v. 3, n. 35, 2023

Journal of
Engineering
Research

INSERTION PROGRAM INTO UNIVERSITY MATHEMATICS, A MODEL FOR LEVELING BASIC COMPETENCIES IN MATHEMATICS WITH THE USE OF A DIGITAL PLATFORM

Carlos Eduardo Rojas Bruna
Pontificia Universidad Católica de Chile
0000-0003-0845-9986

Abstract: The following article aims to present the model applied during the execution of the University Mathematics Insertion Program, which aims to diagnose, level and accompany students so that they can successfully face the first mathematics courses of their university careers, seeking to shorten the gap between the minimum requirements of these courses and their training during the school stage through the guided resolution of problems, properly sequenced, on a digital platform built for this objective.
Keywords: Mathematics, leveling, diagnosis, platform, support.

The Program for Insertion into University Mathematics, PIMU, began in 2013 as part of a pilot incorporated into the performance agreement between the Ministry of Education and `` Pontificia Universidad Católica de Chile``, within the framework of the Program for the Improvement of the Quality and Equity of Education (MECESUP) code PUC1107: "INCLUSION AND INSERTION OF ACADEMICALLY DISADVANTAGED STUDENTS THROUGH A BASIC SKILLS LEVELING PROGRAM" (Pontificia Universidad Católica de Chile [PUC], 2011).

After the end of the financing granted by MECESUP in 2014, the program continues its development, together with the management of the University, the Faculty of Mathematics and the Academic Vice-Rector's Office through the inclusion direction.

Its purpose is to deliver, under the avant-garde of technology and together with a trained and professional team of teachers and assistants, the instances that provide effective support for the reduction of curricular and training gaps, these are those of diagnosing, leveling, if necessary, accompany during the first academic year.

Its mission is to generate the conditions that enable equity of educational opportunities for the success of students in their first-year mathematics courses, to be a program capable of adapting to the relevant needs of the enrolled generation and to provide the necessary inputs for improvement. and innovation of university mathematics courses.

PROGRAM STAGES

The process begins with the diagnosis stage, after the admission and enrollment process. Then, students go through the leveling stage and then the program continues with an instance of accompaniment and monitoring during the academic semester, for those students who meet certain requirements.

The methodological and operating details of each of the stages of the process are presented below.

DIAGNOSTIC STAGE

Newly enrolled students take the "UC Mathematics Diagnosis", which consists of a set of tests, with the objective of measuring the level of mastery in mathematics knowledge that their students have at the time of entering the university and which seeks to deepen their knowledge. the evaluation of the contents beyond the topics and competencies contemplated in the PAES higher education access test (Department of Evaluation, Measurement and Educational Registration [DEMRE], 2022).

Table 1 shows that during the first years of implementation the number of participants remained stable and from 2018 onwards there has been an increase year after year, mainly due to improvements in dissemination, process management and implementation of the online modality to carry out the tests.

Each of the participants, depending on the mathematics courses considered by the career in which they are enrolled, must take a differentiated test on the Canvas platform (Canvas - UC Teaching Development Center,

2021).

Figure 1. *Board, Canvas platform*

The tests are constructed with multiple choice items with 4 alternatives where only one of these is the correct alternative. Students have 2 hours to answer the test and there is no deduction of points for incorrect or omitted answers.

QUANTITATIVE REASONING TEST (CR)

The RC Test is applied to students in artistic, humanistic, communications and non-scientific pedagogy careers, whose curricula do not consider advanced mathematics courses.

The objective of the test is to measure the ability to analyze, interpret, reason and communicate effectively, while at the same time posing, formulating, solving and interpreting problems present in everyday life. Specifically, everyday life situations or information present in mass media are presented in which it is necessary to understand, criticize and analyze the information they contain.

The RC Test consists of 30 questions divided into 6 groups of 5 questions each. Each set of questions seeks to measure mastery in each of the following skills: analysis, representation, calculation, analysis of assumptions, communication and interpretation.

