



25<sup>th</sup> ABCM International Congress of Mechanical Engineering  
October 20-25, 2019, Uberlândia, MG, Brazil

## COB-2019-0354

# IMPACTS OF THE PROJECT "PRÓ-EXCELÊNCIA" ON THE ENGINEERING STUDENTS PERFORMANCES

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**Abstract.** *The main objective of the project was to reduce student dropout and retention rates of the courses of the Faculty of Mechanical Engineering of the Federal University of Uberlândia. Therefore, the primary focus was improving learning of a basic subject: Differential and Integral Calculus I, which is one of the highest failure rates of the engineering courses. The intention in the second half of 2018 was to reach with greater focus the repeating students of the discipline, because in the previous semester the project was not able to achieve them effectively. The activities developed by the project consisted from: weekly attendance, review classes on the eve of the exams and the competition "Rei da Derivada". After the analysis of the results obtained and the comparison with the development of the project in the first half of 2018, it was concluded that the failure rates in the discipline in question reduced in a general way. In addition, the work developed met the initial expectations of the group, so the team finalized the project with the sense of accomplishment, which was also possible to be perceived on the project evaluation and personal satisfaction text taken by students who participated in it.*

**Keywords:** *PROSSIGA, student retention, forms of teaching, Calculus I*

## 1. INTRODUCTION

The PROCOR (Program to Combat Retention and dropout in the Federal University of Uberlândia (UFU)), sub-program of PROSSIGA (Institutional Program for Assisted Graduation), was instituted in 2015 with the objective of promoting the improvement of learning and the fight against retention and dropout in undergraduate courses of the UFU, in order to contribute to the improvement of the quality of education, especially with respect to the curricular components that have lately presented high retention and dropout rates.

From the guidelines of this subprogram, the project "Pró-Excelência" was developed in the Faculty of Mechanical Engineering (FEMEC) for the courses of Mechanical, Mechatronics and Aeronautic Engineering, it started in 2015 and, since then, it has undergone evaluations and changes to get the desired results related to the dropout and retention indices. The main emphasis was on the basic disciplines of the first period, which historically have the highest failure rates: Calculus I and Analytical Geometry.

According to Vaillant (2012) study, students and society have passed and still undergo significant and paradigmatic changes and, therefore, traditional forms of teaching no longer serve or are not as efficient as in the past, promoting the need for improvement of teaching practices. Despite this, many teachers still insist on using traditional methodologies and resources that are not always the most effective for students to learn.

In this sense, in view of the observed retention and dropout statistics and in order to serve as an instrument to support to teaching and learning of students, the project "Pró-Excelência" focused on the discipline of Calculus I. Just as the proposal of student assistance activities developed in 2016 (Oliveira *et al.*, 2017), the project brings differentiated activities that stimulate students' learning, integration and motivation, aiming for approval, with a special focus on repeating and incoming students who present greater difficulties in basic mathematics and also with the possibility of a closer relationship by the fact that the team that carries out the work is formed by students.

## 2. METHODOLOGIES

In both semesters, the program "Pró-Excelência" acted with the Differential and Integral Calculus I classes of the FEMEC's courses using similar foundations for each approach. The students selected for the project were responsible to conduct activities that consisted primarily of: the organization of a directed studies group (EDG) with the participants of the project, the "Rei da Derivada" competition's accomplishment involving all the registered students in the discipline

and the implementation of revision lessons before the exam. Based on these proposals, it will be presented below the methodologies applied in each semester and their related differences to achieve the desired objectives.

## **2.1 First semester of 2018**

In the first half of 2018, the activities of "Pró-Excelência" followed mostly the methodology proposed previously by the project in the earlier editions (Oliveira *et al.*, 2017). Both classes from FEMEC's engineering courses (a class from Mechanical engineering and the other with Mechatronics and Aeronautical engineering together) participated in this semester.

### **2.1.1 Directed Studies Group (GED)**

Based on the method "Trezentos" (Fragelli, 2015), proposed by Ricardo Fragelli, professor of the University of Brasilia (UnB), study groups were held with the intention of developing consistent study habits between the learners. This activity was divided into two different moments: initially, it was given a review lesson with the contents taught in the classroom weekly utilizing selected exercises to practise and stimulate the active participation of the students and, after this, they were assisted individually in their doubts.

