

Innovations in Teaching-Learning Methods Applied to Math Courses of New University Students (MATE+)

Mabel Vega¹, Vanel Lazcano²

Universidad Mayor, Núcleo de Matemática Física y Estadística, Facultad de Estudios Interdisciplinarios, Universidad Mayor, Chile^{1,2}

Abstract

The scenario in higher education must be proactive in taking actions to help new university students to achieve an appropriation of the concepts that lead to meaningful learning. This fact was the motivation to propose an intervention where the motivation of the students was involved [1][2]. This intervention was applied to the initial courses of Calculus and Algebra. During this intervention (program), different experiences were carried out to help students to achieve a better insertion in the university. The objective of this program was to reduce the failure rate of new university students in the courses of Calculus and Algebra through the strengthening of their basic skills and motivation. This program considered an adaptive learning tool, Information and Communications Technologies applied to teach, and finally, gamification. Considered careers in this program were: Civil Construction, Geology, Electronic Civil Engineering, Industrial Civil Engineering, Computation and Informatics Civil Engineering, Agronomy, Biotechnology, Environment, and Sustainability Engineering, Forest Engineering, Commercial Engineering, and Management Engineering. The adaptive learning tool used was ALEKS (McGraw-Hill) [3]. We recorded short video lectures (Capsules) where a docent solves representative examples of Algebra or Calculus that students can review and after the video students can answer an online Quiz. They also have available exercises to prepare online tests and the final exam. All these contents were available to be downloaded from the Blackboard platform. The use the students give to all the available contents where tracked and priced. For example, counting how many times students review Capsules, give students Medals that they can gather and at the end of semester Medals were transformed in a grade. The failure rate of new university students obtained in MATE+ program was compared to the results obtained in the same courses in 2017. In 2017 the failure rate was 49% and in 2018 MATE+ achieved 40%. In all considered careers the failure rate was reduced with the exception of two of them: Geology and Computation and Informatics Civil Engineering. The career of Geology and Computation and Informatics Civil Engineering show an increment of 15% and 5% in the failure rate, respectively. A new version of this project should be applied with an emphasis in those careers that present an increment in the failure rate of new students simultaneously with an early alert system.

Keywords: ICT, online Quiz, short video lectures, ALEKS platform, Blackboard platform, gamification.

1. Introduction

The scenario in higher education must be proactive in taking actions to help new university students to achieve an appropriation of the concepts that lead to meaningful learning. Given this fact, we considered relevant to perform an intervention where the motivation of the students was involved [1][2]. This intervention was applied to the initial courses of Calculus and Algebra. During this intervention (program), different experiences were carried out to help students to achieve a better insertion in the university decreasing the failure rate of new university students in the courses of Calculus and Algebra through the strengthening of their basic skills and motivation. This program considered an adaptive learning platform, Information and Communications Technologies applied to teach, and finally, gamification. Considered careers in this program were: Civil Construction, Geology, Electronic Civil Engineering, Industrial Civil Engineering, Computation and Informatics Civil Engineering, Agronomy, Biotechnology, Environment, and Sustainability Engineering, Forest Engineering, Commercial Engineering, and Management Engineering. Historically Algebra and Calculus courses present high failure rate in new university students and in these courses, besides, students present low motivation levels.

1.1 Objective

To decrease the failure rate of the new university students in considered careers in courses of Algebra and Calculus, through the strengthening of their basic skills in mathematics and increase their motivation level.



This paper presents the following structure: in section 2 we present the proposed methodology in section 3 we present the application of the methodology. In section 4 we present the obtained results and in section 5 we present our conclusions and discussion of our results and future work.

2. Methodology

The MATE+ program uses many differentiating actions to traditional teaching from a pedagogical point of view. Considered pedagogical innovations: the use of an adaptive learning platform (ALEKS [3]), the use of Information and Communication Technologies applied to teach and finally gamification (that includes game elements).

The MATE+ program considers the courses presented in Table 1. In this Table we show, course, code of the course, teaching hours per semester, assigned group, associated career.

The MATE+ program has two fundamental stages: stage1 and stage2.

2.1 Stage1

It begins with a Diagnostic Test using the ALEKS platform [3]. Given the results obtained by each student in this Diagnostic Test, ALEKS platform constructed a customized plan, that the student has to develop during summer vacations (two months). At the beginning of the semester for one week, we performed with students collaborative work and different challenges in order to enforce contents of their customized plan. Finally, we took a written test to evaluate this stage.

2.2 Stage2

Each considered course in this program has an accompanying plan for students. This accompanying plan was based on the Blackboard platform. This accompanying plan includes the following elements:

Short video lectures (Capsules)

In these Capsules, a docent solves representative examples of Algebra or Calculus that students can review and after the video, students can answer an online Quiz.

Challenges

Each Challenge is an online test that the student answered in class. During the semester students have six of these challenges. Students have a second chance to answer each of these challenges.

