



Research Article

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## Use of Nearpod and Blum Modeling to Strengthen the Academic Performance of University Students in Mathematics

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### Abstract

*Introduction.* The method used by educators at the higher level is not usually the most appropriate, which usually affects the learning process of students and, in turn, their academic performance. The main of this study is to demonstrate that Blum's modeling and the use of the Nearpod strengthen academic performance in the mathematics course in university students. *Method.* applied typology, quantifiable approach, explanatory level and pre-experimental design, likewise, the sample consisted of 30 university students, to whom a questionnaire created and validated by the researcher was applied. *RESULTS.* they indicate that Blum's modeling and the use of the Nearpod strengthen academic performance ( $p=0.000<0.05$ ). *Discussion.* Using the Nearpod as a tool to improve academic performance is effective, because it presents characteristics that motivate the student to learn.

**Keywords:** tool, teaching, learning; academic performance; student, mathematical modelling; Nearpod

## 1. Introduction

The change from high school to university is a complex process for students, since the methodological strategies used at other levels of their education are modified according to the new context. Often, the methodology used by teachers at the higher level is not the most appropriate, a factor that affects the students' attention and, in turn, their academic performance.

At the international level, studies have been reported that demonstrate this problem. In a study carried out at the University of Valencia, Spain, by Nacher et al. (2021) It is evident that a large number of students have low grades in the basic courses of their career, one of the main reasons being the poor management of the teachers in platforms that help to strengthen the learning of the students.

Martínez et al. (2020) The low academic performance (AP) and course repetition seem to be a common issue among university students, as 61% of students with poor AP have repeated at least one course during their university journey. This low performance has been identified as one of the main reasons why students drop out of their programs. In Argentina, a study conducted on university students found that 30% of students did not efficiently complete their first years of study, mainly due to underperformance in the field of mathematics. Therefore, these results highlight the importance of addressing and improving student academic performance, especially in key areas such as mathematics, to promote greater student retention and success in higher education (Ortega et al., 2021). Likewise, Meza et al. (2019) demonstrated that universities continue to employ the traditional teaching model, which consists of the teacher being the sole provider of knowledge and information, without allowing the student to develop.

Vilca-Apaza et al. (2022) report that most of the students of the Universidad del Altiplano in Puno obtained regular grades within their AR record, which was related to the tools used by the professors for teaching.

In addition, Paredes (2019) In a research done in Huaraz, it was reported that 50% of students in professional engineering careers have a low level of performance in their first two years of study, due to different factors, one of the main ones being the method used by educators to impart knowledge.

Likewise, Baquerizo-Quispe et al. (2022) report that, in a university in Huancayo, 70% of the students showed an average AR, caused by lack of concentration in class. In the same context, Hernández-Yépez et al. (2022) In the research carried out in Lima, it is specified that the minimum grade obtained by university students is 03. Also, the evidence shows that students at a university in Lima have little motivation and interest in their own learning, in class sessions there is little participation as they tend to follow the traditional model of memorization and oriented only to the cognitive part of the individual; consequently, this leads to students abandoning their studies or repeating subjects (Caldas, 2022). Based on this, they recommend rethinking teaching strategies according to the reality perceived at the university. The current information revolution, as well as the current didactic methods and tools converge for a better preparation of higher education students so that they can develop more demanding skills and abilities.

In this sense, Quiroz and Tubay (2020) mentioned that the nature of the new knowledge in digital media enables access to more collaborative, fair and quality ways in relation to the education of students in the modern world. Therefore, an efficient use of digital platforms represents an essential support tool for the development of learning, achieving that traditional sessions are transformed into sessions with motivational environments, transforming a session in a traditional way in an environment that enhances the motivational components and participation, which is reflected in the academic performance (AR).

For this reason, the Nearpod was chosen as a digital platform; designed to strengthen teaching, creating interactive spaces, lessons that contain videos, images, audios, and even virtual reality experiences, deepening learning.

Thus, it has been decided to develop a proposal using Blum's modeling and the Nearpod tool in order to improve the AR of the students taking the mathematics course. In this sense, the following

question was formulated: How do Blum's modeling and the use of Nearpod influence the academic performance of the mathematics course in students of a private university in Lima?

