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Learning linear and quadratic functions through the use of artificial intelligence in higher education students

Aprendizaje de función lineal y cuadrática mediante el uso de la inteligencia artificial en estudiantes de educación superior

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Abstract
This article analyzes the integration of Artificial Intelligence (AI), based on Deep Learning and Machine Learning, for teaching linear and quadratic functions in higher education. The main objective is to evaluate the impact of AI on academic performance, comparing it with the traditional method and measuring student acceptance using a Likert scale. The research adopted a quantitative approach with a quasi-experimental design, working with a sample of two groups (40 students in section A and 41 students in section B). Data collection involved a satisfaction survey, a diagnostic assessment, and a final evaluation using dichotomous questionnaires. The results were analyzed using descriptive and inferential statistics (Student's t-test, after verifying normality) with the SPSS statistical software. The analysis determined that, while positive perceptions and areas for improvement in mathematical understanding were identified, the AI-based model did not significantly improve grades compared to the traditional method. However, a greater interest from students was evident through the use of AI, generating greater motivation and active

participation, feedback, favoring the interaction of content for learning the subject of Mathematics.

Keywords
Machine learning, artificial intelligence, mathematics, academic performance.

Resumen
Este artículo analiza la integración de la Inteligencia Artificial (IA), fundamentada en el *Deep Learning y Machine Learning*, para la enseñanza de funciones lineales y cuadráticas en educación superior. El objetivo principal es evaluar la incidencia de la IA en el rendimiento académico, comparándola con el método tradicional y midiendo el nivel de aceptación estudiantil mediante el uso de la escala de Likert. La investigación adoptó un enfoque cuantitativo con un diseño cuasiexperimental, trabajando con una muestra de dos grupos (40 estudiantes paralelo A y 41 estudiantes paralelo B). Para la recolección de datos se empleó una encuesta de satisfacción, evaluación de diagnóstico, evaluación final mediante el uso de cuestionarios dicotómicos. A su vez los resultados fueron analizados mediante el uso de la estadística descriptiva e inferencial (prueba *t-student*, previa verificación de la prueba de normalidad) mediante el software estadístico SPSS, determinaron que, si bien se identificaron percepciones positivas y áreas de mejora en la comprensión matemática, el modelo basado en IA no mejoró significativamente las calificaciones en comparación con el método tradicional. Sin embargo, se evidenció un mayor interés por parte de los estudiantes mediante el uso de la IA, generando mayor motivación y participación activa, retroalimentación, favoreciendo la interacción de contenidos para el aprendizaje de la asignatura de Matemática.

Palabras clave
Aprendizaje automático, inteligencia artificial, matemática, rendimiento académico.

1. Introduction
It is essential to ensure that students receive an education adapted to their needs, based on the right to academic inclusion, comprehensive support, and equitable access to technology. However, limitations persist in teacher training regarding active methodologies and the availability of innovative resources. Specifically, there is a lack of curricular integration of Machine Learning and Deep Learning models, meaning that AI has not yet been consolidated as a tool for strengthening academic performance. In this context, the main objective of this research is to evaluate the impact of AI on the learning of linear and quadratic functions in higher education, as well as to determine the level of student satisfaction after its implementation in the classroom.

According to De León De Hernández, the modernization of mathematics teaching through the use of AI is a necessity in the current educational context. In this sense, the author maintains that the right to education is fundamental for the development of children and adolescents, making it essential to incorporate diverse learning technologies, including artificial intelligence, into academic training processes (De León De Hernández, 2024). It is important to adapt pedagogical strategies to the students' circumstances. In accordance with this approach in Ecuador, classrooms are part of the inclusive education model promoted by the Ministry of Education, which establishes the guidelines for the development of this modality that fosters the development of multiple intelligences in students (Ministry of Education of Ecuador, 2021).

Soledispa et al. argue that one of the main challenges in higher education is the teaching of mathematics, given that this discipline requires continuity, abstraction, and constant practice of each student's analytical and critical thinking. Furthermore, with the modernization of learning through the use of artificial intelligence, and despite efforts to guarantee equitable education, the implementation of specific strategies for teaching mathematics in these environments remains a challenge (Soledispa et al., 2024, p. 8). In this context, the main objective of this research is to evaluate the impact of using artificial intelligence in the classroom by comparing it with traditional teaching methods, as well as to establish a student satisfaction scale that allows for assessing students' perceptions of the implementation of this new technological methodology in the teaching-learning process.

Consequently, this research adopts a quantitative approach with an explanatory scope, employing hypothetico-deductive reasoning. Within this framework, technological tools were used to collect numerical data through satisfaction surveys and evaluation questionnaires (midterm and final), integrating Artificial Intelligence models, specifically Machine Learning and Deep Learning, into the teaching of linear and quadratic functions. The study has a comparative-explanatory scope, seeking to analyze the differences in academic performance between the experimental and control groups. The study's relevance lies in its ability to statistically measure the impact of technological innovation on the understanding of mathematical concepts. This allows us to determine whether the use of AI overcomes learning difficulties in the university environment and to identify significant differences in academic averages.

