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Impact of generative artificial intelligence on the development of innovative skills in high school students

Impacto de la inteligencia artificial generativa en el desarrollo de competencias innovadoras en estudiantes de bachillerato

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Abstract
The present study analyzes the impact of the use of generative artificial intelligence tools on the development of innovative competencies in high school students. The research was developed under a quantitative approach, with a non-experimental descriptive-correlational design. The sample was made up of 60 students, to whom a structured questionnaire with a Likert-type scale was applied. Descriptive and inferential statistical techniques were used to analyze the data using SPSS version 27 software. The results show a high adoption of these tools, although their use is predominantly occasional. Likewise, a positive perception is identified regarding the improvement of the quality of educational projects and the strengthening of skills such as creativity, critical thinking and problem solving. However, a significant group of students maintains neutral positions regarding its usefulness. It is concluded that generative artificial intelligence contributes to the development of innovative competencies, as long as its implementation is accompanied by appropriate pedagogical strategies.

Keywords: artificial intelligence, educational innovation, skills.

Resumen
El presente estudio analiza el impacto del uso de herramientas de inteligencia artificial generativa en el desarrollo de competencias innovadoras en estudiantes de bachillerato. La investigación se desarrolló bajo un enfoque cuantitativo, con un diseño no experimental de tipo descriptivo-correlacional. La muestra estuvo conformada por 60 estudiantes, a quienes se les aplicó un cuestionario estructurado con escala tipo Likert. Para el análisis de los datos se emplearon técnicas estadísticas descriptivas e inferenciales mediante el software SPSS versión 27. Los resultados evidencian una alta adopción de estas herramientas, aunque su uso es predominantemente ocasional. Asimismo, se identifica una percepción positiva respecto a la mejora de la calidad de los proyectos educativos y el fortalecimiento de competencias como la creatividad, el pensamiento crítico y la resolución de problemas. Sin embargo, un grupo significativo de estudiantes mantiene posturas neutrales frente a su utilidad. Se concluye que la inteligencia artificial generativa contribuye al desarrollo de competencias innovadoras, siempre que su implementación esté acompañada de estrategias pedagógicas adecuadas.

Palabras clave: inteligencia artificial, innovación educativa, competencias.

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Introduction

Digital transformation has brought significant changes to contemporary educational systems, particularly through the integration of emerging technologies that reshape teaching, learning, information production, and academic skill development. In this context, artificial intelligence (AI) has gained relevance due to its capacity to process information, generate content, adapt resources, and support more personalized learning experiences, factors that explain its growing presence in high school education, as noted by Cardoso García et al. (2025) and Mendoza Villamar et al. (2025).

Generative artificial intelligence (GAI), in particular, has become a tool of considerable educational interest, as it enables the production of texts, explanations, examples, outlines, feedback, and solution proposals based on user prompts. This capability is highly pertinent to student academic work, as it supports the organization of ideas, the development of educational projects, initial information searches, and the overall quality of school products, provided its use aligns with clear pedagogical criteria, according to Gamarra Rojas et al. (2025) and Sánchez et al. (2025).

Consequently, the incorporation of GAI into education should not be viewed merely as a technological upgrade but as a pedagogical process that demands instructional planning, teacher training, ethical guidance, and a clear definition of the learning outcomes to be reinforced. In this regard, Sánchez et al. (2025) caution that while these tools offer opportunities to transform traditional educational models, they also present challenges related to information quality, technological dependence, and the responsible use of digital resources.

From this perspective, the educational value of GAI lies not only in the speed with which it generates responses but, in its potential, to guide students toward comparing information, constructing arguments, exercising creativity, critically reviewing content, and developing their own products. This view aligns with Gamarra Rojas et al. (2025), who emphasize its function as a pedagogical assistant, and with López Vasco et al. (2025), who underscore the need for teacher training to integrate these tools critically and responsibly.

Educational innovation mediated by digital technologies entails methodological, organizational, and cultural shifts within schools, as it goes beyond the mere presence of devices, platforms, or applications. Veloz and Veloz (2024) argue that educational innovation is a cornerstone for ensuring equitable and continuous access to learning, while also promoting flexible, inclusive, and adaptive methodologies in response to current social demands.