In relation to this, the objective of the research was to determine the influence of Blum's modeling and the use of the Nearpod in the academic performance of the mathematics course in university students of a private university in Lima. As specific objectives: (i) To diagnose the level of academic performance in the mathematics course in university students. (ii) To determine the theoretical-pedagogical criteria that support the design of the proposal of Blum's modeling and the use of the Nearpod to strengthen academic performance in the mathematics course in university students. (iii) To validate Blum's modeling proposal and the use of the Nearpod to strengthen academic performance in the mathematics course in university students. (iv) To evaluate the level of academic performance in the mathematics course in university students after implementing the proposal. (v) To know the perception that university students have about the Nearpod. In addition, the general research hypothesis was: Blum's modeling and the use of the Nearpod strengthen academic performance in the mathematics course in students of a private university in Lima.

The relevance of this research is based on the contribution to knowledge about mathematics didactics, by testing the degree of influence of Blum's modeling and the use of the Nearpod in the academic performance of students at a private university in Lima.

On the other hand, it was methodologically justified because an intervention proposal was developed and applied to address the deficiencies that were evidenced in some students of the mathematics course of the university in question. In addition, it was justified practically because, in coherence with the objectives, it allowed finding a solution to the problems presented. Finally, regarding the social aspect, it contributed to improve the interaction of the students during their learning.

On the other hand, the review of the antecedents allowed us to find evidence on the effectiveness of the use of the Nearpod tool in the improvement of AR in university students. Thus, we have García (2020) who conducted a study at a university in Spain where, upon identifying that a large number of students showed deficient AR, he proposed the use of Nearpod as a work platform, which showed an improvement of 26%. In the same way, Cortell et al. (2022) report that the use of the Nearpod increased the general interest of students in learning their subjects, which was reflected in their AR. In Ecuador, it was found that the use of the Nearpod improved teaching in the mathematics course, as well as participation and learning, in students who had presented low AR (Cando, 2022).

The Nearpod, being a playful tool, not only stimulates students' participation and motivation, but also helps students with attention and comprehension difficulties to better learn the didactic material (Casado, 2020). The features of the application allow for dynamic interaction between students, enabling teachers to create interactive activities, where students are encouraged to participate freely. It also provides teachers with timely feedback and allows them to track learning progress after each assessment (Rocha & Santos, 2021).

The theoretical framework of the present research is based on the mathematical modeling of the teaching-learning process proposed by Blum. Blum modeling allows the development of a systematic approach to address real problems through mathematical modeling, enabling researchers to understand complex systems in a more structured and rigorous way. The existence of a learning modeling cycle is with the purpose of exhibiting different circumstances and interrelated subprocesses. Furthermore, not consolidating it in relation to a sequentially established steps, but as a continuous process in a cyclical manner. It is constituted by 7 processes: i) construction, modeled situation in its establishment, ii) structuring, involves the simplification of the problem situation, iii) mathematization, the operationalization of the problem, iv) mathematical work, the achievement of the model through the activity, v) interpretation, explanation of the established assumption, vi) validation, solid construction of the modeled situation and vii) exposure, the socialization of the process of the problem situation in relation to the activity.

Acebo and Rodríguez (2021) mention that, by means of the modeling process, the educational

agents and the students will establish the possibility of the capacity to approach in a preliminary way the generation of the modeled situation; since, the understanding by the student of the problem that arises involves the delimitation of what is relevant in order to solve it on the basis of simplification, structuring and precision. In the constitution of the problem to a mathematical model, equations will be established for its resolution with the purpose of interpreting it and, in turn, the validation of the results will enable the ability to expose it.

It should be noted that in terms of Academic Performance, Díaz et al. (2021) the process of imparting knowledge and its learning, where to obtain the best results it is necessary that the students enrich and develop their cognitive level, all this manifested in a daily and progressive acquisition of knowledge. (Mendoza, 2021). For Ortega and Gonzalez (2016) is the main indicator that allows measuring the average grades obtained by a student in each academic period. Finally, from Estrada's (2018) perspective the AR is obtained as a result of the evaluation of the learning obtained by the students during the academic period. It should be noted that the evaluation can be qualitative or quantitative.