The reported score shows a percentage of achievement over the total number of test questions in addition to the average percentage of the application and the career to which the student belongs.

INTRODUCTION TO MATHEMATICS TEST (IM)

The IM Test is applied to students in administration, economics, design, health sciences and scientific pedagogies, whose curricula include initial and intermediate level mathematics courses.

The IM Test measures the level of mastery of content that is essential to successfully face the first mathematical courses of each career, with particular emphasis on the MAT1000 Precalculus course (PUC, 2016). The test is built considering five thematic axes, numbers, algebra, analytical geometry, inequalities and sets, functions.

The reported score is on a scale of 0 to 100 points. The Faculty of Mathematics considers that students who obtain below 50 points are not prepared to perform sufficiently in the first mathematical courses of their career.

PRECALCULUS TEST (PC)

The PC Test is applied to students in engineering, physical sciences and mathematics, whose curricula include intermediate and advanced level mathematical courses.

The PC Test measures the level of mathematical mastery that students have to successfully complete the Calculus I course, MAT1610 (PUC, 2013). This test consists of 40 questions divided into 4 topics: algebra and functions, polynomials and complex numbers, trigonometry, sequences and summation. Each of the topics is considered Passed if the student achieves 60% correct answers and Failed if the achievement is less than 60%.

Students who take the PC Test in the leveling stage are integrated into the PIMU-A leveling course.

LEVELING STAGE

Depending on their performance in the corresponding diagnosis, students participate in one of the PIMU-A, PIMU-B or PIMU-C remedial courses.

Course	PIMU-A	PIMU-B	PIMU-C
Participants	843	434	241

Table 2. *Number of participants by courses in 2022*

Table 2 shows that the PIMU-A group concentrates the largest number of students, mainly due to the fact that the number of enrollments in the careers that lead to it is greater and, on the other hand, the methodology used in leveling facilitates More students can be incorporated than in the other groups.

LEVELING PLATFORM

The content leveling for the three courses PIMU-A, PIMU-B and PIMU-C is executed in person and online using the platform built for this purpose.

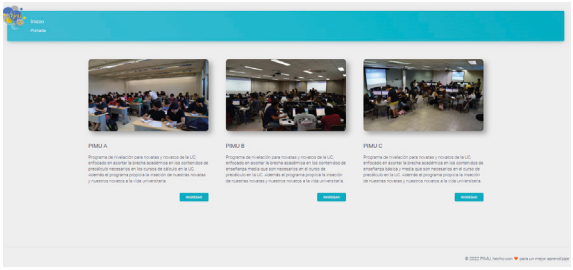

Figure 2. *Leveling Platform Website Front Page: https://pimu-talleres.web.app/*

This platform began to be developed in 2019, seeking to have the main characteristics of a Learning Management System, but with specific functionalities for use as a support tool for teaching mathematics. It was used for the first time in 2021. Previously, a Moodle platform was used.

The main functionalities of the platform are the following:

1. Authentication integrated with the university system.
2. Mass enrollment of students in courses organized into modules and sections.
3. Construction of items of different types of questions.
4. Construction of questionnaires with immediate or deferred feedback.
5. Publication of support material, slides, documents, videos, news.
6. Access and use data of the platform per user.

PIMU-A LEVELING

The students incorporated into the PIMU-A group participate in a leveling course built on four axes:*real functions, trigonometric functions, polynomials and complex numbers, sequences and summation.*

The objective is to give first-year students of courses that require advanced mathematics and who obtain an achievement percentage of less than 60% in any topic of the PC Test, an introduction to the precalculus concepts that the Faculty of Mathematics considers necessary. to pass the Calculus I course, MAT1610 (PUC, 2013). It is estimated that, in this group of students, those who have failed the Algebra and Functions topic of the PC Test have over a 70% probability of failing the Calculus I course, MAT1610 (PUC, 2013).