In this vein, innovative competencies can be understood as cognitive, creative, investigative, and attitudinal capacities that enable students to analyze information, generate original ideas, solve problems, adapt to changing scenarios, and actively participate in their own learning process. Avci and Yildiz (2023) point out that learning environments oriented toward innovative thinking foster creativity, a disposition to produce original ideas, and the ability to respond to novel situations.

The development of innovative competencies requires educational experiences that go beyond the mere repetition of content and that promote academic autonomy, critical thinking, practical application of knowledge, and the construction of well-founded responses. Salazar et al. (2025) indicate that investigative competencies are linked to intellectual curiosity, information seeking, evidence analysis, and the formulation of substantiated answers, capacities essential for understanding innovation in school learning.

In the design and development of educational projects, generative AI can facilitate activity planning, information organization, initial idea generation, text refinement, and academic product review. According to Díaz Guevara and Ramírez García (2025), educational projects allow for the integration of theoretical and practical knowledge, encourage active student participation, and apply learning to real-world contexts.

Similarly, Melquiades-Cruz et al. (2025) maintain that the implementation of educational projects promotes dynamic and innovative learning experiences by articulating knowledge, skills, and situations linked to the environment. Within this framework, GAI can serve as a support resource for creation, inquiry, and problem-solving, provided students critically analyze, contrast, and re-elaborate the information obtained.

The pedagogical use of generative AI requires students to learn how to formulate clear instructions, assess the relevance of responses, cross-check information, recognize the limitations of the tools, and transform generated content into their own academic productions. Moreno et al. (2025) argue that these tools can strengthen student-centered methodologies, streamline evaluation processes, and generate didactic resources tailored to diverse educational needs.

However, these benefits depend on pedagogical mediation, as the instrumental use of AI alone does not guarantee the development of creativity, critical thinking, problem-solving, or academic autonomy. Meza Nieto et

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al. (2025) warn that AI will only become an innovative strategy if its integration serves defined educational purposes, fostering analytical skills and student autonomy that enhance learning quality.

Although much of the existing research has focused on higher education, its contributions remain useful for analyzing high school settings, as this level represents a key stage for strengthening the digital, cognitive, and academic competencies required in today's educational landscape. Castillo Herrera (2023) affirms that the use of AI tools in secondary education can support idea organization, facilitate content development, and improve students' academic outputs.

In Latin America, the integration of AI in education is progressing gradually, albeit constrained by access gaps, infrastructure limitations, technological inequalities, and teacher training needs. Portela et al. (2025) document experiences aimed at democratizing AI use in vulnerable contexts through initiatives that seek to strengthen the teaching role and improve evaluation, support, and feedback processes.

These experiences reveal that AI can contribute to learning, but they also show that its impact depends on institutional conditions, technological access, and the pedagogical preparation required for its appropriate use. Rodríguez Rojas et al. (2025) highlight the benefits for learning personalization while cautioning about the need to consider ethical, formative, and teacher training aspects in its implementation.

In the Ecuadorian context, the integration of emerging technologies is linked to the need to strengthen more flexible, autonomous, and inclusive learning approaches, consistent with the challenges of a continuously evolving digital society. Ruíz et al. (2025) note that AI can contribute to teaching personalization, autonomous learning, and academic feedback improvement within the framework of Education 4.0.

Nevertheless, Ruíz et al. (2025) also caution that the implementation of these technologies faces challenges associated with the digital divide, teacher training, and available infrastructure. This observation is particularly relevant for high school education, as the pedagogical use of GAI may vary depending on device access, connectivity, teacher guidance, and students' digital competencies.

Therefore, analyzing GAI use among high school students allows for a better understanding not only of the adoption level of these tools but also of how students perceive their contribution to learning, the quality of educational projects, and the development of innovative competencies. Moreno et al. (2025) and Veloz and Veloz (2024) concur that technology requires pedagogical mediation, methodological transformation, and active student participation to generate meaningful effects in the educational process.

A central aspect of this analysis involves distinguishing between the mere use of the tool and the development of innovative competencies, as using AI does not necessarily imply thinking critically, creatively, autonomously, or responsibly. This distinction aligns with Sánchez et al. (2025) and López Vasco et al. (2025), who stress that GAI integration must be accompanied by ethical criteria, teacher training, and strategies that prevent technological dependency.

