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# Artificial Intelligence for the Teaching-Learning Process of Physics

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***Abstract---****The research examined the application of Artificial Intelligence (AI) in the teaching of physics at the 5 de Mayo Educational Unit in Chone during 2024. The study focused on understanding its benefits and limitations in a context with technological gaps, complex for teachers and students at these levels. Artificial Intelligence, arguably, is a transformative tool that facilitates the understanding of abstract concepts through simulations, personalizes learning, motivates students, and promotes inclusion. However, it also warned of risks such as overdependence, loss of critical thinking, and inequity if not implemented with ethical and pedagogical criteria. Using a mixed methodological approach, 40 students and 5 teachers were surveyed and interviewed. The results indicated that approximately half of the students perceive that AI facilitates understanding and makes the subject more attractive, although another segment showed neutral or negative positions due to a lack of technological familiarity or limited teacher support. Teachers recognized AI's potential to personalize learning and identify difficulties, but they did not report a significant reduction in their workload or fully trust automated assessment. In conclusion, AI is a valuable pedagogical support that fosters motivation and autonomy, but its success depends on strong teacher training and ongoing guidance to ensure truly inclusive and critical education.*
***Keywords---****Artificial intelligence, educational technology, STEM education, student motivation, uses of technology in education.*

## Introduction

To begin this research work, it can be noted that the integration of artificial intelligence (AI) in education has become an unavoidable phenomenon in the digital age, as it is already present in various areas of daily life, including education, marking a turning point in the way teachers and students interact with knowledge. In a world where information circulates at a dizzying and globalized rate, AI appears as a valid alternative to personalize learning, optimize teaching practice, and promote educational inclusion. Various studies have demonstrated how its ability to adapt content to the individual needs of students and offer immediate feedback is visible in human instruction (Escandón-Caguana et al., 2024). However, it can also be observed that its application raises ethical and pedagogical questions that require rigorous analysis, especially in disciplines that can be considered complex, such as physics, which demand high levels of abstraction and logical reasoning.

To carry out this exploration, a review of recent literature was conducted, which highlights that AI can play a positive role in the teaching of experimental sciences by facilitating the understanding of abstract phenomena through interactive simulations and virtual learning environments, which clearly seek meaningful learning (Loayza Solórzano & Moya Martínez, 2023). Likewise, it has been observed that its potential to improve student motivation and cognitive autonomy opens up new pedagogical possibilities, since a current student feels better knowing that he or she is in line with today's society and not in an outdated structure (Villegas & Ordóñez, 2023). However, despite

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showing great benefits, it is not without drawbacks. Several authors warn that excessive dependence on these tools could weaken critical skills such as analytical thinking and the ability to verify information by only being an unverified receiver (Mora Naranjo et al., 2023). This suggests the need to integrate AI under solid didactic and ethical frameworks that guarantee its value as a complement, and not as a substitute, for the teaching role (Gallent-Torres et al., 2024).

To focus the study on the chosen territorial constituency, it should be mentioned that in the Ecuadorian case, advances in educational digitalization have shown an uneven pace due to gaps in technological access, particularly in institutions in intermediate cities and rural areas, or between institutions with diverse financial resources. This context makes it even more relevant to evaluate the impacts of AI in the classroom and, above all, in the teaching-learning process, since several factors ranging from lack of infrastructure to teacher training can limit its benefits or even generate new inequalities derived from these factors (Barcia Cedeño et al., 2023). Physics, as a key subject in scientific education, faces the double challenge of introducing students to the abstract principles that explain natural phenomena and, at the same time, motivating them in an environment where science is often perceived as inaccessible or unattractive because it is believed to be something exclusive to scholars and difficult to understand.

Despite the many debates and research carried out over the years, and especially in the last decade, there are still empirical gaps regarding how students and teachers perceive the use of AI in physics teaching. Therefore, it is important to conduct studies that can fill these gaps. Most of the studies reviewed clearly focus on the macro level, with general analyses of higher education or institutional policies, among others. However, there is little research documenting specific experiences in secondary education, as in this study. Therefore, it is pertinent to systematically analyze how AI is articulated in physics teaching in local contexts such as the Chone canton, where technological limitations coexist with a growing interest in innovating learning processes (Miller, 2019).