Students are separated into two groups PIMU-A1 and PIMU-A2 according to the percentage obtained in the PC Test and the number of places available. The first group is made up of the most academically disadvantaged students and has two additional days where topics of analytical geometry, order in real numbers and sets are reviewed. Students in the PIMU-A2 course can also access this additional material and

are encouraged to review it. Approximately 70% of the students in this group meet this requirement.

During the morning, students participate in expository classes taught by professors from the Faculty of Mathematics and in the afternoon they work on problem solving independently on the leveling platform.

PIMU-B LEVELING

The PIMU-B leveling course is organized by modules distributed in the morning and afternoon. They are adjusted Day by Day depending on how the teachers observe the students' progress. The modules are the following:

1. Cartesian plane, equation of the line and systems of equations.
2. Parabola, linear and quadratic inequalities.
3. Rational inequalities and absolute value.
4. Functions and transformations of functions.
5. Algebra of functions.

At the beginning of each session, the teacher gives a brief presentation using the material available on the platform, then the students solve the practice questionnaires with the support of the teacher and assistants. The teacher can intervene in a general way if he observes any error or doubt that occurs recurrently.

The in-person course is run in the computer laboratory and students are in groups of eight, located in a circular manner, each with a computer with a network connection. The teacher's presentation is projected on the four walls of the room so that it can be seen by all students.

In online mode, students attend the presentation given by the teacher in the main room of the Zoom session and then are divided into smaller rooms, trying to replicate the dynamics used in the in-person version. In both modalities, students take an intermediate evaluation and a final evaluation.

PIMU-C LEVELING

The group of students that participates in the PIMU-C leveling is the most academically disadvantaged, which is evident in the result obtained in the IM Test. The leveling course lasts seven days and each day we work on two topics. The topics studied are:*the set of real numbers, operations with fractions, algebraic expressions, powers with integer exponent, powers with fractional exponent, factorization, linear equations, order in real numbers, Cartesian plane, quadratic equations, equation of the line, equation of the parabola.*

The work methodology is similar to that of the PIMU-B leveling course, but the resolution of the exercise questionnaires is done together with the teacher and the assistant, given the low level of autonomous work of these students.

ACCOMPANIMENT STAGE

The process ends with the accompaniment stage that is carried out through a tutoring system in the precalculus, calculus I and linear algebra courses, aimed at those students who participated in the leveling stage and who during the academic semester present difficulties in their performance.

The tutorials are closed study groups, with a maximum of 12 students guided by a tutor who meet once a week to work on exercise workshops. They are free and the student assumes the commitment to attend. It is expected that at the end of this stage, students will have acquired a certain level of autonomy that will allow them to perform successfully in subsequent mathematics courses.

RESULTS OF THE LAST RUN AND FINAL COMMENTS

The PIMU-B course of the year 2022 was held from February 28 to March 4 and had 443 students enrolled, the PIMU-C course of the year 2022 was held from February 24 to March 4 and had 243 students enrolled. Of the total number enrolled, 150 attended on one of the days, 132 had an attendance greater than 60%.

As it can be seen in Table XX, in both courses there is a progressive drop in attendance, in part, this may be due to the fact that the remedial courses are executed in parallel with other activities at the beginning of the academic semester. This is no longer an inconvenience when the leveling courses are run during January.

For the PIMU-B course, the drop in attendance also explains why this group of students has greater autonomy and can review the content available on the platform without the need to be present.

At the end of both courses, a survey was administered, which was answered by 181 students, corresponding to 62% of the enrolled students who attended, in the PIMU-B course, while in PIMU-C it was answered by 141 students. The survey asked about aspects of content, methodology and performance of teachers and assistants.

The perception of the students' recognition of the content is one of the variables that we must analyze to accurately identify how much we can assume our students know when they enter the university, beyond what the rules say. curricula of the school system.