The article is structured as follows. The second part presents the theoretical background, a brief review of other research related to the application of artificial intelligence in mathematics education, and theoretical frameworks that explain a conceptual approach to the didactic resources used for learning mathematics with concepts from Machine Learning and Deep Learning. The third section details the research methodology, describing the approach, type, level, and design adopted. It also explains the process of administering the surveys and dichotomous evaluation questionnaires, concluding with an analysis of the reliability of the collected data. The fourth section presents the results derived from the descriptive and inferential statistical analysis. The parametric t-test was applied to analyze possible significant differences in academic performance when comparing the traditional method with the use of AI in the classroom. Finally, the fifth session presents the conclusions of the study, where the integration of AI in educational institutions is discussed and the need to strengthen the learning of Mathematics under a comprehensive pedagogical approach that transcends the use of the technological tool is emphasized.

2. Theoretical Background

In Mexico, following the research of Quiroz-Rosas (2023), it is important to point out that the integration of AI into mathematics education demonstrates how technology has become a fundamental support for human development, advancing rapidly in various areas of knowledge. Education is no exception; digital methodologies provide strategies and techniques that optimize the teaching-learning process, offering distinctive features such as adaptive learning and assessment. Among these tools, Script stands out, which solves complex mathematical problems by interpreting handwriting on mobile devices and offering real-time feedback with a step-by-step guide, as does Photomath, an application that uses the device's camera and an integrated scientific calculator to display detailed procedures and final results.

In Ecuador, the research of Tóala-Zambrano (2024) highlights that the use of AI simulators in mathematics education is a valuable tool, providing practical, dynamic, and engaging methods for experimenting with concepts such as the notion of number, thus facilitating their understanding through contextualization. The author emphasizes that AI has high potential to accelerate the achievement of global educational goals by reducing access gaps, automating management processes, and optimizing learning methodologies. According to the study's findings, the implementation of AI tools fostered a more dynamic and effective teaching model, adapted to the individual progress of students in the early years of Information Technology and Telematics programs. Furthermore, it was observed that students developed additional technological skills that strengthen their academic and professional profiles. Consequently, Tóala-Zambrano underscores the importance of designing policies that guarantee equitable access to AI, the implementation of which should be led by faculty across various university disciplines.

From Peru, and referencing the research of Rubina-López et al. (2025), it is important to note that AI has significantly transformed the landscape of higher education, especially in mathematical problem-solving. Thanks to its ability to process large volumes of data and provide real-time feedback, AI has fostered the development of advanced tools that facilitate the understanding of complex concepts. The study concludes that technologies such as Intelligent Tutoring Systems (ITS) are innovative resources that strengthen teaching and learning processes in mathematics. Adaptive learning platforms and machine learning algorithms are highly effective, offering flexible solutions that allow students to overcome the challenges of advanced mathematics. These tools stand out for their personalization capabilities, adjusting both the content and the pace of learning to the specific needs of each student, which positively impacts academic performance and promotes more efficient teaching.

2.1 Theoretical Framework

2.1.1 Mathematics in our culture

Based on the manuscript by Rivas-Díaz et al., it is important to note that mathematics constitutes a fundamental language for the development of science and technology. Mathematical work has required the construction of a system capable of representing complex reasoning and mental processes through symbols. In this sense, the symbolization of mathematical objects, which was initially limited to concepts associated with number and extension, has been progressively refined to translate increasingly advanced cognitive tasks. According to the authors, this language is based on the determination and verification of the relationships between the created symbols, which provides the precision and rigor necessary for the progress of other scientific disciplines (Rivas-Díaz et al., 2024, p. 10).

Furthermore, analyzing the manuscript by Heredia-Arias et al., it is important to suggest that mathematics is a rather playful activity, making it crucial to stimulate students through games, which can be intelligent systems that have accompanied humankind in a better cognitive learning process through graphs. However, over time, this practice has required powerful tools based on information technologies for its development and resolution that facilitate the understanding of a mathematical object in class (Heredia-Arias et al., 2024, p. 3).

2.1.2 Influence of computers on learning mathematics

Addressing the manuscript by Machuca-Almeida et al., it is important to point out that the emergence of computers in the second half of the 20th century generated a technological revolution that has become integrated into all aspects of contemporary culture. This influence is strongly evident in our immediate environment, from the processing of banking data and business planning to the robotization of production and the control of air navigation. In the field of mathematical research, the influence of the computer has been decisive; an emblematic example is its fundamental role in the proof of the Four Color Theorem. This demonstrates the capacity of digital processing to solve problems of high numerical complexity, providing solutions that were previously unattainable (Machuca-Almeida et al., 2025, p. 12).

2.1.3 Programming Language

Analyzing the U.S. Department of Education's manuscript, it is important to note that the most widely used programming languages in education are those known as high-level languages. These allow for the development of programs using an accessible and user-friendly syntax, without requiring the user to master binary code or the machine's internal processes. Among the historically most used general-purpose languages are LOGO, BASIC, FORTRAN, and PASCAL, which were selected for their ability to enhance cognitive skills such as design and problem-solving. Under this approach, learning was not limited to acquiring coding techniques; rather, learning the specifics of a language was considered secondary to the development of higher-order thinking skills. In this way, programming became established as an effective means for learning mathematics (U.S. Department of Education, 2023, p. 112).