In this context, this research aims to analyze the application of artificial intelligence in the physics teaching-learning process at the 5 de Mayo Educational Unit in Chone during 2024, using a mixed-method approach that combines the results of student and teacher surveys with a critical discussion of the findings in light of recent scientific literature (Cheung & Slavin, 2012). The purpose is not only to describe local perceptions but also to contribute to the global discussion on the possibilities and risks of AI in education, proposing guidelines to guide its ethical and pedagogically relevant implementation. Do not use numbers or letters in headings and sub-headings (*Example A. Introduction 1. Body)*. Use the following style for headings and sub-headings

## Materials and Methods

This research was developed with students (40) and teachers (5) of the high school of the Educational Unit 5 de Mayo of the Chone canton, which is attached to the ULEAM Chone extension. They were selected through an intentional sampling that included those who had direct experience with the use of artificial intelligence tools in teaching and learning physics. This choice allowed us to collect representative information from both actors of the educational process and to obtain a comprehensive view of the phenomenon.

The study combined various methods that complemented each other. The inductive method was used to identify patterns in student and teacher responses; the deductive method was used to contrast AI theory with survey results; the analytical method was used to examine motivation, understanding, and problem-solving; and the bibliographic method was used to base the theoretical framework on recent research.

The empirical phase included the collection of qualitative and quantitative data. In the first phase, semi-structured interviews and non-participatory observations were conducted to explore perceptions, benefits, and limitations of AI. In the second phase, standardized questionnaires were used to assess motivation and academic performance before and after the implementation of these tools, in addition to considering the results of academic assessments.

Data analysis was conducted through content analysis for qualitative data and descriptive and inferential statistical techniques for quantitative data, using Minitab software as a specialized resource to ensure accuracy and reliability of the results.

## Analysis and Discussion of the Results

Artificial intelligence has been consolidating its position as a transformative tool within educational systems over the years, especially recently, as it has at various levels, even in areas traditionally considered difficult, such as physics. In this sense, it can be understood that it is not only a technological advance, but also a profound restructuring of pedagogical paradigms that allow for the personalization of learning and open up spaces for much more active interaction than traditional ones between students, teachers, and technology, something necessary in today's era (Lai & Bower, 2019).

It should be noted that its implementation is not free from ethical and social tensions that must be responsibly addressed by those teachers who have decided to implement it in their daily practice (Gallent-Torres et al., 2024). In fact, it is recognized that AI has fostered the emergence of innovative methodologies that, through the analysis of big data, undoubtedly facilitate educational experiences more adapted to the needs of students. As explained, some studies find that this technology has directly contributed to designing strategies that strengthen personalization and also improve students' academic outcomes (Aparicio, 2023).

Based on the premise that AI seeks to replicate certain human cognitive processes, it can be understood as the ability of machines to perform activities that were once unique to humans, although they do not emulate them 100%. According to Castaneda (2022), this definition has been the basis for its expansion into different sectors worldwide, and in the educational field on which this research focuses, its contribution has become visible both in the personalization of learning and in the automation of administrative tasks, and in promoting accessibility for students and teachers. Along these lines, it is worth mentioning Díaz Tito et al. (2021), who argue that by being able to process large volumes of information greater than a human could do, AI makes it possible to create unique learning experiences for each student, expanding the possibilities of an adaptive approach, which undoubtedly benefits the learner. It is pertinent to add to what was said in the previous paragraph that this technology is not limited to a support function, but, as Sharma et al. point out, (2020), also acts as a catalyst to optimize the efficiency of the teaching and learning process. Likewise, authors Barcia Cedeño et al. (2023) point out that the impact of AI extends to transforming the classic roles of students and teachers, thereby generating more interactive environments, an aspect that becomes more relevant in the teaching of physics, where the abstraction of concepts requires differentiated strategies for their efficient learning.

Next, it is important to note that one of the most recognized contributions by the community that they consider AI has is its ability to personalize the teaching process, as has been emphasized. Thanks to this noted quality, it has been possible to adapt activities and content to the particular characteristics of each student due to the processing and analysis capabilities of this technology. Escandón-Caguana et al. (2024) highlight that the use of interactive simulations and adaptive tutorials, according to the results obtained, has increased performance in natural sciences by 10% in their study, something important to bring up because it is a finding that has a strong impact on the teaching of physics, since it is part of this branch of science.