Consequently, this study considers the use of generative AI tools as the independent variable, while the development of innovative competencies, related to creativity, critical thinking, problem-solving, academic autonomy, and project improvement, constitutes the dependent variable. Teacher mediation, digital competencies, technological access, and ethical use are recognized as conditioning factors, in line with Moreno et al. (2025), Ruíz et al. (2025), and Rodríguez Rojas et al. (2025).

This conceptual precision is relevant because the research follows a non-experimental, descriptive-correlational design; therefore, the impact should be understood as perceived by students rather than as experimentally established causality. The study thus aims to contribute evidence on how students value the use of generative AI in their learning processes, academic production, and development of innovative competencies.

Despite the growing body of research on AI in education, further evidence is still needed regarding its use in high school, particularly concerning student perceptions of innovative competency development within educational projects. This study is therefore timely, as it addresses a current issue at an educational level critical for the formation of digital, cognitive, and academic skills.

The present study aims to analyze the perceived impact of generative AI tools on the development of innovative competencies in high school students. To this end, the research seeks to provide evidence on the relationship between the use of these technologies, learning improvement, the quality of educational projects, and the strengthening of skills necessary to respond to an increasingly digital, flexible, and innovative educational environment.

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Methodology

This study was developed under a positivist, quantitative methodology, which enables the collection and analysis of numerical data to identify patterns and relationships between variables in educational contexts (Otzen & Manterola, 2017). From this perspective, the positivist approach is characterized by measuring, predicting, and generalizing phenomena based on objective data, using statistical procedures and maintaining a neutral observational stance toward the object of study (Concha Zelada et al., 2025).

The research type corresponds to a non-experimental, descriptive-correlational design, as the variables were not manipulated but observed in their natural context. The study sought to describe how students use generative AI tools while simultaneously identifying the relationship between this use and the development of innovative competencies within educational projects.

The population consisted of 105 students from the first, second, and third years of General High School at Unidad Educativa Particular "Nueve de Mayo," located in the city of Machala. The sample comprised 60 students selected through non-probabilistic convenience sampling, based on accessibility and participant availability.

A survey technique was employed for data collection. The instrument was a structured questionnaire composed of 20 items, developed on a five-level Likert-type scale. The questionnaire was administered via a digital Google Forms platform, allowing for organized data collection. Participants responded voluntarily and individually. The validity of the instrument was grounded in the theoretical review of previous studies related to the topic, ensuring the relevance of the items in relation to the study variables.

Regarding ethical aspects, the confidentiality of information and the anonymity of participants were guaranteed, and data were used exclusively for academic purposes.

Inclusion criteria considered students who were enrolled and active in high school levels and who agreed to participate voluntarily in the study. Exclusion criteria involved discarding incomplete questionnaires or those with inconsistent responses.

Finally, data analysis was conducted using SPSS version 27 statistical software. Descriptive and inferential analyses were performed to determine the relationship between the study variables.

Results and discussion

The results show that generative AI has been significantly incorporated into the high school educational context. A total of 81.7% of students reported using these tools in the development of academic projects, reflecting a high level of adoption. However, 48.3% indicated that their use is occasional, suggesting that it has not yet become a systematic practice in learning processes.

Regarding the quality of educational projects, a considerable proportion of students perceived improvements associated with AI use. Nonetheless, a significant percentage maintained neutral positions, indicating differences in the level of technological appropriation and in the pedagogical integration of these tools.

