

Implementation of Peer Tutoring as a Strategy to Promote the Development of Basic Mathematical Skills in University Students

José Alfredo Carazo Luna *

Universidad Tecnológica de la Mixteca, CP. 69000, Huajuapán de León, Oaxaca, México

Email: alfredo@mixteco.utm.mx

Irma Salina Pérez

Universidad Tecnológica de la Mixteca, CP. 69000, Huajuapán de León, Oaxaca, México

Email: isalin@mixteco.utm.mx

Virginia Berrón Lara

Universidad Tecnológica de la Mixteca, CP. 69000, Huajuapán de León, Oaxaca, México

Email: berron@mixteco.utm.mx

José Anibal Arias Aguilar

Universidad Tecnológica de la Mixteca, CP. 69000, Huajuapán de León, Oaxaca, México

Email: anibal@mixteco.utm.mx

Abstract

One of the biggest problems in higher education institutions in Mexico is the high failure rate in the first math courses in areas focused on technology. Tutoring, as a fundamental tool in the integral development of engineering students plays an important role in dealing with this type of phenomena, the role it plays is decisive in controlling or diminishing one of the most worrying indicators: desertion. As a measure that aims to correct these rates, corrective courses of Precalculus have been developed and implemented using the strategy of peer tutoring, which in our case was divided into three different levels: basic, intermediate and advanced. The effectiveness of this strategy was evaluated with two instruments: the first was a placement level test, according to which the student was assigned a course adapted to their specific needs detected in the evaluation; At the end of these courses, a second test was conducted to determine the progress of each student. As a result, it is expected that a high percentage of participants will acquire the necessary mathematical skills to pass to the next level and guarantee their permanence in the following courses with follow-up in academic advising.

Keywords: Peer tutoring; academic advising; desertion; Precalculus courses.

1. Introduction

In their work to train highly qualified human resources, the Universities and Institutes of Higher Education (UIES) face diverse obstacles among which are: the school lag, the low terminal efficiency and the desertion (Enriquez 2006), (Government of State of Oaxaca, 2011-2016), (Vera-Noriega, 2012), (SEP, 2005). These indexes have increased in recent years becoming one of the most important challenges that are trying to solve in the Universities and Institutions of Higher Education around the world and in all educational levels (Chávez, 2007). The causes that originated can be grouped into three categories: family situation including the student himself, the educational system and socio-economic factors (these are foreign to the educational system) and low academic performance (Huesca, 2015).

In the public and private UIES of Mexico, these problems are accentuated especially in the first years of the degree (SEP, 2005). It is stated that half of Mexican students fail to complete their studies (five out of ten students dropout at the beginning of the second year) (Vries, 2011). This is due to the fact that the students have difficulties to integrate into the university environment and to their deficient previous academic formation; that limits the students in the comprehension of the new concepts that they have to learn, or they do not do it at the required speed and consequently they reject the subjects; preventing them from continuing their university training for temporary losses, generating lag, low terminal efficiency and finally dropout which is related to the repeated repetition of non-accredited courses (Gómez, 2000) (Ocampo, 2017).

It is necessary that the Universities and Institutes of Higher Education of México promote actions and strategies aimed at strengthening the formation of students so they progress academically and thus try to decrease the dropout indexes without affecting the quality of the academic level reached by the Universities. One of the strategies most used today to achieve the above is peer tutoring (SEP, 2014). This modality consists of forming pairs of students of different semesters with the intention that the most advanced student called tutor, support academically to his companions of lower semesters called tutees, with the supervision of a professor. In this context, the tutor acts as a point of reference that motivates and facilitates the student's environment since he is immersed in the same context as his tutees and, therefore, knows their problems and sympathizes with them.

One of the essential requirements that must be considered in the implementation of peer tutoring is the specific prior training of the tutor, which must be oriented towards the profile in which the tutoring is given in addition it is necessary to provide continuous technical advice from the tutor by the teacher (FLACSO, 2014). Some universities in the United States, Canada, Austria, France and Spain among others have implemented some type of advice on tutoring given their effectiveness and personal enrichment for the students. In Mexico, this practice is not widely disseminated (Rubio, 2018). In this research was implemented a remedial course of PreCalculus using the strategy of peer tutoring, as an alternative to reduce rates of failure in subjects related to mathematics.

