

THE ROLE OF ARTIFICIAL INTELLIGENCE IN EDUCATIONAL PROCESSES

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Abstract - *The current context of the environment school, influenced by a growing offer of technological applications based on artificial intelligence, requires that all actors in the teaching-learning processes, and especially teachers as mediators of training processes, assume an attitude of resilience in the face of the necessary changes to make the most of these new ICT resources; so that, students can maximize their skills and become trained as teachers. Suitable people who are autonomous to make good use of technology to meet their needs in interaction with their social environment. The main concern was whether the use of artificial intelligence improves the teaching-learning processes, for which the opinion of specialists and avant-garde technologies was consulted, who assert that artificial intelligence has enough potential to transform education. It was also questioned if solving contextual problems of basic subjects with artificial intelligence strengthens the development of critical thinking in students. The role of artificial intelligence in teaching processes and its application in the classroom was also discussed. At last, it was reflected that so much confidence should be had in the solution of mathematical problems generated by artificial intelligence.*

Keywords: *Artificial intelligence, educational processes, critical thinking, quality of education*

INTRODUCTION

The accelerated rise of information and communication technologies available on easily accessible platforms supported by artificial intelligence, is of great concern to the actors of the educational community, especially teachers, who wonder if their application favors or, on the contrary, negatively affects the quality of education shared with students. It is questioned whether the use of artificial intelligence discourages the development of critical thinking in students, because when solving a problem situation with the support of artificial intelligence, it does not carry out the process of analysis itself in the solution of the context, leading to discourage their creativity because the robot immediately provides the solution. But the search to facilitate the learning processes in students, teachers must rely didactically as a motivating and innovative strategy on the use of ICTs. In this sense, Pérez, Gómez, and Gómez show that ICTs offer the possibility of interaction, which allows students to move from a passive attitude to an active attitude, which leads to a search and rethinking the new contents and procedures. In addition to increasing the participation of students in their activities or assignments that develop their initiative, meanwhile this methodology firmly forces them to make "small" decisions, to filter information, to choose and select. (Amor, Hernando-Gómez, & Aguaded-Gómez, 2011)

This study suggests ways to enhance the development of critical thinking in students using artificial intelligence. How to apply and leverage artificial intelligence in education?. The aim is to determine if the use of artificial intelligence improves the teaching-learning processes to achieve a better quality of education, forging better competent and suitable people.

1. METHODOLOGY

This research is **bordered** in a qualitative research approach, which is based on understanding the phenomena or situations that you want to study within the context where they are being presented, according to Hernández Sampieri. To Kemmis, this paradigm is characterized by: being based on experience and intuition, evaluating processes, relating facts that allow a better behavioral study to be made, closely relating the researcher with the researched and finally making descriptions based on observations in a real context. (Hernández Sampieri, Baptista, & Fernández, 2022).

In this qualitative approach, we chose to design the research in a cross-sectional or cross-sectional descriptive way. According to Hernandez, Fernandez, and Baptista, the descriptive type of research is characterized by presenting the information as it is, indicating what the situation is at the time of the

study, analyzing, interpreting, printing, and evaluating what was achieved from the entire research process. (Hernández Sampieri, Baptista, & Fernández, 2022).

The instruments used to collect the information in this research are the following: 1. Research conducted on artificial intelligence and education.

2. Questionnaire with open and closed questions to find out about the use of artificial intelligence in teaching and learning processes.

3. Experiences of the academic community of educational institutions with the use of artificial intelligence.

4. International guidelines on the use of artificial intelligence in education.

5. Reflections on artificial intelligence in education.

2. ARTIFICIAL INTELLIGENCE IN EDUCATION

In recent years, the use of artificial intelligence, especially Chat GPT, has boomed on social networks and the internet. A system that answers most of the questions correctly, an action that is executed by GPT (Generative Pre-Trained Transformer), which is a family of natural language models based on the Transformer architecture. The first model in the family, GPT-1, was developed by OpenAI in 2018. GPT-1 had 117 million parameters and was trained on a 40 GB text corpus. GPT-1 was followed in 2019 by GPT-2, which had 1.5 billion parameters and was trained on a 40 GB text corpus. GPT-2 was notable for its ability to generate coherent and compelling text, leading to concerns about the model's potential use to generate fake news and propaganda. In 2020, OpenAI released GPT-3, which has 175 billion parameters and was trained on a 570 GB corpus of text. GPT-3 has been **welcomed** for its ability to perform complex natural language tasks, such as machine translation and generating coherent and compelling text.