This type of methodology has been utilized on the project since 2015 (Oliveira *et al.*, 2017). The way the classes were conducted had the main objective of offering a different, pleasant and funny moment of study, by making the students the main focus of the class, so that they became active participants during the whole process and they realized the real learning with this approach. The most common questions were used to guide the revision in a general way and then the attention of the team project was destined to an individualized support for those who needed further help.

As the activities were executed during the period, it was possible to adapt better the classes given. In addition, with the focus on obtaining a better performance of the participating students, the members of "Pró-Excelência" had a closer relationship with them, facilitating the communication and improving the student's answers. For these classes, all students were invited to participate in and encouraged to study to succeed the whole period.

### **2.1.2 "Rei da Derivada"**

"Rei da Derivada" is a complementary activity to the project, consisting of a competition between all students of Differential and Integral Calculus I of the engineering courses offered by FEMEC. It is based on a dispute among the learners in order to evaluate at first the domain of the derivation rules and later the speed with which they can calculate the proposed derivatives. Its structure and execution were made inspired by Ricardo Fragelli's proposal (Fragelli, 2015). The award was given as the free participation in some events at UFU.

### **2.1.3 Pre-exam revision classes**

The revision classes were lessons about the themes of the utmost importance related to each exam that would be done the next day. These classes were taught by the members of "Pró-Excelência" with the aid of the monitors of Calculus and were opened to any student who had interest. Due to the significant amount of subject, the applied methodology mostly treated the student as a taxable person, making available only a particular moment for possible doubts and suggestions for exercises, because the time to cover all the contents was short.

## **2.2 Second semester of 2018**

During the second half of 2018, the activities of "Pró-Excelência" had more emphasis on the repeating students. This time, all the participating students at Directed Studies Groups had already failed in Calculus I and the attendance for them was specialized at their greatest difficulties.

### **2.2.1 Directed Studies Group (GED)**

The methodology applied in the second semester still kept the Ricardo Fragelli's proposal (Fragelli, 2015) as the main structure, but this time only the students who had already failed at least once in the discipline of Differential and Integral Calculus I and who were undergraduates at FEMEC's courses were invited to take part in the study groups.

For a better utilization and attendance, the students who demonstrated interest in participating in the project were divided into groups of 3 or 4 persons with one member of "Pró-Excelência" specially dedicated to each group.

That way, the selection of the groups was made according to the common features of the students with the goal of offering a focused assistance at their difficulties and creating a connection between them. Because of the higher specialization and closer attention needed at the classes, it was required to increase the number of the members that constituted the "Pró-Excelência" team by inviting the monitors of Calculus I to contribute and assume the responsibility

of following one group of the project.

### 2.2.2 "Rei da Derivada"

The "Rei da Derivada" competition was executed similarly to the proposal of the first semester of 2018. But, due to the success of the previous edition, this time different sponsors were obtained to support the competition providing prizes from a wide range of commercial sectors to increase the attention of the students. Even with the difference in the approach of the study groups, the structure of "Rei da Derivada" was kept with the invitation extended to all undergraduate students of FEMEC enrolled in Calculus.

### 2.2.3 Pre-exam revision classes

The pre-exam revision classes were conducted the same way as in the previous period, being opened to all students of the graduation courses of FEMEC registered in the discipline of Differential and Integral Calculus I.

## 3. RESULTS

The project "Pró-Excelência" dedicated its attention to the students of the discipline of Differential and Integral Calculus I from the FEMEC's courses, using different approaches in each semester of 2018, in order to reduce the failure rates effectively. As already presented in the methodology section, in the first half of 2018, the activities developed had the intention to cover all the learners, but the vast majority of the participants was composed of entering students only. Consequently, in order to achieve those who needed further help, in the second half, a greater focus was given to the students whose already had failed at least once in Calculus I, except for the "Rei da Derivada", an open competition to all students from Calculus I of FEMEC.

Next, the obtained results in each approach will be presented and their effectiveness and repercussions on results will be discussed, with the primary focus on the student's approval. According to the UFU academic guide (UFU, 2018), the student will be considered approved if he obtains simultaneously 60% of the points of the subject and at least 75% of presence in the classes.

### 3.1 Semester 2018/1

During the first semester of 2018, the project "Pró-Excelência" acted through two calculus groups (one for the Mechanical Engineering course and another for the Mechatronics and Aeronautical Engineering courses), offering weekly classes and revision classes on the eve of the exams, besides promoting the "Rei da Derivada" competition.

In this period, all the enrolled students were invited to these activities and the project team was divided aiming for specialized assistance on each group. A total of 21 students took part in more than 75% of the activities conducted by "Pró-Excelência", all of whom were entering students.

