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Impact of Artificial Intelligence on The Learning of Engineering Students from Bolivian Universities

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Abstract

Artificial intelligence has been progressively incorporated into higher education as a support tool to strengthen teaching, learning, and academic feedback processes. The study aimed to analyze the effect of the use of artificial intelligence as a pedagogical intervention in Basic Education students of two Bolivian universities, through a pre-test-post-test design and the identification of factors associated with learning. A quantitative research was developed, with a pre-experimental design, with the application of pre-test and post-test. The intervention was oriented to the academic use of artificial intelligence tools in learning activities. The instrument was validated by expert judgment, a pilot test was carried out and reliability was estimated using Cronbach's alpha. The results showed improvements after the intervention, especially in the academic use of artificial intelligence, motivation towards learning, digital competence and critical thinking. In addition, positive relationships were identified between technological mastery, academic participation and the use of pedagogical intervention. It is concluded that artificial intelligence can be a relevant pedagogical strategy to strengthen university learning, as long as its application is accompanied by teaching guidance, ethical criteria and activities related to the training objectives.

Key Words: Artificial Intelligence, Pedagogical Intervention, Higher Education, Pre-Test-Posttest, University Learning.

1. Introduction

Artificial intelligence (AI) has become one of the most discussed axes within higher education, due to its ability to transform the ways of teaching, learning, evaluating, and providing feedback on academic processes. Their incorporation into universities not only responds to a technological trend, but also to the need to strengthen more personalized, dynamic learning experiences aimed at the development of competencies. In this sense, AI has begun to occupy a relevant place in university education, especially because of its potential to support problem solving, the search for information, the generation of explanations, the organization of ideas, and the academic accompaniment of students (Zawacki-Richter et al., 2019; Bond et al., 2024).

In the context of higher education, the use of AI has generated new opportunities to improve learning, although it has also opened debates about its pedagogical application, its ethical limits and its true impact on student achievement. Recent research indicates that these technologies can contribute to learning when they are integrated with clear training purposes, under teacher guidance and with criteria of responsible use. In this way, AI should not be understood only as an automation tool, but as an academic support resource that can promote understanding, feedback, and decision-making in the learning process (Miao & Holmes, 2023; Mustafa & García, 2024).

The advancement of generative AI has intensified this debate, as it allows students to interact with systems capable of producing texts, examples, explanations, summaries, codes, solutions, and academic guidance in real-time. This possibility represents an important advantage for careers with high cognitive demand, such as engineering, where students must analyze information, solve problems, interpret procedures and apply technical knowledge. However, its usefulness depends on the way students use it, as superficial use can limit self-reasoning, while guided use can strengthen comprehension and academic performance (Denny et al., 2024; Weng et al., 2024).

In engineering careers, learning requires the integration of analytical skills, logical thinking, use of digital tools, and the ability to solve complex problems. Therefore, AI can become a relevant resource to support learning activities related to case analysis, exercise solving, explanation of concepts, simulation of scenarios and review of results. However, for its incorporation to have educational value, it is necessary to evaluate whether it really produces improvements in learning and what factors influence this process. This need justifies the development of quantitative studies that allow changes to be measured before and after an AI-based academic intervention (Almasri, 2024; Saritepeci, 2024).

One of the central aspects to understand the impact of AI on university learning is artificial intelligence literacy. This refers to the ability to understand what AI is, how it works, what its possibilities are, what limitations it presents and how it can be used critically and responsibly. In the university environment, this literacy is necessary because students must not only use AI tools, but also evaluate the quality of their answers, contrast information, identify errors, and avoid mechanical dependence on automated systems (Laupichler et al., 2022; Hornberger et al., 2023).

AI literacy is also related to digital competence, since the use of these tools depends on the level of technological mastery of the students. A person with greater digital competence can better explore the functions of AI, formulate more precise instructions, interpret the results obtained and adapt the information to their academic needs. On the other hand, those with lower digital skills may use AI in a limited or uncritical way, reducing its contribution to learning. For this reason, digital competence should be considered as a relevant variable when analyzing the factors that influence the improvement of academic performance (Baum & Trzcińska-Król, 2024; Dringó-Horváth et al., 2025).

In addition to digital competence, academic motivation is another important element in AI-mediated learning. Smart tools can increase student engagement by offering immediate responses, tailored resources, and ongoing support in completing activities. However, there is also a risk that some students will reduce their cognitive effort if they use AI solely to get quick answers. Therefore, it is necessary to analyze whether motivation, autonomy, and academic engagement are related to greater improvement after an AI-based educational intervention (Fan et al., 2024; Vieriu & Petrea, 2025).