Smart tutoring platforms are beneficial in offering immediate feedback Villegas & Ordóñez (2023), thus allowing students to advance at their own pace and strengthen their autonomy in disciplines of high conceptual complexity, a style that is already widely used in other levels of teaching, such as MOOCs. However, these potential demands require careful application, since, according to Aparicio-Gómez et al. (2024), excessively depending on these tools could discourage the development of critical thinking and analytical autonomy, since human thought needs to be continuously exercised in order not to atrophy certain aspects.

The personalization of artificial intelligence paves the way for greater educational inclusion. It is worth noting that, as García-Peña et al. (2020) point out, AI applications have proven effective in serving students with disabilities, for example, through voice or text recognition, which eliminates barriers that have traditionally hindered access to learning. Similarly, Barcia Cedeño et al. (2023) emphasize that these technological tools enhance equitable participation, strengthening collaborative environments where the educational experience is enriched for all. Indeed, Gallent-Torres et al. (2024) confirm that developments in accessibility have improved the education of students with visual and hearing impairments, demonstrating that AI transcends the technical to become an agent of social change with profound educational implications.

It is important to note that not everything is beneficial, as significant ethical challenges also arise related to the application of artificial intelligence in schools. In this regard, Mora Naranjo et al. (2023) point out that the management of student data requires clear policies that guarantee their privacy and prevent abuses in the use of sensitive information, as has already occurred with AI in other human settings. However, Gallent-Torres et al. (2024) warn that, if adequate regulatory frameworks are not established, personalization through AI can increase pre-existing inequalities. This may sound contradictory, but it is very common and is especially critical in contexts with digital divides, such as Ecuador. Furthermore, Aparicio-Gómez et al. (2024) draw attention to the risk of perpetuating biases in algorithms, which affects confidence in these systems, which is why it is essential to audit their applications and prepare teachers in ethical and technical aspects to assess their correct application in the classroom.

In relation to the teaching of physics, it is essential to highlight that AI should not be seen as a replacement for the teacher since this human guide is important in the process; therefore, it is not the main guide, but should be considered as a complement that enhances the teacher's task. Furthermore, according to Escandón-Caguana et al. (2024), these tools allow for optimizing pedagogical resources and to differentially address the needs of each student,

which constitutes a valuable support for the understanding of abstract content, but if they are not well directed will lead to a problem instead of a solution. Regarding this topic, Loayza Solórzano & Moya Martínez (2023) highlight that interactive simulations offer the possibility of carrying out virtual experiments that add to laboratory practices, thus contributing to experiential learning that is decisive in the construction of scientific thinking, and manage to avoid those gaps in places like Chone that do not have physical laboratories.

Finally, and by way of conclusion, it is understood that, looking ahead, it is worth noting that the fourth industrial revolution that is being experienced in this country has accelerated the incorporation of technologies such as AI, transforming how teachers, students, and content interact. Juca-Maldonado (2023) indicates that in the future, artificial intelligence will not only continue to optimize administrative processes but will also redefine teaching and learning methods. However, as Mora Naranjo et al. (2023) suggest, this progress must be sustained within an ethical and responsible framework, since only in this way can AI become a true bridge towards a more equitable, quality education focused on meaningful student learning and not a technology that further encourages the emergence of gaps between regions and supports. Figure 1 shows the racialized consultation on AI assistance in physics concepts.

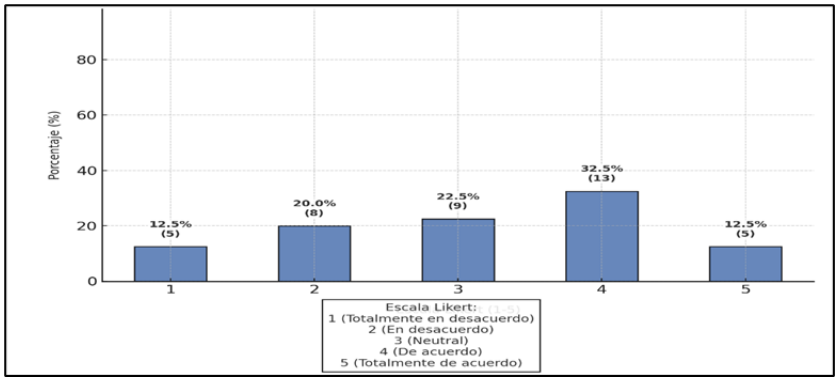


Figure 1. Artificial intelligence has helped me better understand the concepts of physics