Artificial intelligence (AI) has its origins in the field of computer science that focuses on the development of algorithms and systems that can perform tasks that normally require human intelligence, such as learning, perception, reasoning, and decision-making. AI has been developed over several decades and has its roots in the 1950s, when the first jobs in the field began to emerge. Since then, AI has evolved significantly and has been used in a wide **diversity** of applications, from virtual assistants to medical diagnostic systems to autonomous vehicles. AI is based on the use of algorithms and mathematical models, which allow it to analyze large amounts of data and find patterns and trends in them.

According to EDUCAUSE, it is a higher education technology association, and has been characterized by bringing together an important community of leaders and professionals in technology and information (IT), whose purpose is focused on technological advances, to advance higher education. It brings together more than 100,000 people from various higher education institutions around the world. To analyze and publish its famous Horizon report, which in 2021 published that artificial intelligence (AI), blended courses, open educational resources (OER), as well as micro-credentials will continue to have a presence in the university world. (Pelletier, y other, 2021).

In terms of artificial intelligence, the Horizon report states that the world's leading universities are developing various projects linked to AI. Artificial intelligence is defined as "the ability of machines to use algorithms, learn from data, and use what they learn in decision-making just as a human would." The era of "algorithmization" results in the availability of new tools, applications and resources that can be used by the digital citizen. Artificial intelligence can be used in a variety of areas such as static image recognition, object classification and labeling. It is also used in commercial strategies, the processing of customer data, as well as in predictive maintenance, object detection and classification, the distribution of content on social networks, as well as in digital security."(Pelletier, and other, 2021)(Rouhiainen, 2018)(Rouhiainen, 2018).

The 2021 Higher Education Horizon Report highlights the fact that the pandemic has transformed higher education around the world. Consideration is being given to whether these transformations will be considered in the future. However, there is no doubt that they will be different in many other ways. Several of the observations in this report have already been expressed by various authors. It is important to highlight that the report identified five key trends in AI present in the world, such as: social, technological, economic, environmental, and political.

a) **Social Trend.** Here three important components were identified: remote work or learning, widening of the digital divide and mental health. It was appreciated that remote learning will be in the future and that there will be no return to the **starting point** that was initially used. Teachers will require new innovations supported by technologies and new pedagogical strategies for teaching that are characterized by being socially and emotionally clear to support a wide variety of student needs. The



coronavirus pandemic has demonstrated the differences for working in digital environments and widened the existing digital divide. Concern about mental health has increased, so institutions will need to transform their current models of support in this field.

b) Technological Trend. In which the following components are evidenced: Adoption and expansion of hybrid learning models, increase in the use of technologies for learning, and online teacher training and development. The meeting of students and professors of new media and learning experiences will make a great mark on university education. Blended learning provides the basis for the acceptance of new technologies for teaching and learning. The updating of teachers in technological and pedagogical support are essential for the incorporation of these technologies and other tools in the classroom.

c) Economic Trend. The Horizon Report highlights the fall in funding for higher education, the demand for new forms of skills in the workplace, and the insecurity about economic **prototypes**. The pandemic has increased the problems of financing higher education and has brought it into consideration for a debate on the value of higher education, especially of certain models used to deliver education in their academic programs. Higher education institutions face an uncertain future if they intend to continue to deliver their education in models located at the initial baseline; Many of them have already affected hiring, as they have laid off staff and made budget cuts.

d) Environmental Trend. Higher education institutions in their traditional practices make use of certain operations in their facilities of materials and resources that significantly affect the environment. That is why it is urgent to adopt precise practices, which are usually omitted in their planning processes and in the day-to-day operation, therefore, it is mandatory that educational institutions must develop the pertinent actions with respect to climate stability and environmental sustainability.

e) Political tendency. Aspects such as the rise of online globalization, the rise or rise of nationalism, and public funding for higher education were discussed here. The new platforms that work online, as well as providing more opportunities for connection and relationships, aim to transform the global community in a perennial way. As for the growth of nationalism, global politics have been split while nations have looked inward, which is known as "deglobalization." Support for public or state universities has been the salvation for some higher education institutions that were in a great crisis to become stronger again. Changes in political power and the needs of the population in the coming years will have implications for whether universities will continue to be appreciated as essential to the economy and community growth.