2.1.4 Artificial Intelligence

Reading Mohamed, it's important to note that AI refers to systems that exhibit intelligent behavior by analyzing their environment and executing actions with a degree of autonomy to achieve specific goals. This conceptualization refers to systems that demonstrate intelligent behavior, analyzing their environment and undertaking actions with a degree of autonomy to achieve specific objectives. This term is well-received by the scientific community. First, it distinguishes AI from the simple use of algorithms and digital technology in general, and second, it includes deep learning, also known as transversal learning (Mohamed, 2021, p. 22).

It's important to note that Deep Learning “is a field of machine learning. Initially, AI was conceived as the development of systems capable of solving complex tasks using a set of formal mathematical rules” (Alsharidah and Alkramiti, 2024, p. 45). From this perspective, AI was reduced to the simple execution of algorithms by a computer, which could not be considered intelligent. Because of this, AI began to be associated with the development of systems capable of solving problems considered intuitive for humans. However, problems such as recognizing objects in images or words in voice recordings are difficult to reduce to a set of formal rules.

Furthermore, according to González-Jiménez (2024), it is important to note within the analysis that “Artificial Intelligence is designed through Artificial Neural Networks (ANNs), which are mathematical models or computations composed of interconnected numerical processing units. Each processing unit is known as an artificial neuron” (p. 15). By manipulating the connections between neurons, the networks can be made to exhibit the desired behavior to be useful in solving complex problems, including classification and regression problems.

In this sense, Figure 1 provides a concise visualization of the relationship between artificial intelligence, machine learning, and deep learning. As can be seen, AI constitutes a broad field that seeks to imitate human thought and action processes, while machine learning is based on previous experiences to generate predictions. Deep learning, in turn, employs neural networks with input data, hidden layers, and output data, demonstrating how artificial neural connections process information to solve specific problems. Therefore, the image complements the theoretical explanation by graphically showing how neural networks are structured within the learning processes of artificial intelligence.

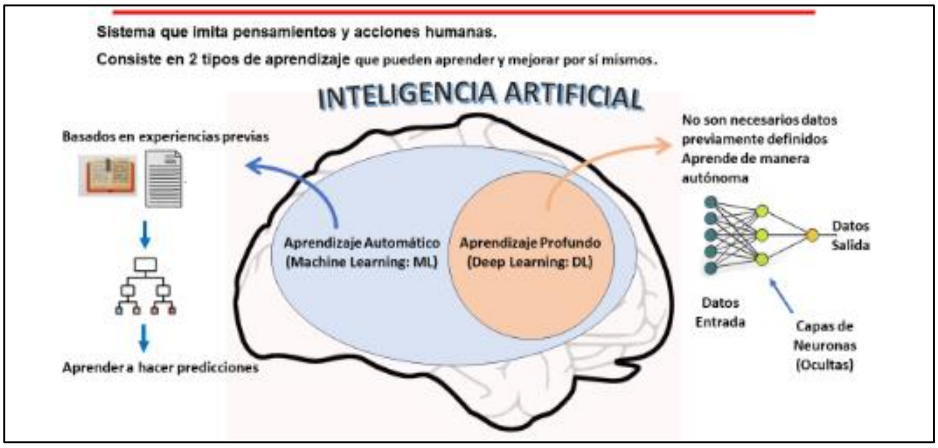

Figure 1. Supervised Learning Diagram using Artificial Intelligence. Artificial Intelligence System. Source: (González Jiménez 2024)).

2.1.5 Machine Learning

Studying Estrada-Oviedo's manuscript, it is important to note that data science is an eminently interdisciplinary field of knowledge, integrating methodologies and techniques from mathematics, statistics, and computer science. Its objective is to obtain useful information or new knowledge from enormous amounts of data that can be complex or inconsistent, dynamic, from multiple sources, and structured or unstructured. Within data science, we find machine learning and deep learning, which also fall under the field of AI (Estrada-Oviedo, 2025, p. 17).

In both cases, the goal is to build models capable of solving problems using a training dataset; that is, the aim is for the system to develop autonomous learning capabilities. This learning is primarily classified as supervised and unsupervised. Simbaña-Nauñay, for his part, explains that supervised learning starts with a set of pre-labeled data, which allows the model to know in advance the possible values and expected solutions for the problem posed. In contrast, unsupervised learning does not have these pre-labeled data, so the system must independently identify underlying patterns and structures in the data (Simbaña-Nauñay, 2025, p. 118).).

2.1.6 Deep Learning

In the analysis of the manuscript by Castillo Del Pezo et al., it is important to highlight that the design of artificial intelligence algorithms for feature extraction has the fundamental purpose of distinguishing the factors of variation that explain the observed data and, in turn, excluding those that are irrelevant to the process of modeling and interpreting the information. These factors affect each unit of information; therefore, if the factors of variation are modified, the observed data also change. An example of this is found in voice recordings, where the speaker's age, sex, and accent influence the data obtained. In this context, deep learning emerges as a solution to the problem of factors of variation, introducing representations expressed in terms of simpler ones. This allows the computer to identify complex concepts from elementary levels of abstraction. For example, when determining whether an image contains a car, the technique does not track elements such as wheels from the beginning; The process begins by identifying basic concepts such as straight lines to build more complex structures (corners or contours) and, finally, consolidate the concept of a car (Castillo Del Pezo et al., 2024).