Those students presented, in general, a good performance during the whole period, as represented in the Figure 1 by their exams results in comparison with the results of the other students. For the following graphics, the students who had at least 75% of frequency in the activities proposed by the project were considered "Pró-Excelência"'s participants and the grades are expressed as a percentage of the maximum grade.

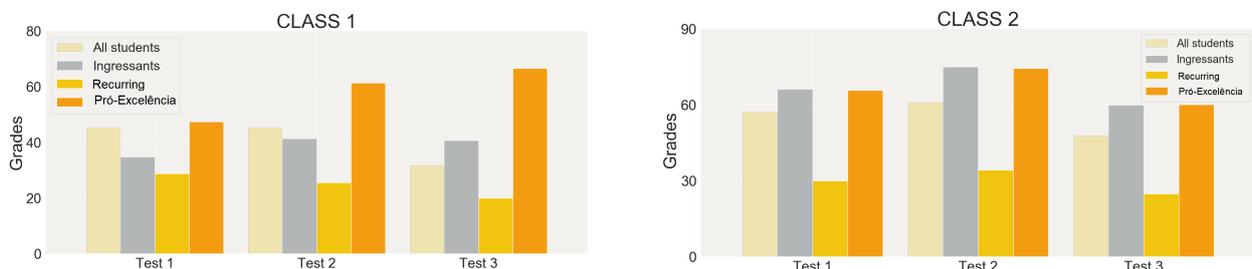


Figure 1. Students grades from the tests applied on the first half of 2018.

In accordance with the graphics, it's possible to see the discrepancy between the grades obtained by the entering and the repeating students. In addition, the grades of the "Pró-Excelência"'s participants had a growing gap during the semester related to the class in general for the first group and they were almost similar to the average of the entering students in the class 2. Therefore, it's possible to conclude that the "Pró-Excelência"'s participants were mainly the ones that would already have a good performance in Calculus and the project helped them to improve even more. This can also be observed in Figure 2, in which the graphics shows the approval rate of "Pró-Excelência"'s participants in comparison with the other students.

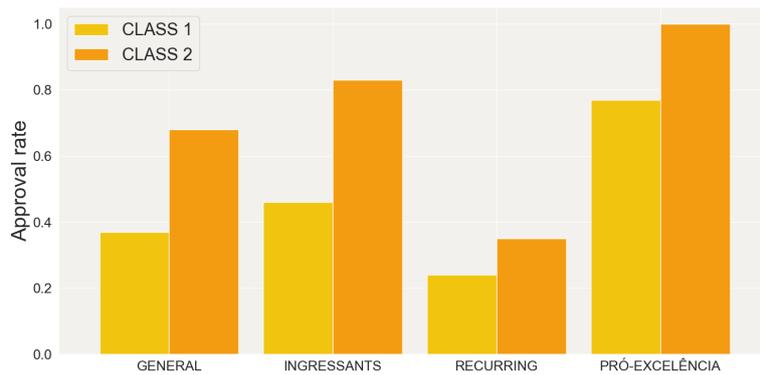


Figure 2. Approval rate of classes participating in the project during the first half of 2018.



Figure 3. Graphs of grade distribution for the classes of the first semester of 2018.

As already observed the students of the program "Pró-Excelência" presented a better performance if compared with mostly of the students. This is evident again in the Figure 3, in which it is presented the distribution of all the participating students ordered by the final grade on the discipline in both classes of the first semester of 2018. In this graph, it becomes clear that most students of "Pró-Excelência" are between those who had a good performance in the discipline and almost all of them obtained grades greater than or equal to the average of 60%. Thus, it is possible to reaffirm that, associated with the fact that the repeating students did not participate in the project's activities, the main beneficiaries were those who would have already a good output in Calculus I.

### 3.2 Semester 2018/2

In the second semester of 2018, the project was specially directed to the repeating students enrolled in the discipline of Calculus I from the FEMEC's courses. Although they were all invited to participate in "Pró-Excelência", only one part of them demonstrated interest and joined the project. Among 43 repeating students enrolled, just 16 of them showed interested themselves initially and just 7 participated actively in the project's activities, being all from the same class (Mechanical Engineering). That way, for the comparison of performance in this case, it will be considered only the students of the Mechanical Engineering class.

