24th COBEM - 2017

24th ABCM International Congress of Mechanical Engineering
December 3-8, 2017, Curitiba, PR, Brazil

COBEM-2017-5967
STUDY OF TEACHING METHODOLOGIES AIMING AT A MORE MEANINGFUL LEARNING IN ENGINEERING SUBJECTS

Antônio César Valadares de Oliveira
UFU – Universidade Federal de Uberlândia
Av. João Naves de Ávila, 2121, 38408-100 – Uberlândia, MG - Brazil
antoniovaladaresmec@gmail.com

Ana Marta de Souza
UFU – Universidade Federal de Uberlândia
Av. João Naves de Ávila, 2121, 38408-100 – Uberlândia, MG - Brazil
amsouza@ufu.br

Elaine Gomes Assis
UFU – Universidade Federal de Uberlândia
Av. João Naves de Ávila, 2121, 38408-100 – Uberlândia, MG - Brazil
elainega@ufu.br

Abstract. *Engineering courses are affected by high levels of evasion and retention, which are higher than 50% in some subjects. These high indexes result in a loss for the whole society, for the student and for the state. In addition, there are frequent cases in which the student is approved in the subject, but he does not have a significant learning, what causes difficulties throughout all his undergraduation. In this context, the main goal of this study is to experiment with different teaching methodologies in order to reduce the failure and retention indexes. The student aid activities were developed in the Differential and Integral Calculus I, subject of the Mechanical Engineering Course of the Federal University of Uberlândia during the 2016/1 and 2016/2 semesters. Several activities have been proposed, such as complementary lectures, challenging activities, lists of targeted exercises, individual attendance, study groups and contests. The development of the students and the efficiency of the activities were analyzed. The activities were evaluated by the students' attendance, grades and their reports at the end of the semesters. The results made it possible to have a sense of which methodologies best serve the purpose of teaching effectively and motivating the subsequent research on education.*

Keywords: *Teaching in engineering, retention, evasion, learning, teaching/learning methodologies.*

1. INTRODUCTION

A meaningful learning of the subjects of the basic cycle of any engineering is of fundamental importance for a student. Concepts acquired in Calculus I, Linear Algebra, Basic Programming, among other subjects, will be used along the engineering course. The student who mastered these concepts will have in his hands powerful tools that will allow him to be a good professional. However, it is very common identify engineering students passing by enormous difficulties in the subjects of the basic cycle, which is evidenced by the high rates of evasion and retention in these subjects. For example, the average disapproval rate for Calculus I of the Course of Mechanical Engineering at UFU is 50%, an index that is repeated in Calculus II and in other subjects in the initial periods.

It is widely believed that the causes of the high disapproval indexes are a combination of some factors, such as: lack of motivation, lack of previous knowledge of high school, anxiety and nervousness during assessments and incompatibility between the student and the learning model. In this way, analyzing the origin of each of these factors, researching how they act on students and proposing ways to solve them seems to be a good path to reduce evasion and retention indexes, as well as to improve the quality of engineering courses.

The present study concentrated activities in the research, implementation and evaluation of the effectiveness of several teaching methodologies in the subject Calculus I. The goal was to determine which of them could contribute to a

significant learning of the students, as well as to analyze the personal impact that each one of the methodologies exerted on the students.

2. METHODOLOGY

Two combinations of different teaching methodologies were proposed in the subject of Differential and Integral Calculus I, through the *Pró-Excelência* project of the Mechanical Engineering Course. These activities got financial support of Prossiga, an Institutional Program of Assisted Graduation of the PROGRAD (Pro-reitoria for Graduation of the Federal University of Uberlândia). The project was developed in two semesters of the year 2016: 2016/1(first phase) and 2016/2 (second phase). The first phase of the project consisted essentially of complementary classes to those of the professors and individual assistance. The differences between the project classes and the professor classes were the contextualization of exercises through engineering practical examples and the effort to make the student an active agent in the learning process. The second phase involved different practices, including study groups and contests, making the teaching/learning activities more dynamics and, really, requiring the student as active agent in the learning/teaching process. After the end of each semester, the student attendance in the activities, performance and reports were analyzed and the methodologies were compared.