Another relevant component is feedback. In higher education, feedback plays a key role because it allows students to recognize errors, correct procedures, and improve their academic products. AI tools can support this process through immediate explanations, suggestions for improvement, and personalized guidance. From this perspective, AI is linked to the contributions of learning analytics, as both seek to generate useful information to strengthen the monitoring of student performance and promote better pedagogical decisions (Ifenthaler & Yau, 2020; Banihashem et al., 2022).

In Latin America, the integration of AI in higher education still presents challenges related to the digital divide, teacher preparation, technological infrastructure, and institutional regulation. In the Bolivian case, these challenges are especially important, since higher education is traversed by historical, social and academic processes that require strengthening educational innovation without neglecting the relevance of the context. Although there are studies that address higher education in Bolivia from different perspectives, more empirical

evidence is still required on the use of emerging technologies, especially in university populations linked to technical and engineering careers (Mujica-Seguera, 2015; Anaya Giorgis, 2024).

Based on the above, the objective of the study is to analyze the impact of artificial intelligence on the learning of engineering students from Bolivian universities through an academic intervention with pre-test-posttest measurement. In a complementary way, it seeks to identify the variables that are most related to the improvement of learning, in order to provide empirical evidence on the use of AI in Bolivian higher education and contribute to the design of more relevant, critical and effective pedagogical strategies.

2. Methodology

The research was developed under a quantitative approach, because it was aimed at measuring the impact of an academic intervention based on the use of artificial intelligence on the learning of university students. The study was applied, with a quasi-experimental design and pre-test-posttest measurement, since the initial level of the participants was evaluated, then an educational intervention was applied with AI tools and, at the end, a new measurement was carried out to identify the changes produced in learning.

The study population was made up of university students of engineering careers from two Bolivian universities, enrolled from the fifth semester onwards. The sample consisted of 140 students, distributed in 60 participants from one university and 80 from another. The selection of participants was non-probabilistic for convenience, considering as inclusion criteria being studying an engineering career, being in the fifth semester or higher, agreeing to participate in the research and completing both the pre-test and the post-test. Students who did not participate in any of the phases of the process or who submitted incomplete answers were excluded.

The academic intervention consisted of the guided use of artificial intelligence tools applied to learning activities typical of engineering training. During this phase, students used AI to support information search, understanding concepts, problem solving, organizing ideas, reviewing answers, generating examples, and academic feedback. The intervention did not seek to replace the student's reasoning, but to strengthen their learning process through a critical, oriented, and supervised use of artificial intelligence.

For data collection, a structured questionnaire-type instrument was applied, organized into dimensions related to the academic use of artificial intelligence, AI literacy, digital competence, academic motivation, critical thinking, perception of usefulness and learning. In addition, a knowledge test applied before and after the intervention was included, with the purpose of comparing the academic performance of the students in two moments: pre-test and post-test. The answers to the questionnaire were measured using a Likert-type scale, while the knowledge test allowed quantitative scores to be obtained on the learning achieved.

Prior to final implementation, the instrument underwent a validation process by expert judgement. To this end, specialists in higher education, research methodology and educational technologies reviewed the clarity, pertinence, coherence and relevance of the items. Based on their observations, adjustments were made to the wording of some questions, in order to improve the understanding of the instrument and ensure its correspondence with the objectives of the study.

A pilot test was also developed with a small group of students with similar characteristics to the main sample. This preliminary application made it possible to identify possible comprehension difficulties, estimate the response time and verify the functionality of the instrument before its final application. The results of the pilot test contributed to adjusting the structure of the questionnaire and to ensuring better quality in data collection.

The reliability of the instrument was evaluated using Cronbach's alpha coefficient, in order to determine the internal consistency of the items grouped by dimensions. The result obtained was higher than 0.80, a value considered adequate for studies in the educational field, so it was established that the instrument had an acceptable reliability for its final application. This procedure supported the stability of the measurements and the internal coherence of the variables analyzed.

The research procedure was developed in three phases. In the first phase, the pre-test was applied to know the initial level of learning of the students and collect information on their perceptions, competencies and previous experiences related to the use of artificial intelligence. In the second phase, the academic intervention based on the guided use of AI was carried out, through activities aimed at strengthening learning in subjects or content specific to engineering training. In the third phase, the post-test was applied to identify the changes produced after the intervention.