The weekly classes given in the first half of 2018 were replaced by specific assistance to smaller groups formed by these students and it became possible to better serve their needs and to improve their individual incomes. Once again, the "Pró-Excelência"'s participants showed a greater performance when compared with the other students in general, which can be seen in the graphics from the Figure 4, having on average a grade 30.61% higher than the class.

In addition, it is possible to observe that, even if all the students helped were repetitive in the subject, they obtained a higher average than the incoming students and this reflected in the approval represented in Figure 5. In the class in which the project acted the approval of the recurring ones and the entrants students had a difference of only 1%, and the "Pró-Excelência"'s students had an approval rate of 72%. The same can not be observed in the other class as no student participated in the project.

It is important to point out that, in this period, "Pró-Excelência" actuated just with the students of the Class 1 because the repeating students of the other class did not show interest in the program or gave up right at the beginning, so their results were not considered as part of the project. Due to the new approach, the grades have shown themselves more equally distributed in the class with the project's action. However, even though the program has been carried out only with repeating students, the results of "Pró-Excelência" were significantly higher than those of rest of the students. In the

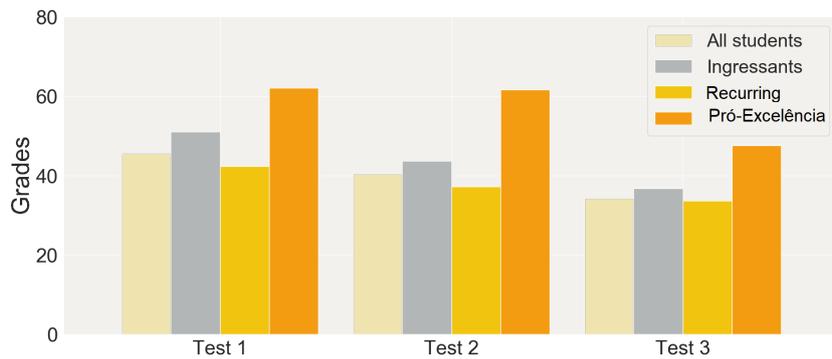


Figure 4. Grade of the students of the class 1 on the tests applied on the second half of 2018.

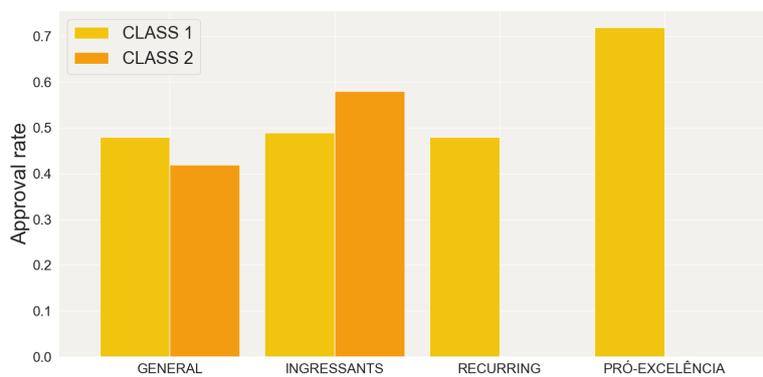


Figure 5. Approval rate of the class during the second half of 2018.

Figure 6, this new distribution can be observed, with the students that would be concentrated on the left part of the graphs (given that the higher failure rate was between those who already failed in the previous semester) being allocated over the other results.

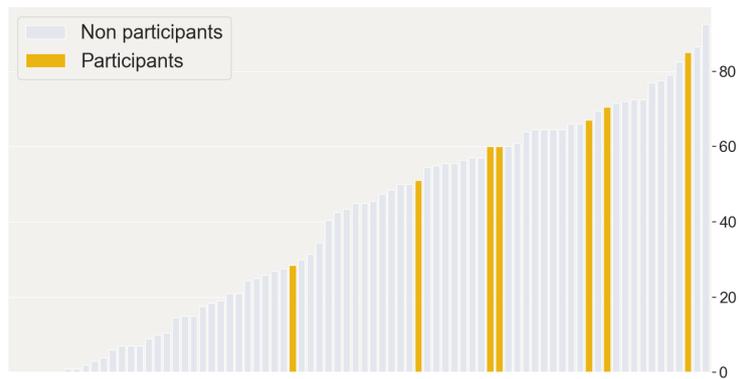


Figure 6. Grade distribution for the Mechanical Engineering class on the second semester of 2018.