From the analysis of the first question, it can be stated that the results reveal that a considerable proportion (50%) agree or strongly agree that AI positively influences the understanding of physics concepts, according to students' assessment. This data suggests that, even in small cities like Chone, and despite technological limitations that may exist, the appropriate integration of AI tools is thought to significantly enhance the understanding of physics. However, it should not be overlooked that 22.5% maintain a neutral position, and that 32.5% disagree or strongly disagree, reflecting possible uncertainties or difficulties in students' effective interaction with these technologies. The question was asked about how AI makes physics work interesting in Figure 2.

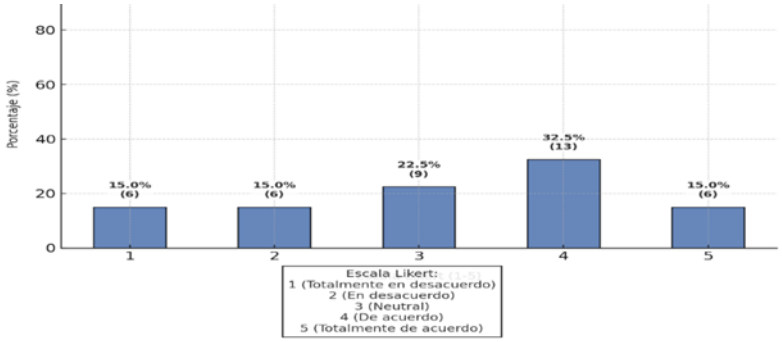


Figure 2. I feel that AI makes learning physics more interesting

Analyzing the graph for this question, we find that approximately 50% of students agree that AI makes the study and learning of physics more attractive, highlighting its motivational potential in settings such as the 5 de Mayo Educational Unit located in the province of Manabí, where student motivation, as in other small cities, tends to be an important area for introducing students to the exact sciences. It is relevant, however, to note that approximately the other 50% adopt a neutral or negative stance depending on the scale used, possibly due to technological barriers or a lack of initial familiarity. This duality highlights the need for appropriate technological training programs

contextualized to the environment. When asked whether you completely trust the AI's responses, the results are shown in Figure 3.

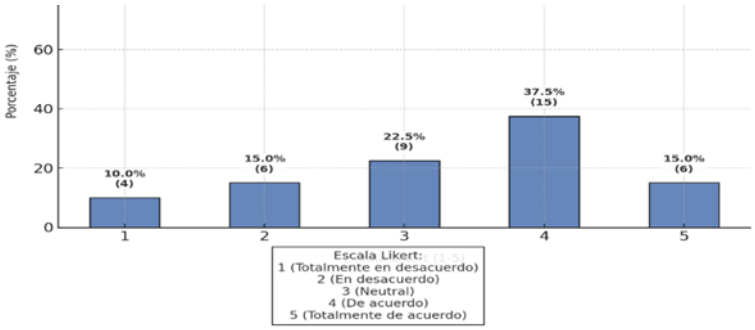


Figure 3. Completely trust the answers provided by the AI without verifying them

Continuing with the analysis, and specifically in this questioning for students, we find that almost 50% show a neutral or negative stance about fully trusting AI without verifying its answers in some way, or at least that they do not fully trust it. However, with a slight difference, the other half responds that they do trust it without any verification. This result is ambiguous because it is positive from a pedagogical point of view, given that it demonstrates that many students maintain a healthy skepticism toward technology, safeguarding their critical capacity, but one cannot ignore the fact that the other half trust without making any comparisons. The lack of absolute trust could also indicate a certain cultural or technological distrust specific to the environment, although blind trust is also due to ignorance about these technologies, thus always highlighting the importance of teacher support as a guide. Figure 4