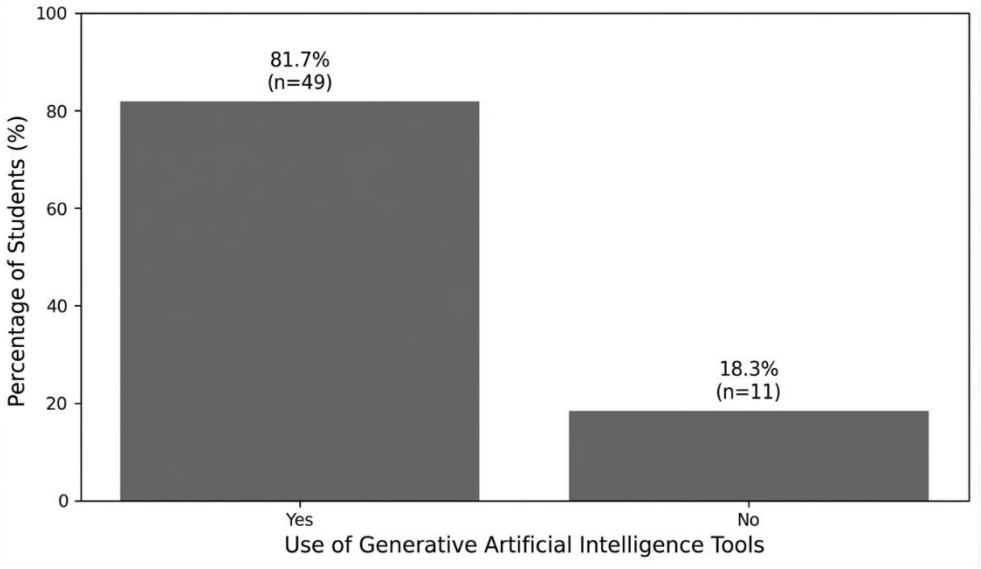
Similarly, results indicated that AI contributes to the development of innovative competencies, particularly in creativity, critical thinking, and problem-solving. The variability in responses, however, suggests that its impact is not homogeneous and depends on factors such as technology access, teacher guidance, and students' digital skills.

Concerning the use of generative AI tools among students, the results shown in Figure 1 reveal that the majority (81.7%) have used generative AI tools in developing educational projects, reflecting a strong presence of these technologies in the current academic context. Nevertheless, 18.3% reported not having used them, suggesting, as previously mentioned, the existence of a gap in access to or use of these tools.

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Figure 1

Student use of generative artificial intelligence tools

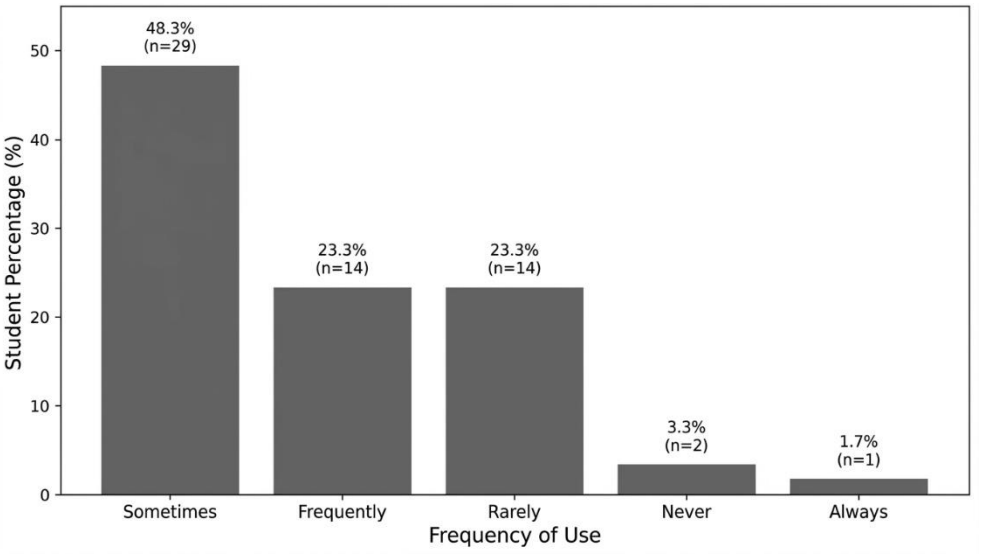


Note. Data collected by the research team

Regarding the frequency of AI use in educational projects, as shown in Figure 2, 48.3% of students reported using AI tools "sometimes," followed by 23.3% who use them frequently. This indicates that while relevant adoption exists, usage is not yet consistent, which may be related to factors such as lack of knowledge, insufficient training, or limited access to these technologies.