It is **significant** that technologies and their key practices play a very important role for the development and quality of life for humanity, as has been seen in their support in the following situations: in the development and use of artificial intelligence, design of new models of bivalent or hybrid courses, monitoring of activities programmed for learning, generation of micro-credentials, diversification of open educational resources, and the quality of online learning. In terms of artificial intelligence (AI), it has disrupted the processes of teaching, learning, LMS systems, supervision, assessment and grading, student information systems, office productivity, library services, admissions and disability support, among other fields. In the times of the pandemic, the sudden need to use hybrid models was born, which led to the redesign of the courses offered, of teachers with new experiences and diversification in learning environments; These hybrid models have contributed significantly to addressing concerns about the humanization of the online teaching process.

3. ANALYSIS AND DISCUSSION OF RESULTS

Many teachers are wondering: *Could it be that the use of artificial intelligence improves the teaching-learning processes?* tags. To answer this question, the opinion of several specialists and avant-garde technologies was considered, who affirm that artificial intelligence (AI) has the potential to transform education, as it allows learning to be personalized, offers tutoring and individualized feedback, collects and analyzes data, automates **jobs** and expands access to education. With the use of AI, student learning can be personalized by adapting to their individual needs and preferences. For example, AI can provide personalized feedback and suggestions to improve students' academic performance. In addition, AI can help students develop problem-solving, decision-making, and creative thinking skills by providing new perspectives and innovative solutions to problems.

One of the strengths of AI is also how quickly it collects and analyzes large amounts of data to identify patterns and trends in students' academic performance, allowing teachers to adjust their teaching to meet the individual needs of each student. Additionally, AI can automate repetitive tasks, such as automatic exam correction, allowing teachers to focus on more important tasks, such as teaching and curriculum development.



UNESCO is committed to helping Member States harness the potential of technologies, such as AI, for the achievement of the Education 2030 Agenda, ensuring that the use of AI technologies in the educational context is framed within the fundamental principles of inclusion and equity. They have realized that artificial intelligence can be a useful tool to improve teaching and learning processes by personalizing learning, as it can offer tutoring and individualized feedback, as well as collect and analyze data, as well as automate tasks and expand access to education. AI can also help students develop problem-solving, decision-making, and creative thinking skills by providing new perspectives and innovative solutions to problems. However, it is important to note that these rapid technological advances inevitably involve numerous risks and challenges.

The use of artificial intelligence will improve teaching-learning processes, due to the potential it must address many of the challenges faced today in the field of education, that of developing innovative teaching and learning practices, which will accelerate progress in achieving SDG 4. AI can personalize learning, offer one-on-one mentoring and feedback, collect, and analyze data, automate jobs, and expand access to education. All this under the guarantee that the use of AI technologies in the educational context is governed by the fundamental principles of inclusion and equity. (UNESCO, Artificial Intelligence in Education, n.d.) (España, s.f.) (UNESCO, Aprendizaje Digital y Transformación de la Educación. La Inteligencia Artificial en la Educación, s.f.)(Questionpro, s.f.) (UNESCO, La Inteligencia Artificial en la Educación, s.f.)

Another question about AI in the educational environment is: ***Will the use of artificial intelligence in the solution of contextual problems in subjects allow the development of critical thinking in students?***

Critical thinking is known to be a cognitive skill that allows students to analyze and evaluate existing information concerning a topic or problem. Artificial intelligence (AI) can be a useful tool for boosting critical thinking in students, as it can help them develop problem-solving, decision-making, and creative thinking skills. AI can help students identify patterns and trends in data, allowing them to make predictions and make informed decisions. In addition, AI can provide personalized feedback and suggestions to improve students' academic performance. However, it's important to note that AI can't completely replace human critical thinking. Students must continue to develop their critical thinking skills to be able to evaluate and question the information provided by AI. (Herrera), n.d.) (Romero, s.f.) (Álvarez, s.f.)(Romero, s.f.) (Álvarez, s.f.) (Herrera), s.f.)

