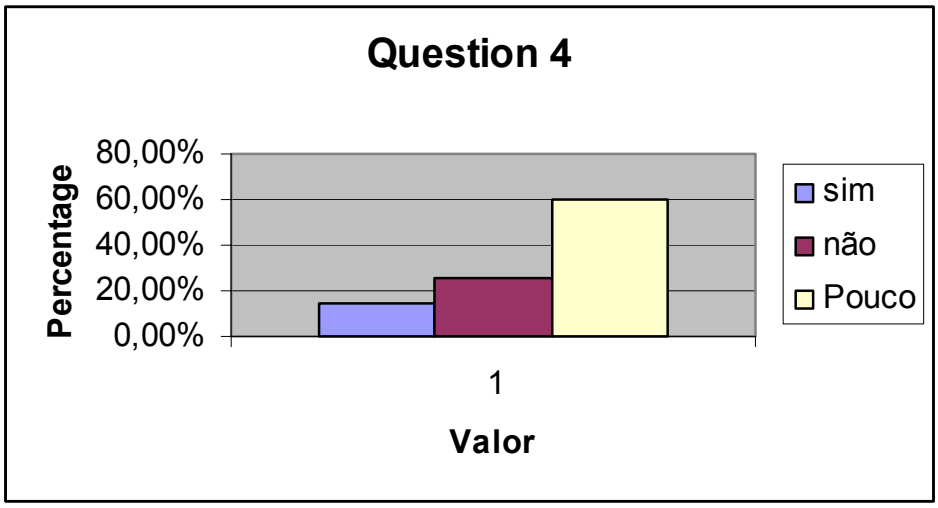
The results obtained with the new methodology are stimulating, but not definitive. During the two semesters of application of the methodology of seminaries a larger search was observed, part of the students went to studies with the monitors. The students sought the monitor to remove doubts on the matter that they will give class and complemented subjects. Another significant change was the students' largest frequency in Experimental Physics laboratories. They need to prepare the equipments, a small example for the colleague then they go at the laboratory with plenty of antecedence to accomplish the practice, to manipulate the equipments and to do measure. That helps in the search of the knowledge and observation of the phenomena in full detail. The students started to seek complemented material. Those facts were observed in 60% of the students. The remaining 40% reacted in a traditional way, without a lot of interest for

what was being developed and presenting works without content. With the seminars, the students needed to study more and study out of the classroom. These are the objectives to be reached with the methodology change. Another interesting aspect is the students' comments that are participating in the seminary as presentation students' group that was the function of presenting the contents. They comment the need to have a task bound with the same content, preparing them better for us to discuss during the presentation. That forces the students to learn more and understand the phenomena that were being studied.
The established process in the cycle of Kolb was all traveled by the students. Through observations of the activities developed by the students, with doubts it is possible to verify that the learning was significant. In several classes, it was possible to notice a larger participation of the students in classroom, with consistent and applied questions.
The great concern and question done during the analysis of the methodology, it is what to do with the 40% of the students that were not stimulated to participate indeed the activities and look for the knowledge that were being presented. A research was accomplished with the students to evaluate the methodology.
For evaluation, an instrument was built with five questions. That instrument was developed with the purpose of identifying as the students noticed the methodology. The suggestions could give to improve the method used in Experimental Physics discipline and identify the level of the students' learning.
The first question asked which the students' opinion on the methodology. 39, 43% of the students found the methodology excellent, 43,8% found good, 15, 10% found regulate and 1,67% found inadequate. Most of the students noticed the methodology as an innovation and a form to improving the learning process. The graphic 1 presents the results commented above.



Graphic 1 – result of first question

It was asked if the learning prepared for the seminars and 37,5% of the students said that the learning is excellent, 54, 23% said that is good and a small minority said not to increase a lot or they found inadequate for the course of Engineering.
However, it was observed that the students don't study when they are not responsible for the class. It was asked a question to know the students if they studied when it was not your day of presentation. 14% said that yes, 86% say that not or they study very a little. That result is presented in the graphic 2. That is a point that needs to be analyzed carefully, because the seminary has the objective to involve the student in the subject that is being studied. If the students do not present the seminars they don't study, we lost 80% of the objectives initials. That observation still provoked some questions in the teachers. This is one of the next steps be studied and lifted up points of improvement.
The fact is if the students are involved with the activities proposed it is a lot of motivation, but not to know to explain the reason of not studying. It is possible that the students are not learning because they have not grasped the methodology of the teacher. That possibility exists and it can be an important point to be analyzed. It was suggested to do test of learning style with the students in the beginning of the semester to identify the learning style of each one. However, another problem starts to exist, the model of curricular structure doesn't allow the students to choose the form how they like to learn and much less the subjects than they would like to study. The teaching is the same for any Engineer independent of the type of engineering. There is no option for studying certain. Then it is necessary to think a significant formula of teaching the subjects. This thing is difficult to do at the present moment and it has been observed in many courses of the University. A constant concern exists in rethinking the methods owed to the teaching the abilities that need to be developed in the futures Engineers.



Graphic 2 – Result of question in Classrom of Experimental Physic

6. Final Considerations

The new methodology of seminaries aided students in the search for knowledge. It brought up the need of the search the knowledge and helped them to study more. Those were the objectives established in the beginning with the change of the methodology. However, to think in the process of teaching and learning is a constant, it looks for new answers of problems that appear. It is Important that new questions be studied again and analyzed that new forms of developing important abilities for the futures engineer can become reality.

The teaching of Engineering has been a constant challenge for the teachers that look for better results in your educational practice. It is a constant search for new methods, new forms of making the student more stimulated and more involved with his professional future. It is also a challenge, because some attempts don't bring the expected results and they generate doubts, frustration and sensation of incapacity in the teachers. However it is an area that has been helping the Engineering to become more and more a science active in the job market through the formation differentiated of the futures Engineers.

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