Figure 2

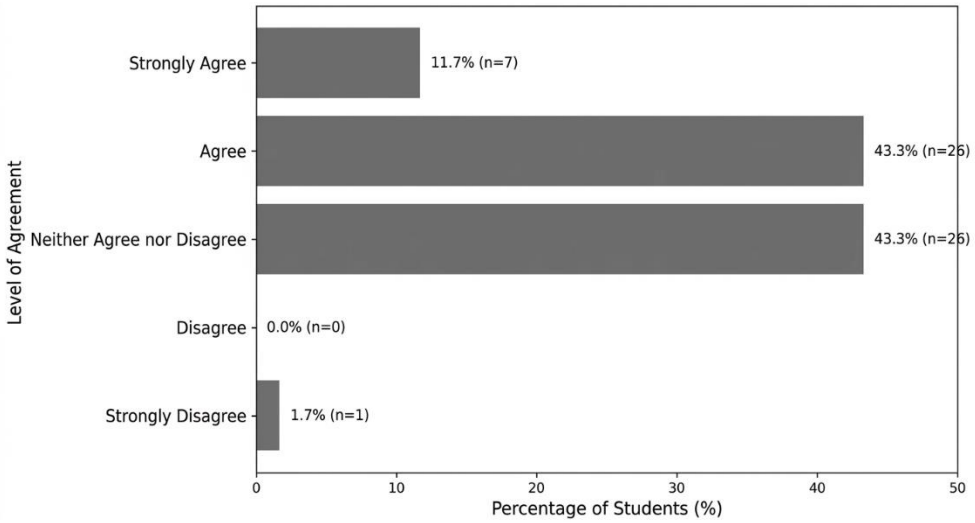
Frequency of artificial intelligence use in educational projects



Note. Data collected by the research team

Figure 3 shows that 43.3% of students agree that AI improves the quality of their educational projects, while 11.7% strongly agree. However, an equal percentage remains neutral, indicating that not all students clearly perceive its benefits.

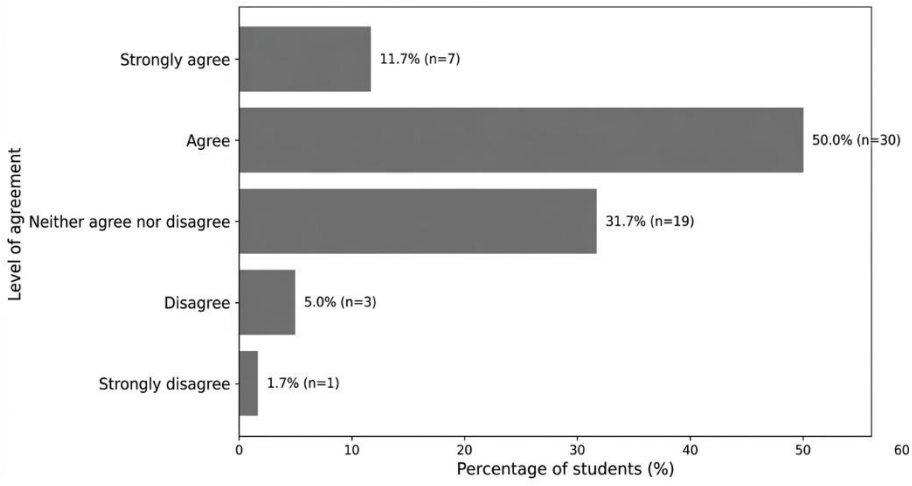
Figure 3
Perception of artificial intelligence's impact on educational projects



Note. Data collected by the research team

As shown in Figure 4, 50% of students consider that AI contributes to solving problems more creatively, evidencing a positive impact on the development of innovative competencies. Nevertheless, a significant proportion of students maintain a neutral stance, suggesting that not all are yet able to fully leverage these tools.