It is stated that "*at the level of higher education, the highest rates of failure are presented in mathematics*" (Ocampo, 2017). And it is precisely in these subjects that the highest rates of failure and consequently of desertion are recorded, especially in the first two years of the engineering degrees, during which the students study: Differential and Integral calculus, Linear Algebra, Differential Equations between others These courses are fundamental and essential for engineering careers and are intended to provide the student with mathematical competences that allow them to: "explain the physical phenomena that surround their environment and establish abstract theoretical models that will later be used in the design of new products that they will be put at the service of society " (Trejo, 2013). In this sense, it is important to design a strategy that allows students to provide the necessary math skills that allow them to successfully perform their professional lives.

Faced with this problem the Institutional Committee of Tutorials (CIT) of the University of Southern México (USM) has executed a series of actions aimed at reducing the failure rates in subjects related to mathematics such as: peer counseling in a group or individual and remedial courses. While it is true that these students when they enter the University receive a preparatory course of approximately 60 hours, it is also true that this is not sufficient to correct their academic deficiencies; For this reason, a 30-hour PreCalculus remedial course was implemented in the 2016-2017 school year to support new students, with the aim of raising their mathematical competences in the areas of Differential and Integral Calculus derived from the deficiencies in algebra, and thus promote their comprehensive training and improve its permanence, departure and timely degree applying the strategy peer tutoring.

2. Methodology

The PreCalculus course was carried out in the 2016-2017 school year, the initial phase consisted of issuing a call to the students of the first semester, whose result of the first partial exam of mathematics was not satisfactory, and to all those who were interested in mastering or expand your basic knowledge of algebra. To determine the level of basic skills in mathematics that each student had, a placement test with 10 items was applied. Approximately 280 students were tested. The rubric allowed us to locate students by level of knowledge: Basic, Intermediate and Advanced. Once the students were classified, they were assigned an adviser according to the level obtained in the exam and their availability of schedules. Trying not to affect the class schedules of both the tutors and the tutees. Once the students were classified, 23 groups were formed with 10 tutees each. In order not to interfere with the normal activities of the semester, the Pre-Calculus course was divided into three consecutive phases of 10 hours each, suspending in the week of partial exams and resuming activities once these were completed. The programming of these phases is shown in table 1.

STAGE 1	October 20 to 31, 2016	10 h.
STAGE 2	November 14 to 25, 2016	10 h.
STAGE 3	January 9 to 20, 2017.	10 h.

Table 1. Phases of the PreCalculus course.

2.1 Recruitment of the advisors.

A team of 23 students from different semesters of the educational program in physics-mathematics as advisers was integrated as tutors. This career was selected because we considered that they could explain abstract mathematical concepts by relating them to the physical phenomena studied in other subjects of the study plan of the tutor. The characteristics required to be selected as tutor in the workshop were: To be a student of the Educational Program in Physics-Mathematics in different semesters, supportive, discreet, committed, easy to communicate and have imparted informal advice, availability of schedules, and above all have accredited the subjects of Differential and Integral Calculus.

The selected students were previously trained in "group control and leadership" techniques; which consisted in showing the participants the different types of personality of the students and the way of resolving certain conflicts that could occur in the classroom, also emphasized at all times the instructors that should be addressed with respect and fairness to their students. Each of the tutors was assigned a group of 10 students, all of them with the same level of knowledge. They were also given a tiered agenda. The groups were formed as follows:

a. Basic: 12 groups.

- b. Intermediate: 10 groups.
- c. Advanced: 1 group.

2.2 During the course

During the course, the CIT monitored each tutorial session with the purpose of supervising the correct behavior of the students, and also to clear up doubts that the tutor could not have solved; situation that was never presented due to the high degree of preparation of our tutors. Several meetings were held to provide feedback to the instructors, helping them in the control of groups and giving some advice on how to develop learning strategies. These tips were not received by all the instructors.

To determine the effectiveness of the workshop, a final written exam with 10 items was applied to evaluate the degree of progress achieved by the tutors; The strategy implemented was "peer evaluation", which means that the tutors evaluated the exams and assigned a grade to each of their classmates; following the helping them in the control of groups and giving some advice on how to develop learning strategies. These tips were not received by all the instructors.

To determine the effectiveness of the course, a final written exam with 10 items was applied to evaluate the degree of progress achieved by the tutors; the strategy implemented was "peer evaluation", which means that the tutors evaluated the exams and assigned a grade to each of their classmates; following the criteria established by the CIT, by means of a rubric. It should be noted that during the entire evaluation process, the CIT was responsible for designing each of the tests applied as well as for supervising that the evaluations carried out by the tutors were objective.