Furthermore, it is possible to see that in the Class 2, the approval between the repeating students was null and the average of their final grades was 9.52 points while the recently enrolled students obtained 50.83 points on average, disregarding those who failed by frequency. If compared to the class in which “Pró-Excelência” acted, it can be stated that at least a better average among the repeating students could have been achieved, since the discrepancy between the two groups was very high.

It is possible to attribute the best performances of the repeating students to the new approach adopted, with this reducing the disparity of them with respect to the whole class and reaffirming the results presented in Figure 5. As only the students of one of the classes participated in the project this semester, just the distribution grades graphs referring to the same group was presented.

### 3.3 "Rei da Derivada"

The "Rei da Derivada" (Fragelli, 2015) was held in both semesters with the enrolled Calculus I students from FEMEC. The presence in the event was significant in both events, but the difficulty of disclosure of the event was greater in the second period due to the change of project approach.

With the approach closer to most students in the first semester, the "Rei da Derivada" competition reported a substantial presence: among a total of 106 students, 51 of them enrolled in this activity, being 25 from the class 1 and 26 from the class 2, according to the Figure 7. There was a great engagement of the students during the competitions during both phases (selection and finals) and several of them showed up at the final stage only for watch the competition and cheer for the classified participants.

Due to the popularity of "Rei da Derivada" competition in the first period, it was possible to get greater sponsorships for the event. However, unlike the first semester, there was a smaller accession this time. The smaller contact with a large part of the class made the dissemination of the event difficult, but even so the competition presented a good quantity of students. The students who participated in the first semester helped with the diffusion of "Rei da Derivada", by encouraging the students enrolled in Calculus in the second semester of 2018. The number of participants fell to 39 students (related to the first semester), with 17 of them from the first class and 22 from the second one, as it can be seen also in Figure 7.

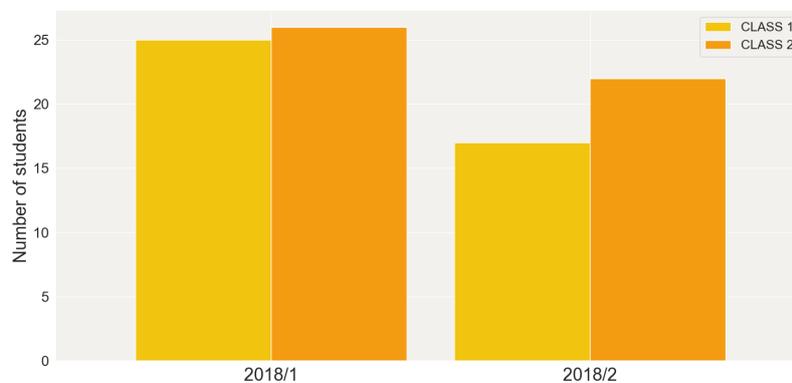


Figure 7. Students participation on the "Rei da Derivada".

## 4. COMPARISON BETWEEN THE APPROACHES

Both methodologies presented differences and each one had its advantages and disadvantages and the analysis will be made as a comparison of results between them and their respective approaches. It is worth emphasizing that there isn't perfect solution to this problem and, as already demonstrated by Almeida (2011), Oliveira *et al.* (2017) and Fragelli (2015), support activities can have great results, even with different areas of actuation.

Also, the words of Raul Carreira Rufato, participant of the project of earlier iterations and in the first semester of 2018, shows that the results are satisfying and give motivation to continue the work in the next years: "I have participated in the project between 2017 and 2018, believing that the students didn't had enough interest on a subject as essential as Integral and Differential Calculus I is for engineering courses. This period showed through statistical surveys of students performance that the project actually works, students have more interest when the discipline is shown in an applied manner, and also when the "Rei da Derivada" competition occurs. It was extremely gratifying to learn from the project and, after seeing the improvement in the approval data, I do believe that it is a viable solution to improve the students avoidance and disapproval in this discipline."

Analyzing the approval rates of the repeating students, presented in the Figures 2 and 5, it can be noted that there was a considerable increase in the rates in the second semester, with their results being similar to the results of the recently enrolled students. This can be directly attributed to the actuation of the project, since the majority of the "Pró-Excelência"'s students were approved.

With the approach's change, it was possible to see that the students, who really needed help and were encouraged to participate in, appreciated this new perspective and the results achieved with the team members. According to Bryan Caixeta, who participated in the second semester, "It was nice, exciting and it takes away the feeling that the Faculty does not care about their students". Also, another student, Felipe Fernandes, evaluated: "I participated in "Pró-Excelência" for two periods and the experience was very positive, not only for reviewing and reinforcing the class's subjects, but mainly for showing alternative ways of study to what the students are normally used to".