Based on the above, the application of artificial intelligence in the solution of contextual problems of subjects can enhance critical thinking in students by helping them develop problem-solving, decision-making, and creative thinking skills. **However**, it is important for students to continue to develop their critical thinking skills so that they can evaluate and question the information provided by AI.

When analyzing the previous answer, we asked ourselves: ***How to apply artificial intelligence to enhance students' critical thinking?***

Artificial intelligence (AI) can be a useful tool for boosting critical thinking in students. Below is some ways AI can be used for this purpose:

- Personalization of learning: AI can help personalize student learning by adapting to their individual needs and preferences. For example, AI can provide personalized feedback and suggestions to improve students' academic performance.(Alejandro, s.f.)
- Problem-solving: AI can help students develop problem-solving skills by identifying patterns and trends in data, allowing them to make predictions and make informed decisions.(Pearson, s.f.)
- Decision-making: AI can help students develop decision-making skills by providing relevant and useful information for decision-making.(Pearson, s.f.)
- Creative thinking: AI can help students develop creative thinking skills by providing new perspectives and innovative solutions to problems.(Pearson, s.f.)

It's important to note that AI can't completely replace human critical thinking. Students must continue to develop their critical thinking skills to be able to evaluate and question the information provided by AI. The application of artificial intelligence in the solution of contextual problems in subjects can enhance critical thinking in students by helping them develop problem-solving, decision-making, and creative thinking skills. Nonetheless, it is important for students to continue to develop their critical thinking skills so that they can evaluate and question the information provided by AI.

With all these **compliments** that artificial intelligence has, the following concern arises: ***What is the role of artificial intelligence in teaching processes?***

As Artificial Intelligence aims to emulate the various capabilities that man has. AI needs to have a large set of systems and machines that allow the performance of various teaching tasks to be automated. By



applying artificial intelligence in education, many benefits can be obtained in the teaching-learning process, since this system allows a more personalized follow-up of the student, which is key to motivate them and thus strengthen their academic performance.

How should Artificial Intelligence be applied in the classroom?

Artificial Intelligence (AI) is a systemic tool that will allow education processes to be automated and simplify activities in the learning process. By means of them, time can be programmed and reduced to improve the academic performance of students. There are several ways to apply and take advantage of AI in education, such as: (aprende, s.f.)

- Identify the topics of study. Teachers can use AI software to search the internet for content that is related to a particular topic. Likewise, AI can design courses automatically, making it easier for the teacher to do this, so that they have more time to review the course information. On the other hand, these computer programs can create questions and exercises about the content that will be developed in a course.
- Virtual tutors. Artificial Intelligence makes it possible to program virtual tutors, who support the teacher in activities such as grading quizzes, identifying mistakes made by students, and even giving real-time feedback, which greatly benefits both students and teachers. These actions allow students to realize their strengths and weaknesses when they learn, which will allow them to improve their learning processes. In addition, this application or software allows students to solve their doubts 24 hours a day using the network or the internet.
- Personalized learning. Artificial Intelligence facilitates the development of educational content based on different learning styles. In this way, students will be able to count on resources and educational aids that are adapted to the way in which they understand a topic or information, given that various kinds of audiovisual materials can be provided that facilitate the understanding of a subject, using the different channels or sensors of the body such as: visual, kinesthetic, and auditory.
- Updating online courses. Teachers will be able to take online training courses to update their knowledge on a topic or use of an application, to strengthen their digital tools for education or social use. Teachers will be able to access various courses to manage their innovative teaching and learning methodologies and strategies, to apply them in the classroom to improve and motivate their students academically.
- Risk alerts about school dropouts. Data analysis in Artificial Intelligence helps predict the probability of dropping out of school, which is key to tracking students who are most at risk of dropping out. Taking advantage of this information to design learning strategies that allow them to work individually with these students. Likewise, they will be able to improve students' motivation towards learning so that they desist from abandoning their studies.
- Although Artificial Intelligence can generate controversies in the ethical sense, the truth is that it can be used to produce significant changes in what constitutes the quality of education and the improvement of the performance of teachers in their teaching tasks.