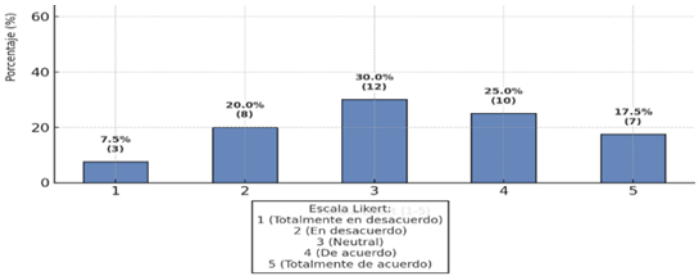


Figure 4. Using AI has allowed me to identify my mistakes more effectively

In this case, the distribution of responses to this question suggests a favorable perception, with 42.5% between "agree" and "strongly agree." This indicates that AI tools play an important role as pedagogical support, or at least that's how they are perceived, helping students recognize and correct their mistakes independently. However, the notable percentage in the neutral range (30%) could mean that not everyone has perceived this advantage with the same intensity. "Disagree" or "strongly disagree" also stands at 27.5%, which, while lower, is still significant and may probably stem from difficulties in initial use or a lack of sufficient feedback from teachers regarding the correct use of AI. Figure 5 AI has made me less dependent on the teacher to solve my physics questions.

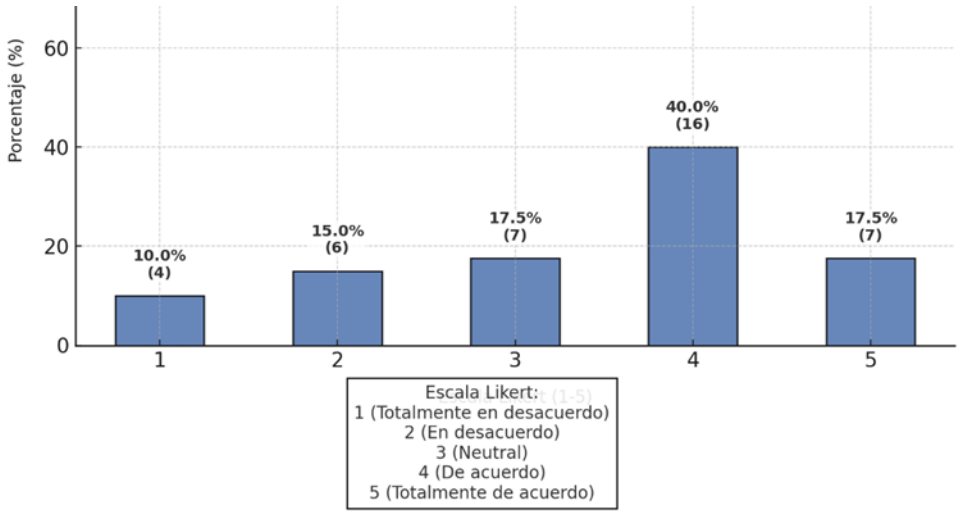


Figure 5. AI has made me less dependent on the teacher to solve my physics questions.

Finally, the perception of autonomy shows positive results in this aspect, with 40% "agreeing" and 17.5% "strongly agreeing." Another similar group, 17.5%, remained neutral, and finally 25% fell between "disagreeing" and "strongly disagreeing." At first glance, this polarization reflects a tendency toward independence among some students who believe they can use AI without a teacher, benefiting from the technological tools. However, this is inconsistent with previous results, making teacher guidance important since it requires students to develop critical thinking. This confirms the thesis that AI should complement, not replace, the teacher. The same questions were investigated with the teachers, obtaining the results in figures 6, 7, 8, 9, and 10.

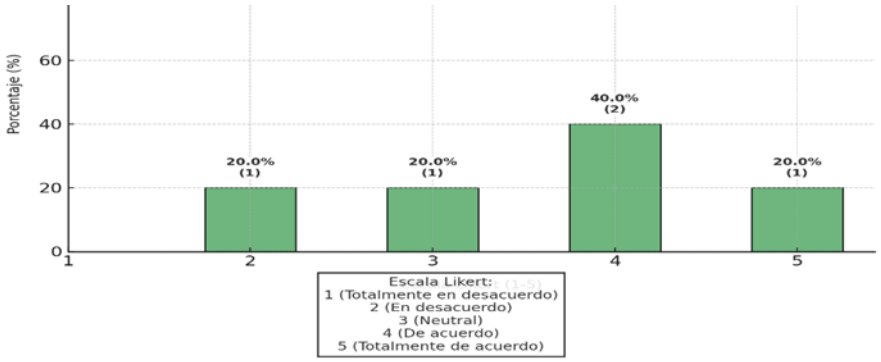


Figure 6. Artificial intelligence has improved my ability to personalize physics teaching

Using AI tools reduces my workload when assessing student performance.