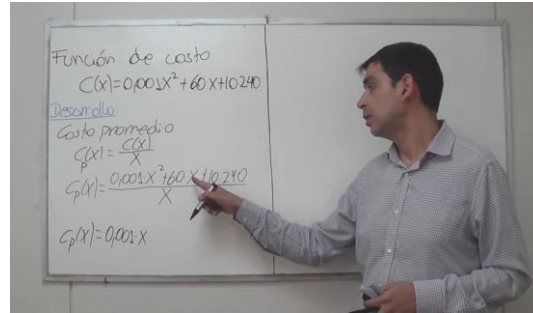
Gamification

It consists of the tracking of the use students give to the available resources in the Blackboard platform. In the Blackboard platform they have Capsules, Quiz, and other resources. We counted the number of times they reviewed Capsules, how many time they answer a Quiz, etc. The achievements of the students are awarded with medals and published in a medal stand of the Blackboard platform. Finally, these medals are transformed in grades of the course.

Course	Code	Hours	Group	Career
Diferential Calculus	CAUM100 1	108	1	Geology-Industrial Civil Engineering-Computation and Informatics Civil Engineering- Electronic Civil Engineering
Diferential Integral Calculus	CAUM101 5	108	1	Civil Construction
Algebra and Calculus I	AGUM100 5	108	2	Biotechnology-Environment and Sustentability Engineering-Forest Engineering-Agronomy
Algebra	AGUM100 6	72+36	3	Commercial Engineering
Elements of Algebra	AGUM100 7	72+36	3	Management Engineering

Table 1: Courses considered by MATE+ program.

In Figure 1 we show a frame extracted form a short video lecture, and an example of a multiple selection question of an online test.



(a)

Detalles: Varias opciones pregunta

Título de la pregunta	Concepto de Proposiciones
Pregunta	¿Cuál de las siguientes alternativas es una proposición?
	A. A mayor costo de producción, mayor es el precio de venta.
	B. ¿Nos vemos en tu casa o en la mía?
	C. ¡Ayúdeme por favor!
	D. ¿Cuál es la mejor respuesta?

(b)

Figure 1: (a) Frame extracted from a short video lecture. (b) Welcome screen to the online test. (c) Example of a multiple selection question of the online test (challenge).

3. Application of the methodology

In the diagnostic test participated 74% of the students. For those who didn't participate in this activity, we gave them a second chance. Only 8% of these students took this second chance, reaching 82% of participation.

The participation in the collaborative work reached 93.3% and in the final written test of the stage1, the participation reached 72.8%.

The 22% of the students passed the diagnostic test. The collaborative work reached 89% of achievement. Finally, in the final written test of the stage1 reached 45% of achievement. In the Diagnostic Test, the worst result was obtained by the group 2 (16%). Achievements of the final test of the stage1 all were higher than 40%.

4. Results

Obtained results of the failure rate in 2018 were compared with the obtained results in the year 2017. We show in Table 2 the failure rate obtained by each career of group 1.



Number	Career	Failure rate 2017	Failure rate 2018
1	Civil Construction	35.00%	22.00%
2	Geology	50.00%	75.00%
3	Electronic Civil Engineering	67.00%	65.00%
4	Industrial Civil Engineering	62.00%	54.00%
5	Computation and Informatics Civil Engineering	60.00%	65.00%
Total (220 students) Weighted average		57.00%	56.00%

Table 2: Failure rate obtained by group 1 in the year 2017 and 2018.

In Table 3 we show the results obtained by group 2:

Number	Career	Failure rate 2017	Failure rate 2018
1	Agronomy	32.00%	26.00%
2	Biotechnology	27.00%	11.00%
3	Environment and Sustainability Engineering	23.00%	11.00%
4	Forest Engineering	60.00%	25.00%
Total (199 students) Weighted average		32.00%	20.00%

Table 3: Failure rate obtained by group 2 in the year 2017 and 2018.

In Table 4 we present the results obtained results by group 3:

Number	Career	Failure rate 2017	Failure rate 2018
1	Commercial Engineering (1)	53.00%	46.00%
2	Commercial Engineering (2)	67.00%	39.00%
3	Management Engineering	54.00%	32.00%
Total (201 students) Weighted average		55.00%	41.00%

Table 4: Failure rate obtained by group 3 in the year 2017 and 2018.

Conclusions

In 2017 the weighted failure rate in Algebra and Calculus courses was 49% in 2018 we reached 40%. In all careers, the failure rate dropped with the exception of Geology and Computation and Informatics Civil Engineering. The failure rate dropped the most in Agronomy, Biotechnology, Environment and Sustainability Engineering, and Forest Engineering. In these careers, the failure rate dropped from 32% to 20%. The minimum of the decreasing of the failure rate was in career of Civil Construction, Geology, Electronic Civil Engineering, Industrial Civil Engineering, Computation and Informatics Engineering from 57% to 56%. We have had an increasing in the failure rate for Geology and Computation and Informatics Civil Engineering from 60% to 65% and from 50% to 65%, respectively. We have demonstrated that a kind of program like MATE+ can decrease the failure rate of new university students. The use of ICT and gamification in new university students increased their levels of engagement and motivation related with Algebra and Calculus courses. A new version of this project should be applied with an emphasis in those careers that present an increment in the failure rate of new students simultaneously with an early alert system.



International Conference The Future of Education



References

- [1] Gómez-Chacón, I. M. "Affective influences in the knowledge of mathematics, Educational Studies in Mathematics", 2000, 149-168.
- [2] Pekrun R. 2006. "The control-value theory of achievement emotions: assumptions, corollaries, and implications for educational research and practice". *Educ. Psycho. Rev.* 18, 315-341.
- [3] ALEKS, McGraw Hill, <https://www.aleks.com/>, accessed on march 03, 2019.