But in terms of concept, **how much confidence should we have in the solution of mathematical problems generated by artificial intelligence?**

(Smodin, s.f.) (El_Comercio, s.f.) (El_Comercio, s.f.) (Parmar, s.f.) Artificial intelligence (AI) has proven to be able to solve mathematical problems with impressive accuracy and speed. However, it's important to note that AI isn't always **guaranteed** and can make mistakes. For example, some AI-powered math problem solvers may provide incorrect solutions if they are presented with a poorly formulated problem or if they are given incorrect information. Additionally, some AI-powered math problem solvers may not provide step-by-step solutions, making it difficult to understand the problem-solving process. While AI can be a useful tool for solving **Math** problems, it's important to note that it's not always foolproof and can make mistakes. It is advisable to use AI as a complementary tool to solve mathematical problems and not as a definitive solution.

To analyze AI solutions in mathematics, a questionnaire was designed with a variety of problems that allow verifying **how reliable are the solutions given by artificial intelligence in mathematics in the areas of:** Arithmetic, algebra, calculus, and advanced mathematics. These were applied to ChatGpt's AI. The questions, answers, and analyses of these were:

QUESTION ABOUT THE MATH TOPICS HANDLED BY AI

- 1) **What math do you master or know?**

ChatGPT: As a language model, I have knowledge of a wide variety of mathematical concepts, including basic arithmetic, algebra, geometry, trigonometry, calculus, statistics, and probability, among others. In addition, I can solve complex mathematical problems and provide detailed explanations on the steps required to solve them. However, it is important to note that, as a language model, my knowledge of mathematics is limited to the information I have been trained on in database.

ARITHMETIC QUESTIONS

2) **How much is 5+2?**

ChatGPT: 5+2 equals 7

3) **Is 5+2 always equal 7? Or are there branches of mathematics where it is not?**

ChatGPT: Well, in most number systems, 5+2 will always equal 7, and this is known as a universal truth in mathematics. However, in some areas of more advanced mathematics, such as set theory or modular number theory, it is possible to define operations and number systems in which 5+2 may not equal 7. But in most practical applications, 5+2 is still 7.

4) **Is 57 a prime number?**

ChatGPT: 57 is not a prime number, as it is divisible by numbers other than 1 and itself, such as 3 and 19.

5) **Is 15485863 a prime number?**

ChatGPT: 15485863 is a prime number, as it is divisible by only the numbers to 1 and itself. It is a very special number, as it is the largest prime number that had been discovered until the year 2004.

Correction: ChatGPT is wrong to say that this prime was the largest discovered in 2004. Well, the biggest prime discovered in 2004 was that it has 7235733 digits. $2^{24036583} - 1$

QUESTIONS ABOUT ALGEBRAIC EQUATIONS

6) **Solving the Equation $2x - 1 = 0$**

ChatGPT: First, we add 1 to both sides of the equation to clear the term -1 on the left side:

$$2x - 1 + 1 = 0 + 1$$

This is: $2x = 1$

Finally, to clear x, we divide both sides by 2: $\frac{2x}{2} = \frac{1}{2}$

As a result: $x = \frac{1}{2}$

The solution to the equation $2x-1=0$ is $x=1/2$

7) **Solving the Equation $x^2 - 2x + 1 = 0$**

ChatGPT: This equation can be factored using the perfect square trinomial, since the first and last terms are both perfect squares, and the middle term is twice the product of the square roots of the extreme terms. So, we have:

$$x^2 - 2x + 1 = (x - 1)^2$$

Now, if we match the result to zero, we get:

$$(x - 1)^2 = 0$$

This means that the only solution is $x=1$, since the square expression will always be equal to zero.

The solution of the equation is $x=1$. $x^2 - 2x + 1 = 0$

8) **Solving the Equation $x^6 + x^3 - x - 1 = 0$**

ChatGPT: There is no general formula for solving sixth-grade equations. In this case, there is no simple way to clear x, and more advanced techniques are needed to get a solution.

One possible way to approximate a solution is by using numerical methods, such as the Newton-Raphson method or the bisection method, which can provide approximate solutions with some margin of error.

Another option is to use more advanced algebraic techniques, such as Galois theory or group theory, which can provide information about the solutions of the equation, although they do not necessarily provide an explicit formula for them.

In any case, solving a sixth-grade equation can be quite a complex math challenge. If you need more information on this topic, I suggest you consult with a math teacher or an advanced algebra textbook.