2.1.7 Cognitive Learning

Addressing the manuscript by Bolaño-García and Duarte-Acosta, it is important to point out that metacognition structures, or rather, the knowledge that people construct about their own cognitive functioning. This involves mental operations of monitoring and regulation that individuals exert over their daily dynamics, allowing them to distinguish the awareness of their mental processes from personal content, beliefs, and motivations. These skills are essential for monitoring and regulating one's own thinking. In this sense, linking metacognitive strategies with learning allows us to diagnose the causes of academic performance in relation to educational quality. It also facilitates the design of techniques that promote autonomous and independent learning, ensuring that the process does not depend exclusively on the teacher. This approach is especially beneficial when the student is able to plan, regulate, and evaluate their own learning, applied in this case to the study of linear and quadratic functions (Bolaño-García and Duarte-Acosta 2025, p. 43).

3. Methodology

This section describes the quantitative approach of the research, which employs a quasi-experimental design with two working groups: a control group and an experimental group. The total sample consisted of 81 students selected through simple random probability sampling, ensuring the representativeness of the data. The control group (Parallel A) comprised 40 students, while the experimental group (Parallel B) had 41 participants. Furthermore, for the statistical analysis, Hernández-Sampieri et al. (2014) "established criteria for the Shapiro-Wilk normality test independently for each group; this statistic was selected because the size of each subsample is less than 50 subjects" (Hernández-Sampieri et al., 2014, p. 312). After confirming the normal distribution of the grades, the parametric Student's t-test for independent samples was used to compare the academic performance of the traditional method versus the innovative AI-based model.

3.1 Research Approach and Design

This research adopts a quantitative approach, based on the collection and analysis of numerical data obtained through satisfaction surveys and evaluation questionnaires. This methodological procedure allowed for the testing of both null and alternative hypotheses to determine the validity, significance, and consistency of the results obtained.

Likewise, hypothesis testing is a fundamental aspect of the research process, since the use of descriptive and inferential statistics enables the objective interpretation of the data and informed decision-making regarding the phenomenon under study. This facilitates the measurement of academic performance and the comparison of the traditional method with the new, innovative AI methodology and its academic impact.

According to Arias, the quasi-experimental design allows for the comparison of a previously established control group with an experimental group. This design allows the verification of one of the null hypothesis (Ho) or alternative hypothesis (Hn) on the impact on grades with the use of the artificial intelligence technological tool, through the analysis of the Type and Level of Research. The research adopts an explanatory approach, based on the technical measurement of academic performance and the determination of the influence of artificial intelligence use in the experimental group, compared to the control group.

A quasi-experimental design is also employed, which allows for the analysis of the influence of the independent variable on the dependent variable. The research has a longitudinal focus, as data collection was carried out at two points in time: an initial diagnostic assessment and a final assessment, with the purpose of comparing the results obtained before and after the intervention.

variations in grades in the two AI courses after the pedagogical intervention with the use of *Machine Learning and Deep Learning templates* (Arias, 2012, pp. 58-60).

3.2 Population and Sample

The population consists of 102 first-year higher education students majoring in Business Administration, divided into four sections at the Ibarra Higher Technological Institute. A simple random sampling method was used to determine the sample size, resulting in a sample of 81 students (45 men and 36 women) with an average age of 19 years. The following method was used to determine the sample size:

N = population size

e^2 = squared sampling error

Z^2 = squared confidence level

pq = population variance (constant of 0.25)

$$n = \frac{N}{1 + \left[\frac{e^2 * (N-1)}{Z^2 * pq}\right]}$$

$$n = \frac{102}{1 + \left[\frac{0.05^2 * (102-1)}{1.96^2 * 0.25}\right]}$$

$$n = 81$$

Ecuación 1

For the organization of the groups, a quasi-experimental design was implemented using simple random sampling, resulting in a sample of 81 students. The groups were organized as follows: the Control Group (Group A), consisting of 40 students, received instruction using the traditional method. The Experimental Group (Group B), consisting of 41 students, received instruction using the innovative methodology that integrates the use of AI (Machine Learning and Deep Learning).

To ensure the validity of the study, the instruments were validated by five academic experts in higher education. Inclusion criteria included legally enrolled students with a minimum of 80% regular attendance at scheduled sessions, voluntary participation, and attendance at individual and group workshops. Exclusion criteria included students who did not complete the final summative assessment or the satisfaction survey, including those who submitted blank instruments. Finally, students with advanced knowledge in programming languages (*Java, Python*) or development environments (*TensorFlow*) oriented to *Machine Learning* *and Deep Learning* were excluded, in order to avoid bias in measuring the impact of the intervention.

3.3 Research Technique and Instrument

In this research, a survey was used as the technique to determine the level of satisfaction with the use of artificial intelligence (AI) in the topic of linear and quadratic functions among higher education students. The instrument used was a dichotomous questionnaire with questions on subtopics such as quadrants of the Cartesian plane, increasing and decreasing functions, the quadratic formula, and concave and convex parabolas. An open-ended questionnaire with exercises was also used, where students developed solutions both manually and using the AI system. This was key to measuring the academic performance of higher education students.