Figure 4
Artificial intelligence helps solve problems more creatively

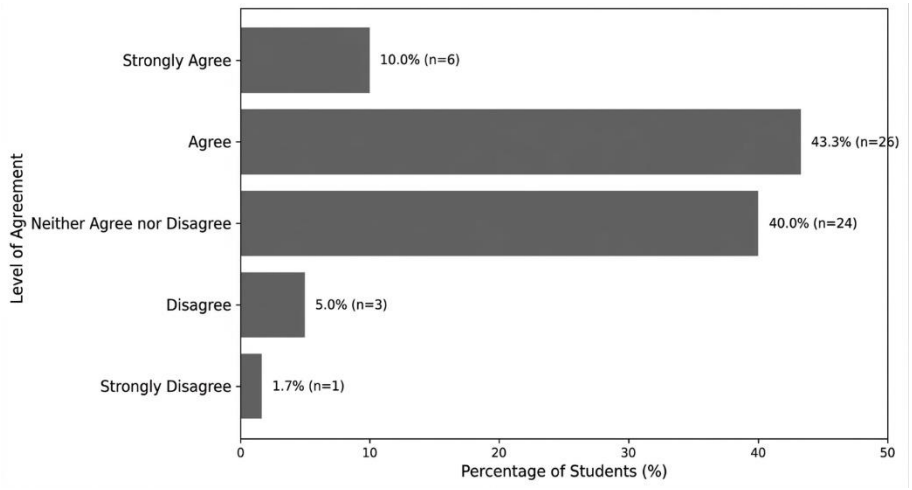


Note. Data collected by the research team

Figure 5 shows that 43.3% of students agree that AI improves their learning in educational projects, while 10% strongly agree. However, 40% maintain a neutral position, indicating that the impact of these tools on learning is not perceived uniformly across all students.

Figure 5

The use of generative artificial intelligence tools improves my learning in educational projects

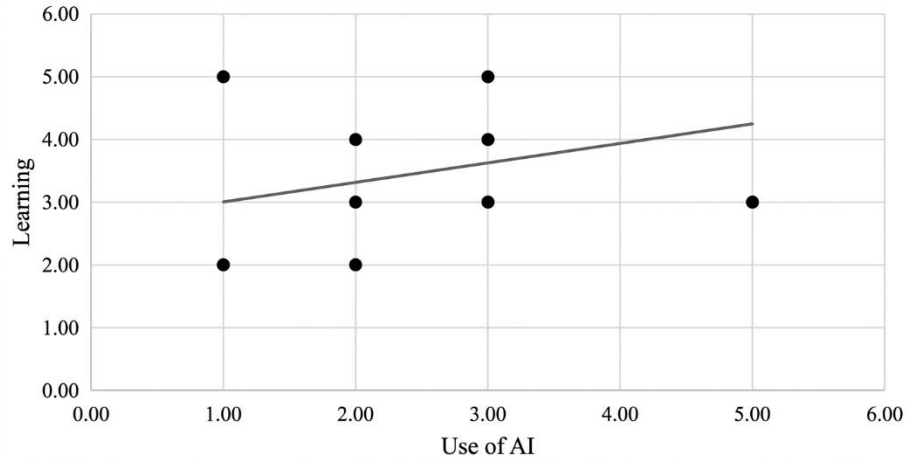


Note. Data collected by the research team

Figure 6 reveals a positive trend between the use of generative AI tools and student learning. As the frequency of use of these technologies' increases, an improvement in the development of educational projects is observed, suggesting a favorable relationship between both characteristics.

Figure 6

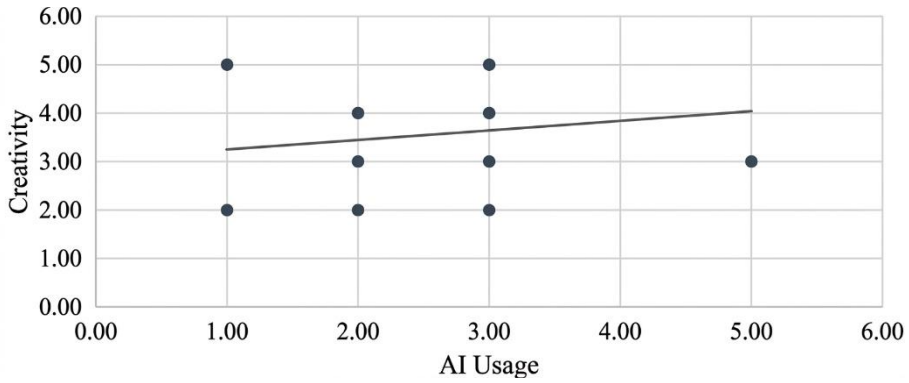
Relationship between the use of GAI tools and learning in high school students



Note. Data collected by the research team

Similarly, Figure 7 shows a positive trend between the use of generative AI tools and student creativity. As the use of these technologies' increases, creativity tends to rise. However, this relationship is of low intensity, indicating that other factors influence this variable.

Figure 7
Relationship between the use of GAI tools and creativity in high school students



Note. Data collected by the research team

Based on the results obtained, it is evident that generative AI has begun to be significantly integrated into the high school educational context, as reflected in the high percentage of students who reported using these tools in academic projects. However, the predominantly occasional frequency of use suggests that while access exists, systematic appropriation of these technologies in learning practices has not yet been consolidated.