The activities were carried out by students with good academic performance and who had already been approved in the subject, under counseling of the coordinators of the project.

2.1. Methodologies applied during the semester 2016/1

During the first semester of 2016, the activities carried out had the main objective to complement what was passed by the professor in classroom through a continuous study of the subject. Thus, a contest and two weekly activities were defined, which, if fully developed by the student, resulted in an extra bonus of five points in the subject at the end of the semester. They were the Reinforcement Classes, the Challenges and the King of the Derivative.

2.1.1. Reinforcement Classes

Weekly reinforcement classes were given during the semester, in two hours in the course countercurrent to better serve the students. In these classes the student was a passive being in the learning process, that is, it acted mainly as a receiver of information. The classes consisted of a brief review on the subject given by the professor in the week, followed by the resolution of some exercises with the students, as well as the clarification of some doubts that they brought. In addition, the lecturing instructor always sought intense interaction with the students, encouraging them to think and develop their reasoning together. Such interaction took place in a more informal and relaxed way than that between the professor and the student, thus seeking to simplify the teaching without, however, abandoning the concepts and mathematical rigor necessary for the subject. A total of 12 classes were taught during the semester. These classes consisted of the main activity carried out during the semester, established with the intention of fostering a continuous study habit in the students and, consequently, promoting a strongest learning.

2.1.2. Challenges

The Challenges consisted of higher level exercises passed on to the students to solve during the week. They were passed at the end of each reinforcement class and should be delivered the following week class. A total of 12 challenges were applied to students throughout the semester.

2.1.3. King of the Derivative (RDD)

In addition to these activities, another one, in which the student played a more active role, was performed. It consisted of a contest called The King of the Derivative (Fragelli, 2017), in which the student who derived the proposed function more quickly would be the winner. The activity was performed shortly before the test that approached the subject of derivatives. Thus, the activity was also a review class to consolidation of the knowledge.

2.2. Methodologies applied during the semester 2016/2

During the project second phase, the proposed activities required a more active role of students and had as goal to promote good study habits. A biannual contest was organized, consisting of, basically, three minor activities: Group-Led Studies (EDG), a Test and the King of Derivatives (RDD). The results of each activities scored points to the students, which were computed throughout all the semester. In the end of semester, there was a contest ranking. The top three places in the contest were awarded. The first place won a tablet, a technical visit and an inscription for the Week of Mechanical Engineering (SEMEC); the second place won a technical visit and an inscription for SEMEC for the

second place; and the third place won a technical visit. Such prizes were stipulated in order to attract more students to the contest. It´s important to point out that the winner of contests was not necessarily the student with the higher notes, but the student that get better development when compared his initial and final notes. In addition, the student that performed the activities correctly could get an extra bonus of up to ten points in the subject.

2.2.1. Group-led studies (EDG)

The EDG was the main activity carried out during the semester, based on the method called "*Trezentos*" (Fragelli, 2015). The students were divided into groups and, every week, each group met and carried out the set of proposed exercises. In this way, students should study continuously and collaborate with each other in solving weekly exercises. After every test, the groups were reconfigured to maintain a homogeneous distribution of students. Each student was evaluated by his improvement compared the grade obtained in relation to the grade in previous test. Each student was evaluated also by the other students about how he helped the classmate to improve performance. These evaluations were computed and converted into points for the semester contest.

2.2.2. Test

An extra test, which value was five extra points, was applied between the second and the third tests. The purpose was to motivate the student continuous study.

2.2.3. King of the Derivative (RDD)

It was carried out as the RDD already describe in 2.1.3.