On the other hand, it is also foreseen to consider the constructivist theory of learning, which holds that the emergence of meanings begins in experience, so that this process is a mental act in which the former adheres to that which comes from outside the person and then makes that reality something of its own. For this theory, learning occurs through interactions with reality or context and one's own experiences, so that people build and interpret the environment in a personal way from their interaction and individual experience in realities that mean something to them (Figueroa et al., 2017).

Similarly, as Rivera (2016) According to constructivism, learning is specific to each individual and is constructed based on his or her social interactions, depending on his or her environment. However, it can be considered that the construction of learning is not a replica of the context, but an interactive and dynamic procedure of knowledge coming from the outside, which is interpreted and reinterpreted through higher processes occurring in the mind, which progressively builds powerful and complex explanatory schemes, so that from this construction a certain reality is known.

Additionally, the theory of insightful learning or the theory of the psychology of form, proposed by Kohler, which considers that human learning is directed towards a specific purpose, which presents a cognitive approach, the student perceives the situation as a whole, making an assessment of the link between the totality of factors involved in the apprehensible situation, was also considered (Gallo, 2021). Hence, the learning that is generated would be a task that is assumed by choice and is oriented by objectives, as well as by the motivation, interest and curiosity that the student experiences in the learning process, the latter being perceived as a whole, highlighting the organization adopted to carry it out (Sáez, 2018).

In this sense, the motivation for mathematical modeling, which is enhanced by the use of Nearpod, a fundamental technological tool in the teaching-learning process that is the subject of this study, acquires special relevance.

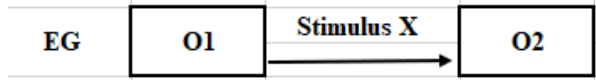
## 2. Method

This research, as Ñaupas et al. (2018), argue, corresponds to the applied type, since it aims to solve a dilemma present in society, which in the case of this research, is the perceived deficiencies in the AR of university students.

The approach used was the quantitative one, which from the point of view of Hernández-Sampieri and Mendoza (2018) can be considered a relevant process to measure the scope of the phenomenon and test the hypotheses. In this sense, numerical information is collected as a result of the measurements made through the application of instruments.

The design was pre-experimental, since the variable under investigation was manipulated with the purpose of gathering information about the events that took place, using only one group of participants, which is considered as the "experimental group" (Hernández - Sampieri & Mendoza,

2018). In the same context, the scope was explanatory, in terms of Arias and Covino (2021) to establish the cause-effect between the study variables. The research design is shown below:



G = Sample (Experimental group)

O<sub>1</sub> = Pretest application

O<sub>2</sub> = Application of the post-test

The population refers to the group of units constituted by subjects that show similar characteristics, which is considered as the main particularity to be considered as part of the research (Sánchez et al., 2018). In this sense, 30 students from the mathematics course of the Faculty of Humanities of a private university in Lima were considered. It should be noted that the following criteria were considered for the selection of participants:

- Discussants enrolled in the summer cycle.
- Students belonging to the Faculty of Humanities.
- Students between the ages of 16 and 19 years old approximately.

Regarding exclusion criteria:

- Discussants who do not agree with the development of the study.
- Students who do not attend the school on a regular basis.

In the same line, the sample is constituted by a characteristic subgroup of the population so that the results obtained at the end of the study are characterized by showing universal results (Cabezas et al., 2018). Therefore, it was constituted by 30 students of the mentioned faculty - summer cycle. In order to determine this sample, a non-probabilistic census sampling was used, which from Arias' point of view (2020) is that type of sampling where the units of analysis coincided with the number of elements of analysis of the population. On the other hand, for the pilot test, 30 students from the Business School of another university, corresponding to semester 2022-II, were considered.

The technique used was educational evaluation in order to determine whether the program, using Blum's modeling and Nearpod, strengthened the AR of university students. It is worth mentioning that this platform was only implemented in the evaluation phase.

In this sense, the instrument used was the test, which was developed by the researchers and consisted of 8 items based on the indicators of the "Quantitative Reasoning Competence" dimension of the AR. In addition, with the purpose of complementing the results obtained, a 15-item interview was conducted with the students in order to establish the knowledge of the individual perception of the use of the Nearpod digital tool.