3. Results

The course was given to 23 groups of 10 students each, with a total of 690 hours taught in all phases, at 10:00 a.m. to 7:00 p.m. 69.5% of the groups were scheduled between the hours of 7:00 p.m. to 8:00 p.m., that is, after completing their normal class schedule. While 30.4% took classes between 10:00 h and 18:00 h. Only 72 of the 270 tutors originally enrolled submitted the final exam, that is, they obtained a stay in the PreCalculus course of 26.6%. In figure 1, the distribution of the students who finished the course is shown. 39% belonged to the basic level, 56% were students of the intermediate level and 1% of the students who submitted the exam did not indicate to which level they enrolled. 93% were students in the first semester and 7% were students in the fifth semester enrolled in the advanced level.

Advancement of students at basic level

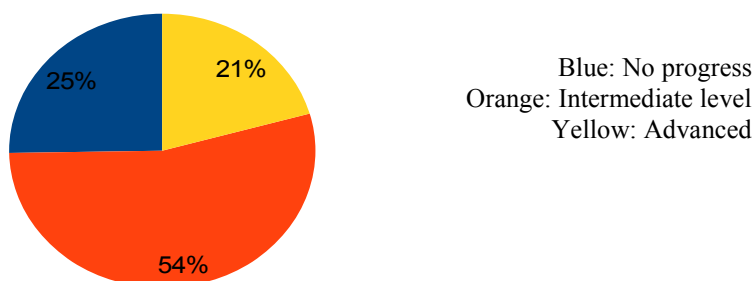


Figure 1. Distribution of students who did the final exam for its initial level.

Figure 2 shows the academic performance of the students enrolled in the basic level who took the exam, in this graph it can be seen that 75% passed the exam, 54% showed to have sufficient mathematical skills corresponding to the level intermediate while 21% acquired the skills of the advanced level and 25% did not record any progress.

Students who took the final exam of the course

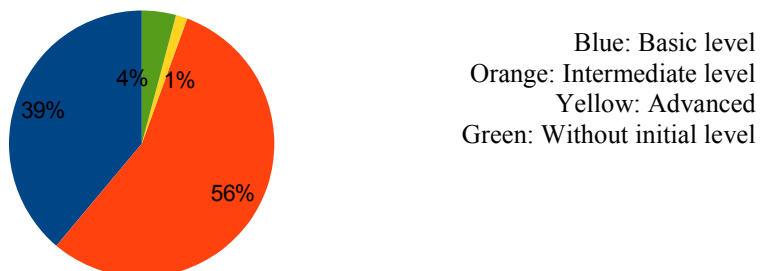


Figure 2. Academic performance of first-year students enrolled in the basic level of the PreCalculus course.

In Figure 3, the graph shows the academic performance of first-year students who originally enrolled in the intermediate level is shown. 70% showed that they had the skills corresponding to the advanced level while 30% did not pass the exam and remained at the same level.

Advancement of students at intermediate level

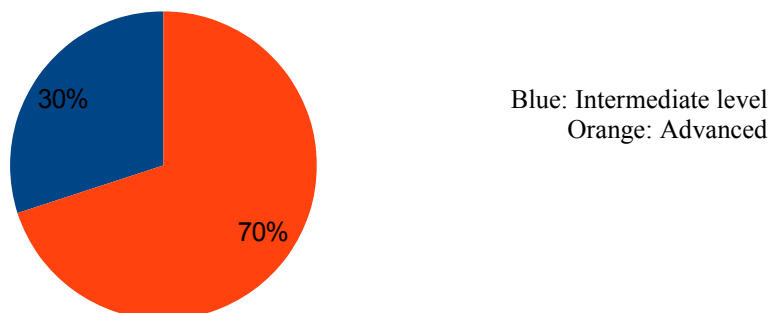


Figure 3. Academic performance of students originally enrolled in the intermediate level.

Figure 4 shows the percentages of participation per career being the educative program 1 and 2 the professions with more students participating in the course.

Percentage by school career

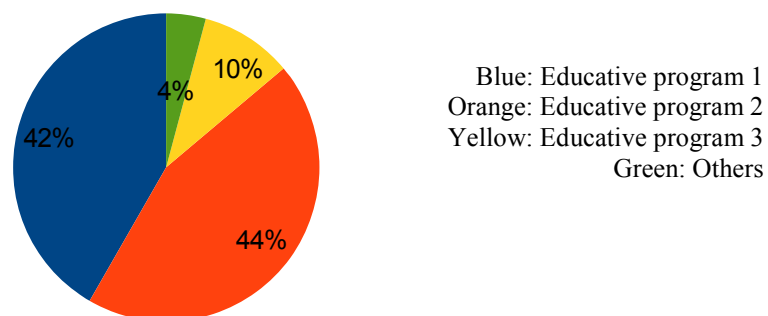


Figure 4. Percentage by career of the students who presented the final exam of the course.