The first approach also had its advantages. As it got a greater participation of students a variety of results appeared: the ones that already had good performances in Calculus had the chance to deepen their expertise on the subject and

improve even more their results; and the ones that maybe could fail found in this groups and classes the support to get the approval. In the words of Larissa Barbosa: "I thought it was very good for me to learn the rhythm of the university, to better understand what is being explained in the room and to have more time of application with someone accompanying you. In the classrooms the teachers usually teach the material and give an example, as beginners in the graduation we were lost and the "Pró-Excelência" knew how to direct us".

It also should be noted the effects of the approach in the "Rei da Derivada". The difference in participation in both semesters was considerably large, even though in the second realization there were many attractions that didn't exist beforehand. It can be concluded that with a closer relation with more students it's easier to develop events and create an enduring image of the program, although the benefits of focusing the aid proved to be more effective considering the program proposal.

From the comparison between each of the classes of the graphs 2 and 5 there is a great difference between the "Pró-Excelência"'s classes and the one without its participation. Even though the students from the class 2 of 2018/2 showed difficulties with the subject, none of them participated in the program. That way, the gap between both classes regarding the recurring students grew considerably.

Although both approaches succeeded in aiding the students, each one showed excellent results in different domains. The first reached a greater number of participants and the program had a good influence over the classroom, making it easier to promote the "Rei da Derivada" and eventual classes. The results of the participants had also a very high approval rate if compared with the rest of the class. The second approach reached a smaller quantity of students, but the results were also great, increasing considerably the approval rate of the repeating students, that became the focus of the project.

About this topic related to the comparison between the two approaches, George Dechichi, who participated in the "Pró-Excelência" team, exposed his point of view and how he felt during the year of 2018: "I joined the project in my second period with the objective of aid the people who had difficulties in Calculus I, which did not seem so complicated to me. In the first half of 2018, with the model of weekly classes and revision on the eve of the exam, I felt the students more involved and with more interest, such that they really wanted to participate in more activities with prizes (as the "Rei da Derivada" competition), which were funnier and helped with the practice. In the second semester, on the other hand, with a model oriented to the repeating students, I was afraid they refused the support and even they showed interest with the smaller groups, at first it seemed to be going very well, but then the students demonstrated many difficulties at simple math. As the semester went on, they started to be absent from the meetings, they did not justify and at the end almost none of them was participating anymore, except for one student. Anyway, I don't think this bigger focus on the repeating students is not important (it is actually very necessary), but for the "Pró-Excelência" team the first approach was easier to carry on and much more motivating because only the ones who were truly willing to learn were participating. The energy of the interested students and their appreciation for our help in the first semester made me feel very well and with a sense of accomplishment at the end of every lesson given."

## 5. CONCLUSIONS

Given the presented analysis, it can be concluded that the project "Pró-Excelência" obtained great results in both approach proposals and proved itself as an essential instrument of support to the students of Differential and Integral Calculus I. Thus, it effectively contributed to the reduction of failure rates in the first basic mathematics discipline for engineering bachelors.

In addition, because of the significant involvement of the students in the first semester, the project attracted some of the students who needed help and support in the second semester, having been very well evaluated by them. The concrete results and the demonstrations of self-realization and satisfaction from the participants are the strongest evidence that the "Pró-Excelência" undertook an indispensable job. All of this done by turning its attention to the new entrants and repeaters of the basic engineering cycle, whom were the ones who needed most assistance and it was not provided properly, before the start and development of the project.

In the face of what was exposed, for the next editions of "Pró-Excelência", it can be said that the ideal would be the application of the two different types of approaches together to support specially the recently enrolled students that present basic difficulties coming many times from a deficient secondary school and the repeating students that clearly need help, mainly observing that historically the ones who fail most are those who already failed. Increasing the efforts with this in mind and taking maximum advantage of the contributions of the monitors of Calculus I and the "Pró-Excelência" team (with a greater quantity of members), the positive results would be amplified and the problem of high retention and dropout rates could be even more minimized.

## 6. ACKNOWLEDGEMENTS

The authors are grateful to the DIREN / PROGRAD (Directorate of Teaching / Pro-Rectorate of the University) from the Federal University of Uberlândia for the fundamental financial support for the realization of this present activity.

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## 8. RESPONSIBILITY NOTICE

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