The results of Table 4 reveal aspects specific to the intention of each course and some doubts arise. On the one hand, the PIMU-B course receives less disadvantaged students and seeks, in addition to leveling, to introduce content that is found in their first mathematics course. On the other hand, the PIMU-C course, by receiving the most disadvantaged students, only seeks to level and deepen known content, which is why it is striking that despite the analysis of the curricular bases, the diagnostic test and the selection test university, there is still a percentage of students in this course who do not recognize certain content.

Regarding the methodology implemented in each course, Table 5 shows differences in the students' perception in the three aspects consulted. regarding the contribution of the expository class, in accordance with what was mentioned about attendance, given the higher level of autonomy of the PIMU-B students, compared to the PIMU-C students, which in turn makes them more critical of the operation of the platform and the material available on it.

In general terms, the evaluation of the platform by the students is good and from the point of view of the process, its characteristics allow us to maneuver efficiently when faced with the need for modifications. We must dynamically adjust each of the elements of the stages of the process, in fact, currently the IM diagnostic test is being redesigned and in each iteration of the process content modification, incorporation of new content and restructuring of the courses are carried out, depending on the answer we can give to three fundamental questions: What can we assume our students know? What do we need them to know as a minimum? And how deep can we go?

In relation to the results obtained about the specific work on the platform, for example, questionnaire responses, self-assessments and time of use, currently, the data obtained from the platform is in an analysis stage.

Year	2015	2016	2017	2018	2019	2020	2021	2022
Participants	2466	2617	2586	2588	2857	3077	3618	3924

Table 1. *Number of participants in the diagnosis from 2015 to 2022*

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
PIMU-C	133	128	129	132	122	119	90
PIMU-B	269	256	244	223	185		

Table 3. *Attendees per day*

Affirmation	Course	They totally agree	They agree	Neither agree nor disagree	In disagre-ement	They Totally disagree
The course helped me reinforce already known content	PIMU-B	67%	25%	8%	0%	0%
	PIMU-C	73%	23%	4%	0%	0%
The course addressed content that I did not know	PIMU-B	48%	27%	13%	7%	5%
	PIMU-C	40%	17%	17%	19%	7%

Table 4. *Student responses in relation to the contents*

Affirmation	Course	They totally agree	They agree	Neither agree nor disagree	In disagree-ment	They totally disagree
The expository class contributed to my learning	PIMU-B	54%	24%	7%	0%	15%
	PIMU-C	82%	14%	2%	0%	2%
The exercises on the platform were a contribution to my learning	PIMU-B	59%	18%	6%	3%	14%
	PIMU-C	85%	13%	0%	0%	2%
The platform allows you to work properly	PIMU-B	54%	23%	6%	4%	13%
	PIMU-C	82%	13%	2%	0%	3%

Table 5. Student responses in relation to the methodology

REFERENCES

Centro de Desarrollo Docente UC. (2021, agosto 09). Canvas. Recuperado Julio 15, 2022 de https://desarrollodocente.uc.cl/programas/canvas/

Departamento de Evaluación, Medición y Registro Educacional. (2022). Temario Prueba obligatoria de Matemática. [PDF]. Ministerio de Educación. Gobierno de Chile. https://acceso.mineduc.cl/wp-content/uploads/2022/ 01/Temario-Matematica.pdf

Pontificia Universidad Católica de Chile. (2011). Inclusión e inserción universitaria de estudiantes desfavorecidos académicamente a través de un programa de nivelación de competencias básicas. [PDF]. http://mecesup.uc.cl/images/FIAC/PUC1107/Docs/PUC1 107_Convenio.pdf

Pontificia Universidad Católica de Chile. (2013). *Cálculo I*. Catálogo de Cursos. Recuperado Julio 15, 2022 de https://catalogo.uc.cl/index.php?tmpl=component&option=com_catalogo&view=programa&sigla=MAT1610

Pontificia Universidad Católica de Chile. (2016). *Precálculo*. Catálogo de Cursos. Recuperado Julio 15, 2022 de https://catalogo.uc.cl/index.php?tmpl=component&option=com_catalogo&view=programa&sigla=MAT1000