Continuing with the analysis of what teachers have expressed, a marked dispersion is observed here, with the majority (60%) expressing total disagreement or disagreement. However, the fact that 40% of the group is in total disagreement and 0% in total agreement regarding the effective reduction of teaching work thanks to AI is striking and marks a trend: if we count neutrality, only 20% express a positive view by agreeing. This data suggests a significant difficulty in the integration or lack of optimization of these tools in the evaluation field, possibly linked to the lack of technological familiarity on the part of teachers. Consequently, technological implementation must include specific training for it to be effective and perceived as beneficial. Figure 7.

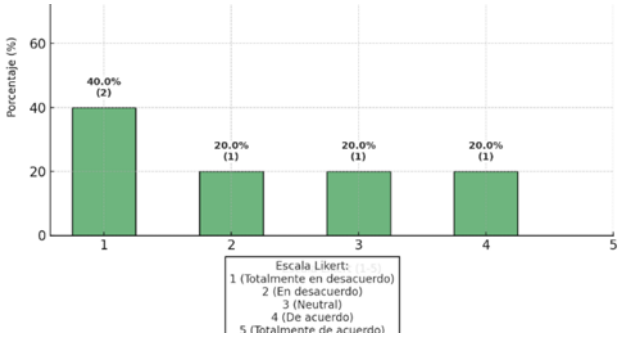


Figure 7. Using AI tools reduces my workload when assessing student performance

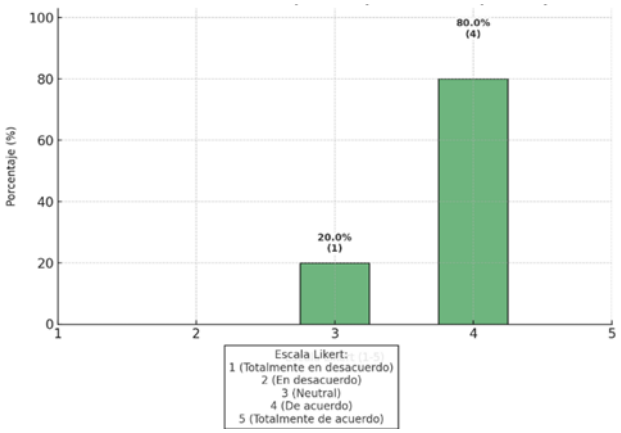


Figure 8. AI facilitates early identification of learning problems in students

Despite the data from the previous question, this question shows a very clear, favorable consensus (80%) agrees and a small proportion neutral (20%), indicating that teachers recognize AI as a highly effective resource for detecting difficulties at early stages, since having quick and easier-to-analyze results contributes to this. This result reinforces the academic argument about the preventative potential of AI to support education in diverse contexts, such as the case of the UE 5 de Mayo in the Chone canton, where early interventions are especially valuable due to limitations in educational resources shown in Figure 9.