Nevertheless, AI can be considered to have generated significant transformations in contemporary educational processes. As Rivero Panaqué and Beltrán Castañón (2024) point out, these technologies enable task automation and learning personalization, contributing to improved efficiency in educational systems and the creation of more dynamic environments.

Furthermore, these findings align with Moreno et al. (2025), who argue that AI integration in education depends largely on pedagogical mediation and didactic design, factors that determine the extent to which these tools are leveraged. In this sense, the intermittent use identified in this study may be associated with the lack of structured methodological strategies guiding their application in the classroom.

Regarding the impact on the quality of educational projects, results show a predominantly positive perception, although a considerable percentage of students remain neutral. This pattern is consistent with Meza Nieto et al. (2025), who indicate that AI's potential to improve learning does not manifest uniformly but depends on factors such as students' digital competency levels and the educational context in which it is implemented. Castillo Herrera (2023) argues that the use of AI tools among high school students optimizes idea organization, facilitates content development, and improves academic outcomes, translating into higher quality in student-produced educational products.

Likewise, results demonstrate that GAI contributes to strengthening innovative competencies, particularly in areas such as creativity and problem-solving. This finding relates to Avci and Yildiz (2023), who highlight that technology-mediated learning environments favor the development of creative thinking and the generation of original ideas. Nevertheless, the presence of neutral responses indicates that not all students are able to capitalize on these benefits, suggesting the need for more effective pedagogical integration.

This finding is relevant, as the analysis indicates that generative AI is directly linked to the development of innovative competencies in students by facilitating knowledge construction and idea generation in digital environments. Chasín Medranda et al. (2024) provide evidence that the use of these tools strengthens investigative competencies, critical thinking, and analytical capacity in students, promoting key skills for educational innovation and problem-solving in academic contexts.

The divided perception regarding autonomy development reflects an important tension in the use of these tools. While some students consider that AI facilitates independent learning, others do not clearly perceive this effect. This situation aligns with Veloz and Veloz (2024), who caution that educational innovation is not limited to technology use but requires a profound transformation in pedagogical approaches to promote active and autonomous student participation.

Finally, results related to responsible AI use reveal an emerging ethical awareness among students, which is fundamental in the context of digital education. In agreement with Ruíz et al. (2025), AI implementation in education should be accompanied by guidelines ensuring ethical and critical use, avoiding risks such as technological dependency or superficial learning.

Likewise, both benefits and challenges of AI in education are underscored; Rodríguez Rojas et al. (2025) highlight that these technologies favor learning personalization but also require attention to ethical, formative, and teacher training aspects for their proper implementation.

Along these same lines, AI use also directly impacts the development of educational projects by facilitating processes such as planning, organization, and execution of academic activities. Kroff et al. (2024) point out that these technologies allow the optimization of academic work through task automation and improved content structuring, contributing to higher quality and efficiency in student-developed projects.

Overall, the findings support the assertion that GAI has a positive impact on the development of innovative competencies in high school students, although its effectiveness depends on pedagogical, technological, and training factors that still require strengthening.

Conclusions

The study shows that generative AI has become significantly integrated into the high school educational context, with most students using it in academic projects. However, its use has not yet become a consistent practice, reflecting the need to strengthen its integration within pedagogical strategies.

The findings support the assertion that GAI contributes to the development of innovative competencies, particularly in areas such as creativity, critical thinking, and problem-solving. These skills are essential in educational environments shaped by digital transformation, positioning AI as a relevant resource in student education.

However, its impact was found not to be homogeneous, as a significant group of students maintained neutral perceptions regarding its benefits. This suggests that the effectiveness of these tools depends on factors such as teacher training, methodological design, and the level of technological appropriation.

In this regard, AI integration in education should be understood as a process of pedagogical transformation aimed at promoting active learning, autonomy, and critical thinking, beyond its instrumental use.

Based on these results, the need to design educational strategies that guide the appropriate use of these technologies is highlighted, strengthening both digital competencies and ethical application. Likewise, the importance of teacher training to ensure effective and contextualized implementation is emphasized.

Finally, the development of experimental and longitudinal studies is recommended to analyze more deeply the impact of generative AI on academic performance and the development of innovative competencies over the long term.

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