First, the survey technique (ordinal qualitative variable; student satisfaction) was used to measure the perceptions of the 81 students who received technological intervention through the use of AI in the classroom. Regarding the instrument, the satisfaction survey was administered after the AI classes concluded. The items consisted of five Likert scale questions structured as follows: strongly agree, agree, neutral, disagree. The cognitive process, in turn, facilitated the evaluation of the use of the AI-powered templates in terms of mathematical problem comprehension, graphical representation, feedback, and self-learning. Furthermore, to assess academic performance, a pretest (diagnostic assessment) and a posttest (final assessment) were administered to both the experimental and control groups to compare performance before and after the intervention.

Secondly, an assessment questionnaire (academic performance variable) was used to measure the understanding of mathematical concepts. The instrument was used for summative assessment on the topic of linear and quadratic functions. The items consisted of ten questions with mathematical problems involving linear and quadratic functions, including subtopics related to the Cartesian plane, increasing and decreasing functions, the general formula of the quadratic function, manual problem-solving with verification, and structured academic support clues within the AI-powered templates. Regarding the cognitive process, this was developed through the resolution of mathematical problems related to linear and quadratic functions, combined with methods of logical and abstract reasoning, reading comprehension, and decision-making. In this way, cognitive skills oriented towards the analysis, interpretation, and solution of mathematical problems were strengthened..

3.4 Descriptive Statistics

It is important to mention that the descriptive analysis is structured around the ordinal qualitative variable corresponding to the satisfaction survey, using frequency tables based on the Likert scale (strongly agree, agree, neutral, disagree). Pie charts and bar graphs were used to represent the results, allowing for better visualization of the frequencies obtained. The median was also considered as a measure of central tendency, as it allows for identifying the central value of the averages achieved by each group: control and experimental (Maureira, 2025).

To determine the impact of AI use on student averages, a quantitative numerical variable was used to assess learning of linear and quadratic functions, recording the grades of the 81 students (section A and section B). The research focuses on the use of measures such as central tendency and the mean for both courses in terms of student averages, for both the control and experimental groups. That is, essential characteristics of the dependent and independent variables are presented by observing the total number of subjects structured as a sample, using percentages of valid and missing data.

3.5 Inferencial Statistics

The inferential statistics used in this research allow for comparing differences between groups within the studied sample by calculating the significance level (p-value) of the average scores of students in both groups (control and experimental) to determine the impact of using artificial intelligence compared to the traditional method. For the main experiment, a quantitative (numerical) variable was used, focusing on the data distribution and the significance level, which means that student scores are symmetrically clustered around the course mean. The categorical or ordinal component mentioned in previous sections was limited exclusively to the descriptive analysis regarding students' perceived satisfaction with the use of AI in the classroom, but not to verifying the hypothesis of academic performance.

To validate the impact of using artificial intelligence, the parametric Student's t-test was applied, which allows for comparing the means between the control and experimental groups. According to Gordillo-Armijos, this procedure requires that the data have a normal distribution, considering that the values tend to cluster around the mean or average of the course. Likewise, the significance level is expressed as a value between 0 and 1. In experimental studies, the most commonly used alpha levels are 0.05 and 0.01. In this sense, when the p-value is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted; whereas, if the p-value is greater than 0.05, the null hypothesis is not rejected, indicating that there is no statistically significant difference between the groups analyzed (Gordillo-Armijos, 2021, p. 52).

3.6 Results of Descriptive and Inferential Statistics

Question 1 is worded as follows: Does using Machine Learning software to graphically represent a linear function help you understand the class topic by fostering logical thinking?

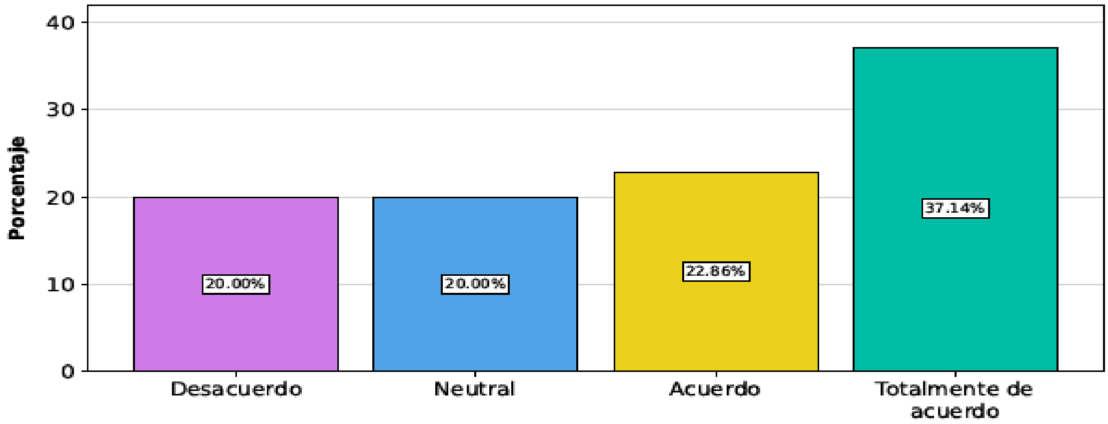

Figure 2. Percentages of responses in the acceptance of the template for graphical representation of the linear function.