3. RESULTS AND DISCUSSIONS

For the analysis of the results were evaluated two quantitative parameters, the student attendance and grade, and one qualitative, the student reports, which were collected at the end of each semester. In all the analysis, students who attended at least 50% of the project activities were considered participants of the project. In addition, subject grades ranged from 0 (zero) to 100 (one hundred), with an average of 60 (sixty).

3.1. Analysis of quantitative parameters

The Figure 1 shows the distribution of approved students in 2016/1 and 2016/2 semesters, and the Figures 2 and 3 present the evolution of test scores (Pi is the ith test) in 2016/1 and 2016/2, respectively. It is possible to identify that the activities of the period 2016/1 showed a greater positive influence on the participant grade. This result was not expected due the fact that many dynamic activities were applied in the second phase. However, there are some factors that could have affected the results. The professor of the subject was not the same in the two semesters analyzed. Each professor has his own teaching methodologies and his own way to require the content from the students, which may had have an impact on the results. In addition, the students of different classes have different characteristics of learning and knowledge level. Anyway, it is possible to verify in the Figure 1 that, in both semesters, the percentage of approved students is higher among the participants of the project. It is possible to observe yet (Figures 2 and 3) that, in both semesters, the evolution of the project participants grade was higher than that non-participants.

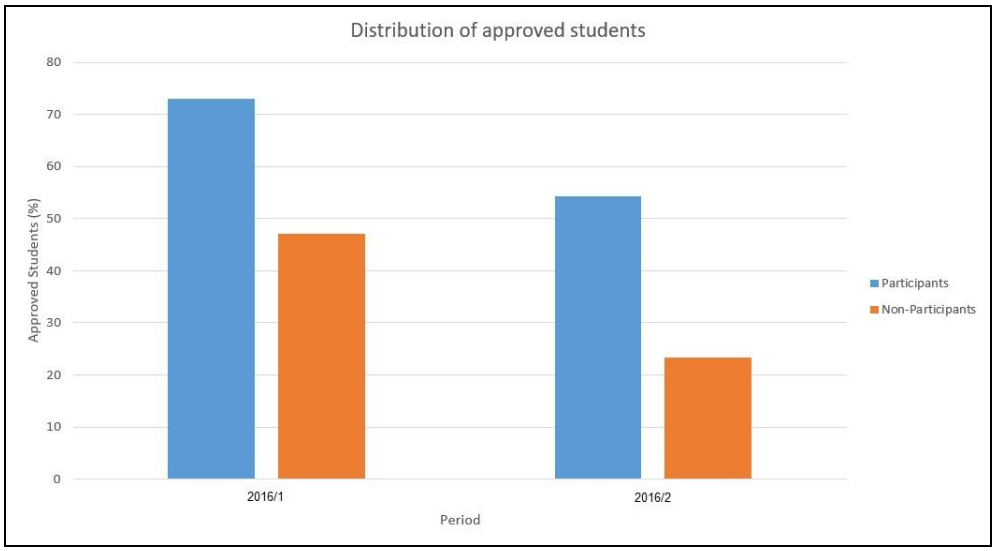

Figure 1. Distribution of approved students by period

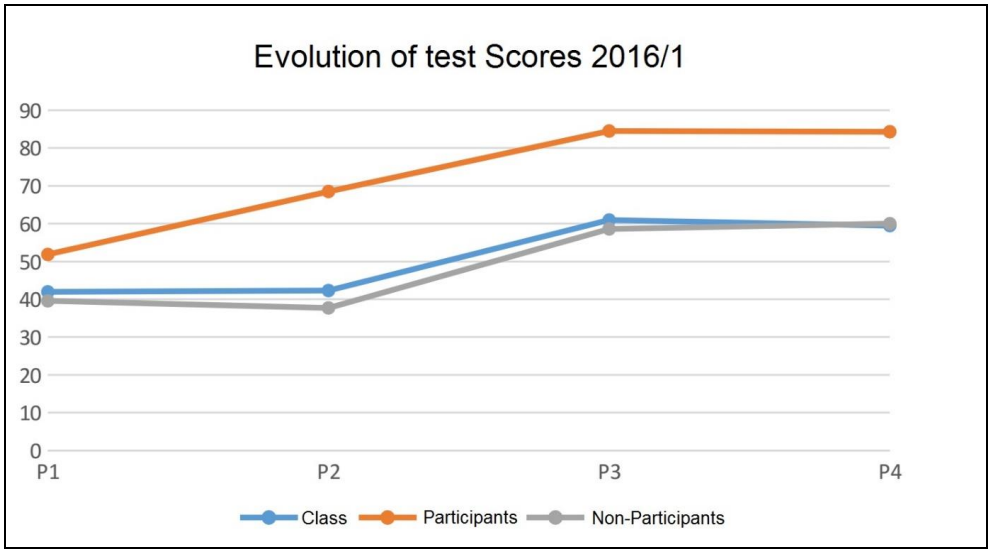

Figure 2. Evolution of test scores in 2016/1

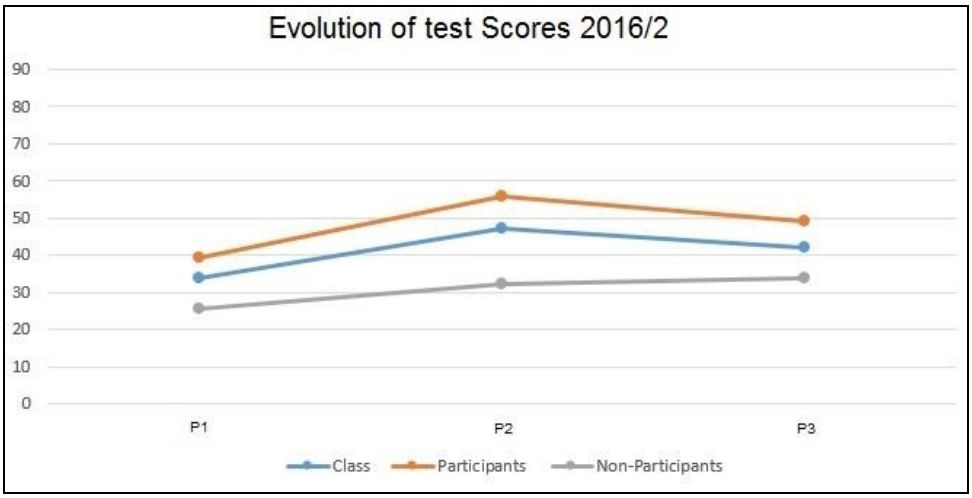

Figure 3. Evolution of test scores in 2016/2

The Figures 4 and 5 show the percentage of students who attended the project during the semester. It is possible to note that the semester 2016/2 presented a greater attractiveness. This fact is probably due to the accomplishment of more dynamic activities, in which the student had an active role.