4. Conclusions

In general, it can be stated that some limitations were found in the implementation of the workshop, such as the lack of time for the students to attend the course due to the academic load, which is why most of the students attended to the course in the hours after class, when they were already tired. Factor that negatively influenced our results. With the students who finished the course, it can be affirmed that 72.5% of the exams show an advance in the evaluated mathematical skills, while the rest remained at their initial level. This is a relatively satisfactory result. However, given the academic load of the students and the short time available, it is probably pertinent to address other types of strategies such as the preparation of textbooks and videos for students to consult autonomously and when they have time. For their part, the tutors have reported that they felt motivated and committed to this experience. We also consider that peer tutoring is a potential path for the training of mathematics teachers. Future work should focus on an intervention aimed at the academic performance of students, and the integration of more educational programs. In addition to evaluating the relevance of the topics adapting them to the profile of each educational program, reinforcing the knowledge and modifying the teaching technique, which guarantees the full satisfaction of the students.

References

- J. O. Enriquez Clavero. (2006), "Higher Education: trends and challenges", Medical Education Journal, vol. 46, pp. 10-16, ISSN 1575-1813. Available: <http://scielo.isciii.es/pdf/edu/v9n1/colaboracion2.pdf>.
- Government of the State of Oaxaca, (2011-2016) General Coordination of Higher and Higher Secondary Education, Science and Technology, OAXACA SUPERIOR EDUCATION PROGRAM.
- J. Á. Vera-Noriega, D. Y. Ramos Estrada, (2012). "Factors associated with lag in students of a higher education institution in Mexico," Iberoamerican Journal of Higher Education (RIES), No. 7, vol.III, pp 41-56, Available: <https://ries.universia.net/article/viewFile/81/139>
- Ministry of Public Education (SEP), (January 2005), "Guidelines for the formulation of educational indicators", Educational Policy Planning and Evaluation Unit, General Planning and Programming Directorate.

- R. M. Chávez Rocha and C. Vargas Cortés. (2007). "The role of academic advising in tutoring programs" *Time to educate*, No. 15, January-june.
- Ma. G. Huesca Ramírez and Ma. B Castaño Corvo, (2015) "Causes of Dropout of Students of First Semesters of a Private University", *REMO Magazine: Volume V, Number 12*, pp 34-39. Available: <http://www.alfaguia.org/alfaguia/files/1319582164causas%20de%20desercion%20en%20una%20universidad%20privada.pdf>
- W. de Vries, P. León Arena (October - December 2011), "Deserters or disappointed? Different causes to abandon university studies ", *Journal of Higher Education* ISSN: 0185-2760. Vol. XL (4), No. 160, pp. 29 - 50
- J. Ma. Gomez Urrutía, (2000), "Factors that Influence the High Index of Reprobation in the Matters of Basic Sciences of the Faculty of Mechanical and Electrical Engineering", Master Thesis, Division of Postgraduate Studies, Faculty of Mechanical Engineering and Electrical Autonomous University of Nuevo Leon.
- J. D. Ocampo Díaz, M. Á. Martínez Romero. (2017), "Failure and desertion in the Faculty of Engineering Mexicali of the Autonomous University of Baja California" Faculty of Engineering Mexicali. Autonomous University of Baja California; Available: http://www.repositoriodigital.ipn.mx/bitstream/123456789/3653/1/Reprobacion_y_desercion_en_la_facultad_de_ingenieria_mexicali.pdf.
- Ministry of Public Education (SEP), (2014), Undersecretariat of Higher Secondary Education, "Yo no abandono 4", IEPSA Publisher, , Mexico, D.F.
- L. P. Rubio Rosas, (2015), "peer tutoring in support of the learning process of first-year students: mutual learning?", X National Congress of Educational Research | area 14: Educational Practice in School Spaces.
- E. T. Trejo, P. C. Gallardo, (2013), "Mathematics in the training of an engineer: mathematics in context as a methodological proposal". *Journal of University Teaching* Vol.11, 397-424 ISSN: 1887-4592 .
- Undersecretariat of Higher Secondary Education and the Latin American Faculty of Social Sciences (FLACSO), (2014), "Manual for Implementing Peer Tutoring (Student-Student) in Higher Secondary Education Facilities", Mexico.