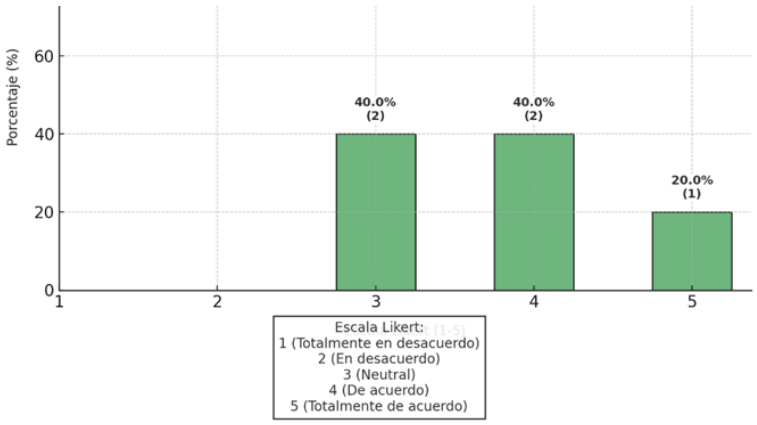


Figure 9. Students show greater interest in physics classes when I use AI tools

When teachers were asked whether the use of AI helped capture students' interest in physics classes, 40% agreed with the survey, while 20% strongly agreed. This indicates a positive perception, as no one expressed disagreement or strong disagreement, and only 20% were neutral. This is explained by the fact that today's young people are

clearly attracted to technology because they are digital natives. In Figure 10, trust the results of evaluations performed by AI systems.

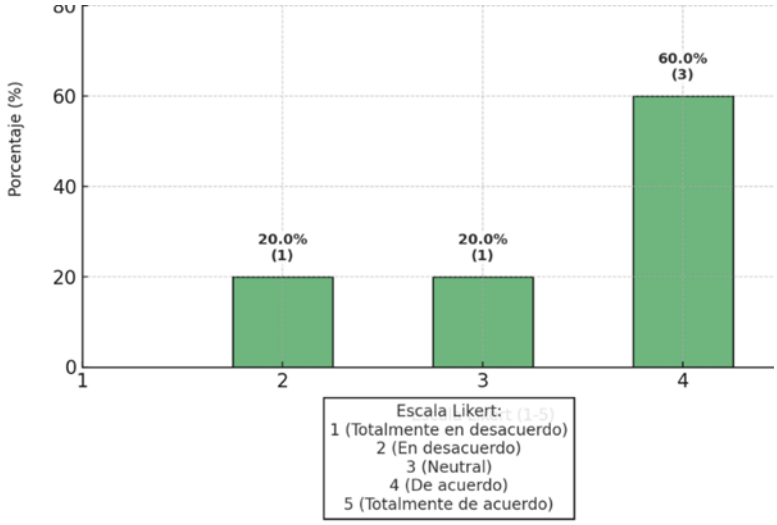


Figure 10. T trust the results of evaluations performed by AI systems

Regarding trust in assessments conducted by AI systems, the distribution reveals a relatively balanced perception, with 60% in favor (agreement and neutrality) versus a less convinced 40% (disagreement). This indicates moderate trust, meaning their usefulness is recognized, but there is not yet absolute trust in them, nor is there evidence of total distrust. This implies an explicit call for the development of better automated assessment systems, adapted to specific contexts and consistently validated by teachers so that they can be used and, above all, fully understood (Espinoza-Cedeño et al., 2024).

The findings obtained from the triangulation of surveys and interviews used in this study should also be presented. These findings reveal a significant overlap regarding the potential of artificial intelligence as a pedagogical resource in physics teaching. However, they also highlight tensions and limitations that influence its real impact on the educational field and the teaching-learning process at Unidad Educativa 5 de Mayo. On the one hand, students stated that AI contributes to improving the understanding of abstract concepts and fosters a certain degree of autonomy in problem-solving, although there remains a segment that exhibits doubts or excessive dependence on technological responses, which coincides with the teacher's perception that teacher guidance remains irreplaceable. In the interviews, teachers highlighted the usefulness of AI in personalizing teaching and detecting learning difficulties early, which aligns with the survey results, where a majority recognized these advantages. However, both stakeholders pointed out challenges related to a lack of training, partial distrust of automated assessment systems, and unequal access to technological resources. Thus, the triangulated results show that AI awakens interest and motivation in students and facilitates personalization strategies in teachers, but its effective application depends on formative and ethical support that guarantees a balance between technological support and the development of critical thinking.

## Conclusions

The study showed that the application of artificial intelligence in physics teaching at the 5 de Mayo Educational Unit in Chone has a positive impact, although not without tensions and limitations. The results show that a significant portion of students perceive that AI facilitates the understanding of abstract concepts and increases interest in the subject, although some groups remain unsure or show excessive dependence on technological solutions. This reflects the need for ongoing teacher support that balances the support of digital tools with the development of critical thinking. This requires adequate teacher training and openness to the use of AI.

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