In the same framework, the reliability of the instrument was determined based on a pilot test using the Kuder Richardson, where a value of 0.8 was obtained, i.e., the instrument presents an adequate level of reliability. Similarly, the instrument's validity was tested by means of the expert judgment technique, where three experts in the field approved the instrument at an adequate level.

In the present research, in order to begin the data collection, permission was requested from the universities. After that, we proceeded to collect data through the test, which lasted approximately 90 minutes, with the purpose of finding out if the implementation of a program based on Blum's modeling and the use of Nearpod influences the AR of university students.

For the development of the research and according to Krause (2017) the following ethical criteria were considered: (i) Respect: The information collected will only be used for research purposes and will be published if the participant so wishes. (ii) Beneficence: The research seeks to benefit others, so the study seeks to generate academic knowledge, benefiting the university community in general. (iii) Justice: Consists of the right to privacy and good treatment for the participants, as well as to avoid exclusion.

The data processing phase was developed based on the information collected from the

instruments, detailing what was found in tables and figures. The software used for processing were SPSS version 25 and Excel 2019. Based on this, descriptive and inferential results were analyzed. Also, to complement the data analysis, AtlasTi version 9 was used to identify the main subcategories related to the students' perception of their experience with Nearpod.

### 3. Results

The results of the university students participating in the study are shown below:

**Table 1:** Level of academic performance in the pre-test and post-test

	Level of academic performance	N	%
Pre-test	Achievement in progress	21	70,0
	Achievement in process	5	16,7
	Expected achievement	2	6,7
	Outstanding achievement	2	6,7
	Total	30	100,0
	N	N	%
Pos-test	Achievement in progress	12	40,0
	Achievement in process	2	6,7
	Expected achievement	2	6,7
	Outstanding achievement	14	46,7
	Total	30	100,0

Table 1 indicates that 70% of the university students participating in the study were at the beginning of learning achievement, while 16.7% were at the level of Achievement in progress. Likewise, 6.7% are in expected achievement and, finally, 6.7% in outstanding achievement. In this sense, according to the results of the exam, the great deficiency in the students' learning can be perceived. Likewise, after the application of the program based on Blum's modeling and the use of Nearpod, the AR of the university students managed to improve, since 46.7% were in outstanding achievement, 6.7% in expected achievement, the other 6.7% in achievement in process and, finally, 40% in initial achievement.

**Table 2.** Test for normality

	Shapiro-Wilk		
	Statistic	gl	Sig.
Pre-test	,962	30	,342
Post-test			

To determine whether the variable in the pre- and post-test followed a normal distribution, the Shapiro-Wilk normality test was used, since the study sample consisted of 30 students. In this sense, it was observed that the significance level was greater than 0.05; therefore, the Student's t-statistic was used to find out if there is a significant difference between the tests, that is, if the application of the study worked or not.

**Table 3.** Student's t-test

	t	Gf	Sig. (bilateral)
Pre- Posttest	-5,573	29	,000

To determine if there is a significant difference between the pre- and post-test, the Student's t-test

was used, where it was affirmed that the development of the mentioned program using Blum's modeling and the Nearpod does strengthen the AR of the university students, since the p-value was less than 0.05, that is, there is a significant difference ( $p=0.000$ ;  $p<0.05$ ).