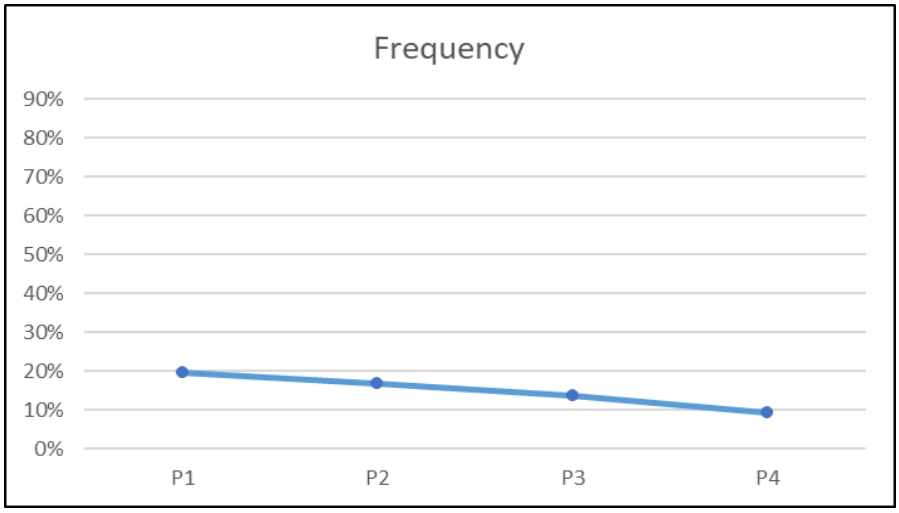

Figure 4. Percentage of students who participated in the project at each evaluation for the 2016/1 semester.

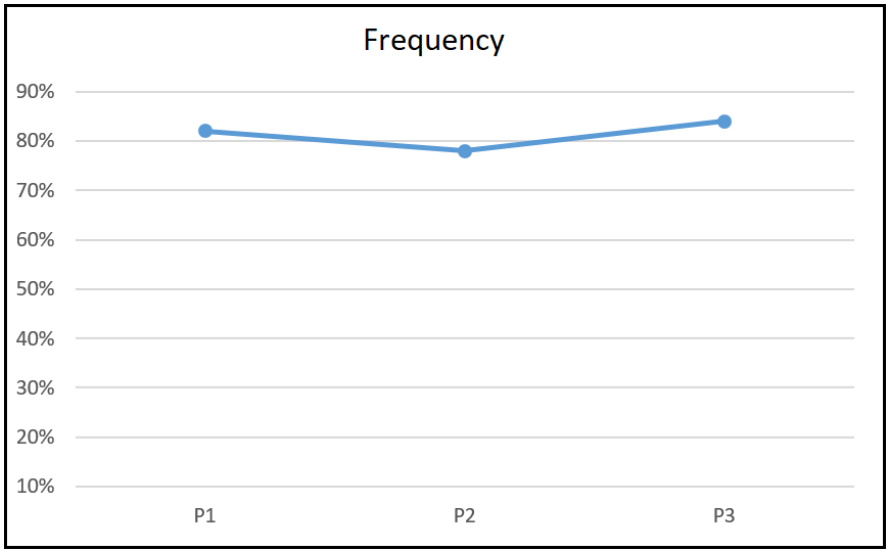

Figure 5. Percentage of students who participated in the project at each evaluation for the 2016/2 semester.

The results observed for the two semesters seem to be antagonistic. In the first phase, it was observed a significant influence on the student scores and little attractiveness. It is believed that the activities performed were not able to affect positively the students that had more difficulties in the subject. In contrast, the second phase showed a high attractiveness to students, motivating them to remain in the project. However, the activities carried out did not contribute so significantly to improve the grades of the participant students. Another important fact is that participation in EDG, in the second phase, was 85% until the first test, and approximately only 10% in the others. In sum, each activity presents its pros and cons, requiring a qualitative analysis in order to obtain a more detailed and conclusive response.

3.2. Analysis of qualitative parameters

At the end of each semester, a questionnaire was applied to the students. So, each student could give your feedback on the activities carried out, evaluating the project and giving suggestions on the future activities. The questionnaire made possible to obtain indications about the reasons of the behaviors observed in the quantitative parameters.

In the semester 2016/1, statements such as "The lessons of the project are encouraging", "There is greater motivation due to the interaction in the reinforcement classes" and "The monitors of the project better understand my difficulties"

indicated that the project participants felt extremely welcomed and aided by the reinforcement classes. However, reports such as "It was another appointment for me, which discouraged me a lot" and "Classes beyond the regular school time are difficult to attend" were repeated among students who did not stick to the project. This fact shows a possible, and perhaps, the main factor responsible for the low participation in the project. The proposed activities were not so interesting to the most part of students, being seen only as "one more class" by them. Thus, those who most needed help ended up without even knowing the benefits of the activities.