According to the results, among the students of the Higher Education Institute, 37.14% strongly agree, 22.86% agree, 20% are neutral, and 20% disagree regarding the application of the machine learning template in the graphical representation of linear functions.

Furthermore, it can be interpreted that 60% of the students in the entire course agree with the use of AI-powered templates to improve the learning process for linear and quadratic functions by fostering cognitive skills.

Question 2 is formulated as follows: Does using machine learning software in the graphical representation of quadratic functions help you understand the exercises proposed in class?

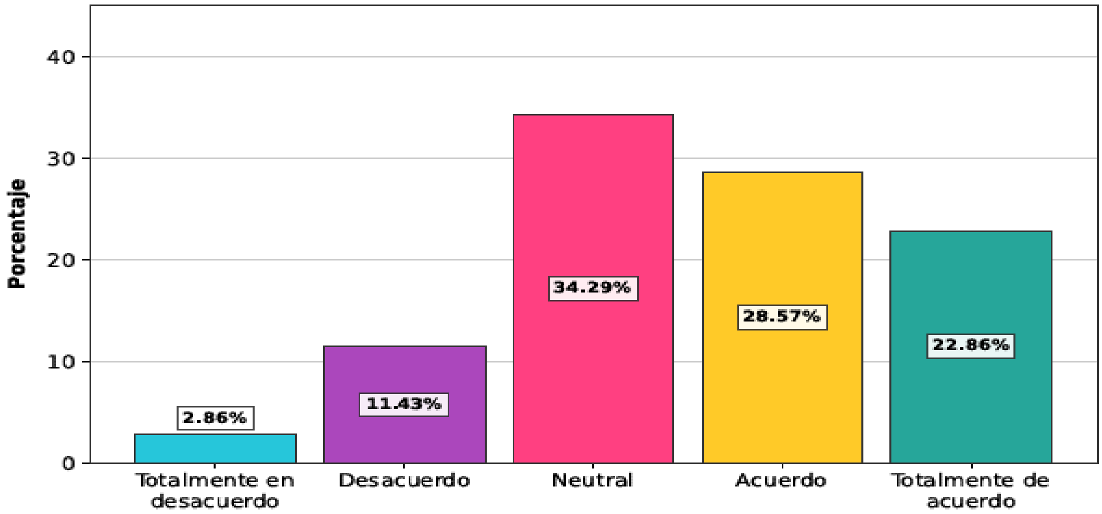

Figure 3. Percentages of responses in the acceptance of the template for graphical representation of the quadratic function

According to the results, among the students of the Higher Education Institute, 22.86% strongly agree, 28.57% agree, 34.29% are neutral, 11.43% disagree, and 2.86% strongly disagree. It is important to note that 34.29% of the class is neutral. Furthermore, the results indicate that 22.86% of the class strongly agrees with the application of the machine learning template for the graphical representation of the quadratic function. This perception demonstrates that the tool facilitates the understanding of the exercises developed in class, particularly those related to the algebraic determination of the parabola from two points located on the Cartesian plane. However, it is considered necessary to implement feedback processes to improve the template in those areas where students experience the greatest difficulties, with the aim of strengthening the teaching and learning process.

Question 3 is worded as follows: Does applying Deep Learning to the feedback boxes in the template help you develop cognitive skills such as logical reasoning?

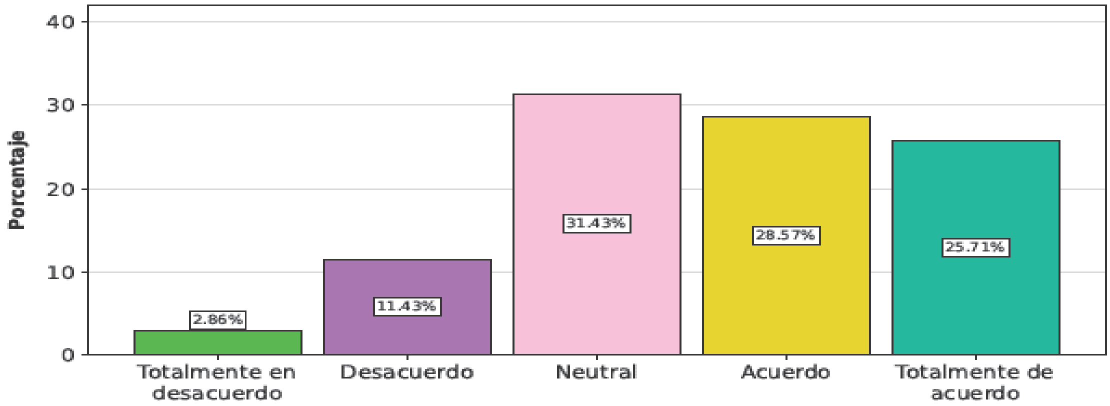

Figure 4, Percentages of responses in the acceptance of feedback boxes in the Deep Learning template

According to the results, among the students of the Higher Education Institute, 25.71% strongly agree, 28.57% agree, 31.43% are neutral, 11.43% disagree, and 2.86% strongly disagree. Furthermore, it can be interpreted that 54.28% of the students have a high acceptance of the application of Deep Learning in solving linear and quadratic function exercises using the feedback strategy. However, 45.72% of the students are skeptical about the application's potential to improve their learning, indicating the need for timely feedback during class time to help them solve algebraic expressions.