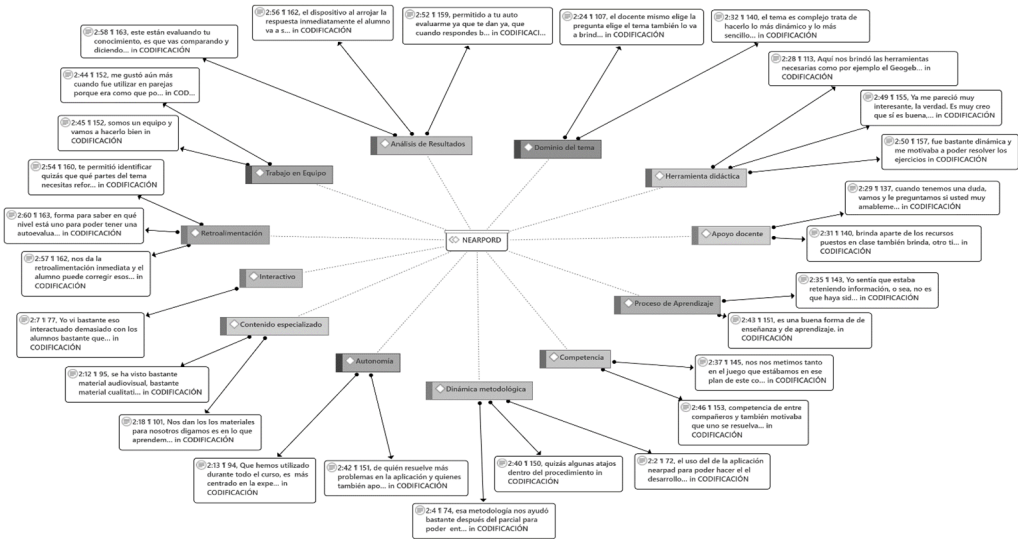


Figure 1. Perception of the usefulness of NEARPOD

Additionally, it was possible to identify the subcategories that students considered as part of the use of the technological tool Nearpod (Figure 1), which contributed to the mathematics learning process through the interactive mode and as a didactic tool in its use; this, in turn, promoted a methodological dynamic, involving specialized contents, the development of competencies such as autonomy, mastery of the subject and teamwork. Finally, it also allowed the student to analyze the results obtained by interacting with the tool and with his peers through teamwork, achieving the purpose of new learning, making use of feedback, and acting under the supervision and support of the teacher responsible for the subject.

#### 4. Discussion

Based on what was shown above, regarding the general hypothesis of the research, which was that Blum's modeling and the use of Nearpod strengthen AR in the mathematics course in students of a private university in Lima, it was specified that the development of the program using Blum's modeling and Nearpod did influence AR in university students, since the p-value was less than 0.05, that is, there is a significant difference ( $p=0.000<0.05$ ). This finding is related to the study by García (2020) who, by using the Nearpod as a teaching tool, achieved a 26% improvement in AR. Likewise, this was reflected in the statistical test that found significant differences, i.e., an improvement in the AR of the students by using the Nearpod ( $\chi^2$  test  $p=0.001$ ). Similarly, the following details Cortell et al. (2022) reports that the use of Nearpod increased the general interest of students in learning their subjects, which was reflected in their AR. Also, Cando (2022) who found used Nearpod as a teaching tool, concluding that the tool improves the teaching of the mathematics subject ( $p=0.000<0.005$ ) and, in turn, in promoting participation and learning together.

In view of the above, it is essential to consider the contribution of the Insightful Learning Theory or Theory of the psychology of form proposed by Kohler, in which he points out that human

learning is directed towards a specific objective, which is a cognitive approach, the student perceives the situation as a whole and evaluates the interdependence of all the elements that intervene in the apprehensible situation (Gallo, 2021). Based on this, it is specified that learning would be a task that is assumed by choice and would be goal-oriented, therefore, it highlights the importance of the motivation provided by educational agents to strengthen the development of teaching during classes, in this case, the teacher would be responsible for planning their class sessions including the Nearpod as a fundamental tool in the teaching-learning process, and following Blum's model.

Regarding the first specific objective, which was to diagnose the level of AR, it was found that 70% of the university students are at the beginning of learning achievement, while 16.7% are at the level of Achievement in process. Likewise, 7% are in the expected achievement level and, finally, only 7% are in the outstanding achievement level. This shows the great deficiency in the students' learning. These results coincide with the study carried out by Bonilla (2022), who pointed out that 19% of the AR before the Nearpod-based intervention was at a low level, 43% at a medium level and only 28% at a high level. Similarly, with Misari (2020) who reported that 37.5% of the students were at a low level of AR, 35% at a medium level and only 27.5% at a high level. In the same framework, the study confirms the contribution of the Constructivist Theory of Learning, which refers that the learning process is a mental act of appropriation of what comes from the outside and then converts that reality into something of one's own (Figuerola et al., 2017).

In this way, it can be understood that individuals interpret and construct knowledge based on the interactions they have with their environment, with AR being a reflection of how little or how much the individual has learned.