Using Wolfram Alpha software, for example, you can find two approximate real solutions: $x=-1.1673$ and $x=0.75488$, and four complex solutions.

Fix: ChatGPT does not solve the equation, and the answer according to the Wolfram Alpha software is not correct, because the equation is solved correctly in the form:

$$x^6 + x^3 - x - 1 = (x - 1)(x + 1)(x^4 + x^2 + x + 1) = 0$$

The real solutions are $x=-1$ and $x=1$.



CALCULUS QUESTIONS

9) Derive $f(x) = x \sin(e^x + x^2)$

ChatGPT: To find the derivative of the function, the product rule and the derivation chain rule are used. $f(x) = x \sin(e^x + x^2)$

First, we derive the function, using the string rule to get: $\sin(e^x + x^2)$
 $\cos(e^x + x^2) (e^x + 2x)$

Then, we apply the product rule to get the full derivative of f(x):

$$f'(x) = x \cos(e^x + x^2) (e^x + 2x) + \sin(e^x + x^2)(1 + 2x)$$

Therefore, the derivative of the function is $f(x)'(x) = x \cos(e^x + x^2) (e^x + 2x) + \sin(e^x + x^2)(1 + 2x)$

Fix: ChatGPT does not properly bypass the function $f(x)$.

10) What is the antiderivative of $\frac{x^2}{2}$

ChatGPT: An antiderivative of is , where is an arbitrary constant of integration. $\frac{x^2}{2} \frac{x^3}{6} + CC$

To verify that this is an antiderivative of you can derive it using the power derivation rule and see if you get the original function. $\frac{x^2}{2}$

$$\frac{d}{dx} \left[\frac{x^3}{6} + C \right] = \frac{3x^2}{6} = \frac{x^2}{2}$$

As you can see, the derivative of is , which is the original function that was integrated. Therefore, it is the antiderivative of $\frac{x^3}{6} + C \frac{x^2}{2} \frac{x^3}{6} + C \frac{x^2}{2}$

MATH OLYMPIAD QUESTIONS

11) Let a, b, c, d be real numbers such that and . Find the minimum value and maximum value that the product can take and determine for which values of a, b, c, d that minimum and maximum are achieved. $a + b + c + d = 0$ $a^2 + b^2 + c^2 + d^2 = 12abcd$

ChatGPT: To find the minimum and maximum value of the product, the AM-GM inequality is used, which states that the product of n non-negative numbers is maximum when all numbers are equal and minimum when one or more of the numbers are zero. However, since the numbers a, b, c, and d can be negative, we need to make a small modification. $abcd$

First, we note that . We can use this to express in terms of the other two terms: $(a + b + c + d)^2 = a^2 + b^2 + c^2 + d^2 + 2(ab + ac + ad + bc + bd + cd)abcd$

$$abcd = (ab + ac + ad + bc + bd + cd) * (-a - b - c - d)$$

From the first equation, we know that , so we can simplify this expression to: $a + b + c + d = 0$

$$abcd = (ab + ac + ad + bc + bd + cd) * (-a - b - c - d) = -(ab + ac + ad + bc + bd + cd)^2$$

That is, the product is equal minus the square of the sum of all possible combinations of two numbers. Since we want to find the minimum and maximum value of , we need to find the minimum and maximum of the sum of all possible combinations of two numbers. $abcdabcd$

To find the minimum of this sum, we observe that if we choose two positive numbers and two negative numbers, the sum will be negative. If we choose three negative numbers and one positive number, the sum will also be negative. Therefore, the minimum of the sum is reached when two positive numbers and two negative numbers are chosen. In this case, we can arrange the numbers in such a way that $a < b < 0 < c < d$. Then

$$ab + ac + ad + bc + bd + cd = ab + c(d + b + a) + bd = ab + c^2 + bd = (a + d)(b + c)$$

Therefore, the product is maximum when and , i.e. when and . In this case, the maximum value of the $abcd + d = 0$ $b + c = 0$ $a = -db = -cabcd \left(\frac{12}{4}\right)^4 = 1296$

To find the maximum sum of all possible combinations of two numbers, we observe that if we choose four positive numbers or four negative numbers, their sum will be positive. If we choose three positive numbers and one negative number, or three negative numbers and one positive number, the amount will also be positive. Therefore, the maximum of the sum is reached when three positive numbers and one negative number are chosen, or three negative numbers and one positive number. In this case, we can sort the numbers in such a way that $a < b < c < 0 < d$. Then