Question 4 is formulated as follows: Does entering values of the linear function into the Machine Learning template help you develop the algebraic solution of the equation of a line?

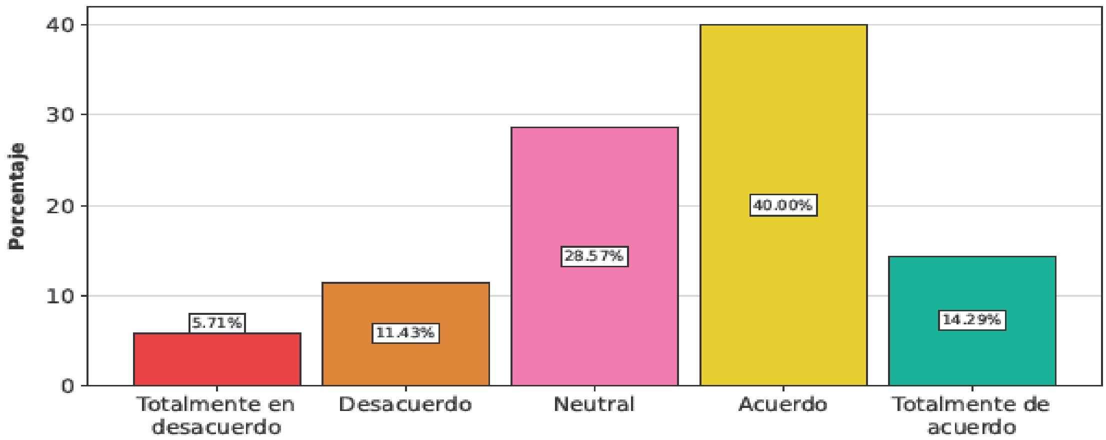

Figure 5. Percentages of responses in the acceptance of income values in the quadratic function in the Machine Learning template

Regarding the results, 14.29% of students strongly agreed; 40% agreed; 28.57% were neutral; 11.43% disagreed; and 5.71% strongly disagreed. These data show that 54.29% have a favorable view of using the Machine Learning template to determine the equation of a line in a linear function. However, the 28.57% of neutral responses reflect the need to strengthen support through demonstration classes and feedback in the areas of greatest difficulty.

Question 5 is worded as follows: Did the deep learning template, by allowing peer feedback comments, help you understand the topic of linear and quadratic functions?

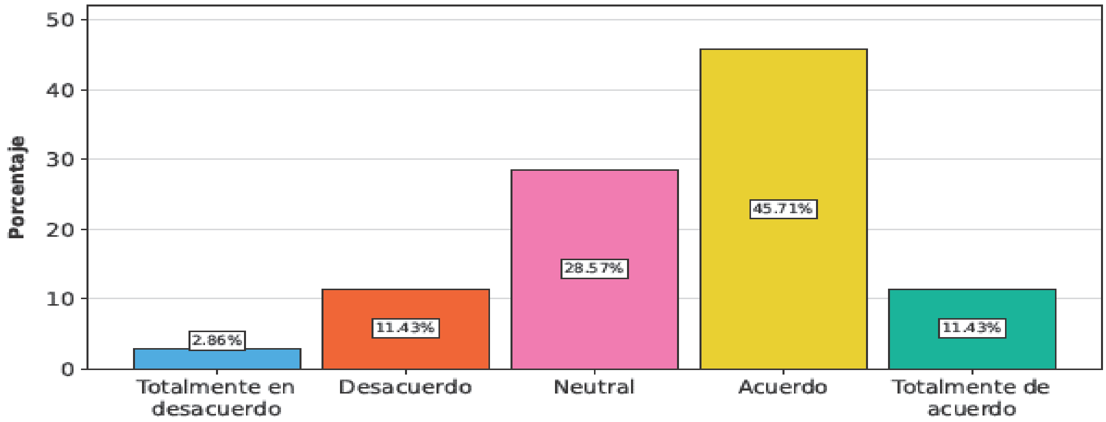

Figure 6. Percentages of responses in the acceptance comments on the quadratic function in the Deep Learning template

Regarding the results, 11.43% of the students strongly agreed; 45.71% agreed; 28.57% were neutral; 11.43% disagreed; and 2.86% strongly disagreed. These data show that 57.14% of the students have a favorable view of peer discussion as a feedback strategy for solving linear and quadratic function exercises. However, the 28.57% of neutral responses reflect the need to strengthen pedagogical support to consolidate learning. It is important to emphasize that a high percentage of the class was skeptical, so personalized feedback was necessary in areas such as the algebraic solution of a concave and convex parabola.

3.7 Normality Test

It is important to mention that the Shapiro-Wilk test was applied to assess normality, considering that the sample consisted of more than 30 and fewer than 50 students. The experimental group yielded a significance value of 0.138, while the control group yielded a significance value of 0.225. Since both values exceed the established significance level (α = 0.05), it is determined that both the experimental and control groups exhibit a normal distribution in their scores, as shown in Table 1..