Regarding the second objective, which aimed to determine the theoretical-pedagogical criteria that support the design of Bloom's modeling proposal and the use of Nearpod to strengthen AR in the mathematics course for university students, the use of Blum's model was specified, which supports mathematical modeling during the development of learning because it helps to show a diversity of interrelated circumstances and subprocesses. It should be noted that the aforementioned methodology has 7 processes that were used for the elaboration of the intervention program. The steps taken into account were: First, construction, modeled situation in its establishment; second, structuring, entails the simplification of the problem situation; third, mathematization, operationalization of the problem; fourth, mathematical work, achievement of the model through the activity; fifth, interpretation, explanation of the established assumption; sixth, validation, solid construction of the modeled situation; and finally, exposition, socialization of the process of the problem situation in relation to the Blum activity (Blum and Borromeo, 2009 as cited in Bossio et al., (2018). In this sense, it is specified that the importance of using this modeling is that educators and students will determine the possibility of an approach prior to the creation of the modeled situation, since understanding the problem faced by the student implies delimiting the relevant elements to be able to solve it in terms of simplification, structuring and precision (Acebo & Rodríguez, 2021). In this sense, by constituting the problem in a mathematical model, equations will be created to solve it in order to interpret it in reality and, at the same time, the validation of the results will be shown.

On the other hand, in reference to the fourth specific objective, which aimed to evaluate the level of AR after implementing the proposal, it was found that in Blum modeling and the use of Nearpod, the AR of the university students managed to improve, since 46.7% was located in the outstanding achievement, 6.7% in expected achievement, the other 6.7% in achievement in process and finally 40% in initial achievement.

Along these lines, in the study conducted by Bonilla (2022) similar results were found, since after applying the program based on the same methodology mentioned above, 76% were at a high-performance level, 14% at a medium level and only 10% at a low level, indicating that the program was effective. In the same way, as Lopez (2022) refers in his study where he revealed that the Nearpod as a gamification tool achieves the improvement of the students' AR, since after the intervention, 60% of them were at a high level, 28% at a medium level and only 12% at a low level.

In this sense, the details are based on the contribution of the constructivist theory, since, as



Rivera (2016) states, Learning is a mental process that is obtained through social and environmental interactions and that also involves the cognitive, affective and social aspects of the subjects; therefore, it is not usually considered as only a replica of reality but as an interactive and dynamic process of knowledge coming from outside and that is interpreted and reinterpreted through higher processes occurring in the mind, which progressively builds powerful and complex explanatory schemes, in such a way that from that construction a certain reality is known. In this sense, the importance of the use of didactic tools that efficiently assist this process is highlighted, being the case of the present investigation the use of Nearpod, a platform characterized by stimulating motivation and the participation of the students, as confirmed by research.

In relation to the fifth specific objective, which was to know the perception that university students have about Nearpod, they indicated that they found the use of the tool interactive at the time of performing the mathematical activities, since it provided them with specialized contents in the subject to be treated, allowing the student to develop autonomy in solving exercises, this associated to a dynamic and practical methodology proposed by the tool, which leads to the development of the competence and the learning process, that also in relation to the support provided by the teacher for the proper use of the resource, since it is a teaching tool that aroused the interest and motivation to master the subject represented in the results that the students themselves were able to observe, which ended in maintaining an environment of teamwork that results in feedback the knowledge acquired through interaction with this digital tool.

The integration of Blum's modeling and the use of Nearpod presents a valuable opportunity to improve the quality of education in the teaching of mathematics in universities, encouraging student participation and generating a positive impact on their academic performance.

In conclusion, the present study demonstrates that Blum's modeling and the use of Nearpod did strengthen AR in the mathematics course of the university students participating in the study, since the statistical test showed a value lower than the established value ( $p=0.000<0.005$ ). Likewise, changes in the level of performance before and after the intervention were evidenced. Thus, it is recommended that the use of this type of tools be promoted within the university in intervention so that their benefits can reach all members of the institution. On the other hand, it is recommended that the results obtained be disseminated as a reference for the academic community.

- The present research was not free of limitations, such as the small number of precedents carried out with the use of Nearpod as a tool for the development of teaching in university students. Likewise, the size of the population, due to the season in which the research was conducted. Therefore, it is recommended that the number of investigations in this academic field be expanded with larger populations to reduce bias. The study can be extended to primary or secondary education levels, since it is useful for the development of any area of study.

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