$ab + ac + ad + bc + bd + cd = a(b + c + d) + bc - d^2 = a(-b - c - d) + bc - d^2 = -(a + d)(b + c) - d^2$
 Therefore, the product is minimal when and , i.e., when and . $abcd + d = 0$ $b + c = 0$ $a = -db = -c$



Fix: ChatGPT fails to find the solution, because when solving the problem, it can be calculated that the correct solution is:

The maximum is obtained for and occurs when $abcd = 9a = b = c = d = \sqrt{3}$

And the minimum is obtained for and occurs when $abcd = -3a = -3, b = c = d = 1$

ADVANCED MATH QUESTIONS

12) Is the Euler-Mascheroni constant an irrational number?

ChatGPT: Yes, the Euler-Mascheroni constant, denoted by the letter gamma, is an irrational number. This number has been shown to be transcendental, meaning that it cannot be the solution of any polynomial equation with rational coefficients. Therefore, it cannot be expressed as an exact fraction, not as a square or cube root. In short, the Euler-Mascheroni constant is a very interesting number in the world of mathematics. (γ)

Fix: ChatGPT fails to provide the solution, because so far this constant is not known if it is a rational number or not.

13) What is the solution of , for positive integers a, b, and c? $a^4 + b^4 = c^4$

ChatGPT: The equation has no solutions in positive integers. This equation is known as Fermat's Last Conjecture and was formulated by Pierre de Fermat in the 17th century. Fermat claimed to have a proof for this conjecture, but he never shared it with anyone, and his proof remained unknown for more than 350 years. $a^4 + b^4 = c^4$

In 1994, mathematician Andrew Wiles finally proved Fermat's latest Conjecture using advanced tools from number theory and algebraic geometry. Wile's proof is very complicated and requires advanced knowledge of mathematics, but it was eventually shown that there are no positive integer solutions to the equation. Therefore, it is not possible to give a positive integer solution to the given equation. $a^4 + b^4 = c^4$

14) Explain to me what the Riemann hypothesis is.

Chatgpt: Riemann hypothesis is a very famous mathematical conjecture that has yet to be proven or disproved. This conjecture is related to the distribution of prime numbers in the natural numbers. To understand it easily, you must first know what prime numbers are. Prime numbers are those that are only divisible from themselves and the number 1, such as 2, 3, 5, 7, 11, 13, 17, 19, etc. The Riemann hypothesis states that the distribution of prime numbers follows a highly regulated pattern that can be described by a mathematical function, known as the Riemann zeta function. This function is very complex and requires advanced knowledge of mathematics to understand, but its behavior is related to the distribution of prime numbers.

The results obtained from ChatGpt on each of the math questions in the AI domain areas were:

Topics	Question	Answer	Percentage of certainty
Areas of Knowledge in Mathematics	P1	Correct	100,0%
Arithmetic	P2	Correct	75,0%
	P3	Correct	
	P4	Correct	
	P5	Wrong	
Algebra	P6	Correct	66,7%
	P7	Correct	
	P8	Wrong	
Calculation	P9	Wrong	50,0%
	P10	Correct	
Mathematical Olympiad	P11	Wrong	0%
Advanced Math	P12	Wrong	66,7%
	P13	Correct	
	P14	Correct	

It can be **perceived** that ChatGPT has problems to solve problems that require construction and skills in mathematics, such as exercises present in the mathematics olympiads and in problems that require high knowledge in mathematics, it was also possible to verify the difficulty it has to solve some problems in the area of differential and integral calculus, as well as in the area of advanced mathematics; while in the area of general knowledge and arithmetic or numerical calculations he performs excellently.

CONCLUSION

After the analysis **approved** out, we can deduce that with the use of artificial intelligence, the teaching-learning processes can be perfected, deduced from the opinion of specialists and avant-garde technologies who state that artificial intelligence has sufficient potential to transform education. That by solving contextual problems of the core subjects by applying artificial intelligence, the improvement of critical thinking in students can be improved. That artificial intelligence plays a well-defined role in teaching processes and its application in the classroom, so that the solution of the processed mathematical problems can be trusted.

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