Normality Test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistical	Gl	Sig	Statistical	Gl	Sig
Grades A	0.082	40	0.200	0,958	40	0.138
Grades B	0.077	41	0.200	0.964	40	0.225

This is a lower bound on true significance.
Lilliefors significance correction

Table 1. Normality test of the control and experimental groups using the SPSS statistical software.

3.8 T-Test for independent samples

It is important to mention that the parametric t-test for independent samples was used, given that there was a control group and an experimental group where the scores passed the normality test and the data were numerical. A p-value of 0.843 was obtained with a two-way p-value, given the significance level of α=0.05. The difference between the means was 0.267 units, and the difference in the standard error was 1.34 units. Furthermore, in the interpretation of the results, the null hypothesis was accepted, which states that there is no significant difference in the students' scores. Therefore, it was determined that academic performance did not show a statistically significant improvement after the application of artificial intelligence as a learning method, through the use of machine learning and deep learning templates.

In this sense, the results demonstrate that there is no significant difference between the means of the two working groups at the Higher Education Institute. The control group obtained an average of 8.25 points, while the experimental group reached an average of 8.52 points, which shows that, although there is a slight numerical difference between both averages, this is not statistically significant.

Independent Samples Test									
	Levene´s test for equality of variances				t-test for equality of means				
					Significance				
	F	Sig	T	Gl	*P of a factor*	*Two-factor P*	Difference of Means	Standard Difference	Error
Equal variances are assumed	0.048	0.826	-1.99	0.79	0.421	0.843	-0.26707	1.34110	
Equal variances are not assumed			-1.99	78.999	0.421	0.843	-0.26707	1.43063	

Table 2. T-test for independent samples using SPSS statistical software

4. Discussion of Results

Quiroz-Rosas's research indicates that, although students recognize the transformative support that AI provides, many do not feel fully prepared to effectively integrate it into their teaching practices. The implementation of AI in education raises concerns about the potential for dehumanizing the educational process, as well as the possible excessive dependence this technology generates (Quiroz-Rosas, 2023, p. 18). In accordance with this, the present research shows that while Deep Learning and Machine Learning templates, consisting of continuous feedback charts, had a high acceptance rate among students (66.71% of the course), there is too much dependence on the solution software. Consequently, students did not develop broader cognitive skills in reasoning and critical and analytical thinking, resulting in poor integration into the pedagogical learning process.

Torres-Torres's research shows that the arithmetic mean of the experimental group was 7.71, while the control group obtained an arithmetic mean of 6.22. In turn, the standard deviation of the experimental group is 2.40 units and that of the control group is 1.66 units. A significant difference in the standard deviation between the performance of the experimental and control groups is observed (0.74). Therefore, it can be concluded that the experimental group, which used AI in the development of the classes, had higher academic performance than the control group (Torres-Torres, 2024, p. 35). In contrast, this research used the parametric Student's t-test for independent control and experimental groups with a p-value of 0.843 units, indicating that there is no significant difference between the means of the groups. The control group obtained a mean of 8.25 units and the experimental group 8.52 units, demonstrating that there is no significant difference in the averages.

5. Conclusions

Students at the Higher Education Institute showed high acceptance of the application of artificial intelligence in the study of linear and quadratic functions. The results demonstrate that in the satisfaction survey, 57.14% of the sample was in favor of using AI in the classroom, while skepticism remained low or in the minority. It is important to note that more than half of the students found the feedback process helpful; peer discussions encouraged students to solve linear and quadratic function exercises. It is important to emphasize that a high percentage of the students were skeptical, so feedback was needed in specific areas such as the algebraic solution of concave and convex parabolas, and, in linear functions, the input of limits of an increasing function to solve the proposed exercises.

This research determined that there is no significant impact of AI application compared to traditional teaching methods. This was corroborated by the parametric t-test for independent samples (control and experimental groups), where the scores met the normality test requirements. The statistical analysis yielded a p-value of 0.843 with a two-way p-value, given a significance level of $\alpha=0.05$, leading to the confirmation of the null hypothesis that there is no significant difference in student grades. Therefore, their performance does not improve when using AI with Machine Learning and Deep Learning templates as a learning method. Furthermore, there is no significant difference in the mean scores of either group of students at the Higher Education Institute.

This study highlights an important dichotomy: despite high acceptance among higher education students of AI as a teaching tool, it does not influence academic performance, as students' grades do not surpass those obtained with the traditional method. Detailing the opportunity to integrate artificial intelligence methodology into lesson planning, which requires high pedagogical feedback, this study integrates various skills within multiple intelligences to develop abstract and logical reasoning skills in proposed and developed exercises, along with assessments, highlighting difficulties in the areas of increasing and decreasing functions. As a future line of research, the need arises to delve deeper into the design and implementation of a hybrid teaching model that incorporates AI-supported diagnostics to address learning difficulties with functions. In this regard, it is pertinent to explore how teachers can leverage AI-generated feedback systems to focus their pedagogical intervention on the most complex areas, such as the algebraic solution of complex parabolas or the incorporation of the concept of limits.

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Statement on the use of artificial intelligence

The authors declare that they used the ChatGPT tool – GPT-4 model (OpenAI), June 2025 version, exclusively to support language improvement. None of the scientific content, results, analyses, or interpretations were generated by artificial intelligence. All material was written, reviewed, and validated by the author, who is responsible for its accuracy and rigor.