However, reports such as "King of the Derivative is a fun way to learn", "Learning from colleagues is an added incentive" and "Staying with friends, see who is the best, encourages me to study", reflect the high participation of students verified during the both semesters. The active learning methodologies, mainly the contests, are motivating and pleasing for the large majority of students.

On the other hand, there were also interesting reports about EDG's that allowed investigating why the students did not follow up the activity during the semester (a great majority dropping out after the first test). The statement that illustrates well the situation is: "The proposal of the EDG was very good. The formation of study-oriented groups, where the help to the colleague is stimulated was really very interesting at first. But, after the first test, the groups were changed and those people that I had become acquainted with were no longer part of my group. Members less interested in the project did not attend or disrupt the group activities. This made me feel very unmotivated. I believe that the fact of the EDG activities continue to occur even beyond the test dates has made the proposal lose its sparkle in the eyes of those less interested in studying". From reports such as this it is possible to evaluate the possible reasons that led the EDG not to obtain the expected success. The method EDG is based on the "*Trezentos*" Method" (Fragelli, 2015). However, in the original method, the group activities are performed immediately after a test. As soon as the test is performed, the students have the possibility to perform another one in order to improve their grade. That is, in the original method the group activities are of short duration. The EDG, methodology used in this study, is based on long-term activities throughout all the semester and whose main stimulus to their participation was the prizes already mentioned. It is believed that the prizes, which only three students would win, may have generated in the participants a possible feeling of impossibility of winning the reward. This feeling is not present in the Fragelli's (2015) methodology, once the prize is the improvement of the grade, which is feasible to all participants. It is considered these factors led the most of the participants to drop out the EDG. As the EDG was the main activity of the second phase, it is justified the worse results obtained for the student academic performance during the semester 2016/2 when compared to the semester 2016/1.

4. CONCLUSIONS

The present work made possible to experiment different learning/teaching methodologies and to analyze them. It was possible to observe that there are several factors that will influence the methodology attractiveness and effectiveness, such as the accomplishment of activity; the benefits belong to student; how are their own motivation to study and the relationships among the participants.

It must be emphasized that the present project was performed concurrently with professor classes, in such way that the own methodologies used by him (or her) in classes, and how demanding he (or she) is, could have had impact on the presented results. It is important to work in cooperation with the professor of the subject.

It was possible to proof that the major of students are very interesting in good grades, but not so much in studding to learn. Activities that were punctuated had the attendance guaranteed, while the others, not. On other hand, competitive activities seem to be appealing. It is necessary to try different ways to motivate the learning.

It was identified that many students have difficulties in basic mathematics, which become difficult the current learning. Activities to solve this problem are being development and applied.

Finally, it is worth emphasizing that each student has their own personality, level of motivation and interest in the chosen course, what make difficult develop an unique way to teach. The application of different kind of methodologies maybe can promote good results in a larger number of students. In this way, studies in education are very important to a better comprehension about student needs and development of effectiveness methodologies to reduce the evasion and retention indexes in the Institution.

5. AKNOWLEGEMENTS

The authors thank PROGRAD-UFU (Pró-Reitoria de Graduação da Universidade Federal de Ubelândia) by the financial support.

6. REFERENCES

Frageli, R., Three Hundred: Active And Collaborative Learning As An Alternative To The Problem Of Test Anxiety, Electronic Magazine Gestão & Saúde. Vol. 6 (Supl. 2). April, 2015 p.860-72.

VEIGA, Ilma Passos Alencastro; SILVA, Edileuza Fernandes da. A multidimensionalidade da docência na educação superior. Rev. Diálogo Educ., Curitiba, v. 12, n. 35, p.33-50, jan./abr. 2012

VEIGA, Ilma Passos Alencastro; NAVES, Marisa Lomônaco de Paula (Orgs.) Currículo e avaliação na educação superior. São Paulo: Junqueira & Marin, 2005. p.175-197

7. RESPONSIBILITY NOTICE

The authors are the only responsible for the printed material included in this paper.