Data analysis was performed using descriptive and inferential statistics. First, frequencies, percentages, means and standard deviations were calculated to describe the general characteristics of the variables studied. Then, the results of the pre-test and post-test were compared in order to determine if there were significant differences in learning after the intervention. To this end, the application of a t-test for related samples was considered, because two measurements made on the same participants were compared.

In addition, the difference in results between the two participating universities was analyzed, considering the distribution of 60 students in one institution and 80 in the other. This comparison allowed us to identify whether the improvement in learning was similar in both groups or if there were differences in the results after the intervention. For this analysis, the means obtained in the pretest, the post-test and the variation between both measurements were considered.

This procedure allowed us to identify which factors were most associated with improved learning after the intervention. Relationships between variables such as AI literacy, digital competence, frequency of AI use, academic motivation, critical thinking, perception of usefulness and academic performance were analyzed. In this way, the study not only sought to check if there was an improvement between the pre-test and the post-test, but also to determine which variables had the strongest influence on the results obtained.

3. Results

The results were organized into three sections: comparison of the scores obtained in the pre-test and post-test, comparative analysis between the two participating universities and relationship between the variables associated with learning mediated by artificial intelligence. The sample was made up of 140 university students of engineering careers, from the fifth semester onwards, belonging to two Bolivian universities.

General comparison between pre-test and post-test

In the initial measurement, the students obtained an overall average of 62.4 points in the pretest, which evidenced an average level of performance before the intervention. After applying the academic activities supported by artificial intelligence, the average post-test increased to 81.7 points. This represents an average improvement of 19.3 points, indicating a significant increase in post-intervention learning.

Table 1 General comparison between pre-test and post-test

Measurement	Media	Standard deviation	Difference
Pre-test	62,4	9,8	—
Postest	81,7	8,6	19,3

Note. Results of the pre-test on the use of AI, learning, academic motivation and digital competence before the intervention.

The results show a positive difference between the two measurements. The increase in the average score suggests that the AI-based intervention contributed to improving engineering students' learning. The decrease in the standard deviation in the post-test also shows a greater concentration of the results, which indicates that, after the intervention, the students reached more homogeneous levels of performance.

To determine whether the difference between the pretest and the posttest was statistically significant, a t-test was applied for related samples. The results showed a significant difference between both measurements, with a p-value of less than 0.001.

Table 2 t-test for related samples

Comparison	Average difference	t	Good luck	p
Pretest–Postest	19,3	18,72	139	0,000

Note. Post-test results after applying the pedagogical intervention based on artificial intelligence in university students.

The result allows us to affirm that the observed improvement was not the product of chance, but is related to the application of the academic intervention based on artificial intelligence. This supports that the guided use of AI had a favorable effect on the learning of the participating students.

Comparison between universities

When analyzing the results by university, it was observed that both groups showed improvements after the intervention. In University A, made up of 60 students, the average of the pre-test was 61.8 points and increased to 80.5 points in the post-test, with a difference of 18.7 points. In University B, made up of 80 students, the initial average was 62.9 points and increased to 82.6 points, with a difference of 19.7 points.

Table 3 Pre-test-post-test comparison by university

University	n	Pre-test	Postest	Upgrade
University A	60	61,8	80,5	18,7
University B	80	62,9	82,6	19,7
Total	140	62,4	81,7	19,3

Note. Pre-test-post-test comparison to identify changes associated with the pedagogical use of artificial intelligence.

The results show that the improvement was slightly greater in University B; however, the difference between the two institutions was not wide. This indicates that the intervention had a positive effect on both groups, regardless of the university of origin. The similarity of the results suggests that the academic use of artificial intelligence can be effectively applied in different university contexts, provided that there is adequate guidance during the process.

Results of the variables associated with the use of artificial intelligence

In addition to academic performance, variables related to the use of artificial intelligence were analyzed. The dimensions with the highest scores were perception of usefulness, AI literacy and digital competence. This indicates that students positively valued the use of AI as a learning support and showed a favorable disposition towards their academic integration.

Table 4 Average of the variables associated with the use of artificial intelligence

Variable	Media	Interpretive level
Perception of AI's usefulness	4,42	High
AI Literacy	4,18	High
Digital competence	4,05	High
Academic motivation	3,96	High
Critical thinking	3,88	High
Frequency of AI use	3,74	Medium-high

Note. Relationship between digital competence, motivation, critical thinking and academic use of artificial intelligence.

The results show that students perceived AI as a useful tool to improve content comprehension, resolve doubts, organize information, and receive support in academic activities. However, the frequency of use obtained a lower average compared to the perception of usefulness, suggesting that some students recognize the value of AI, but still do not incorporate it consistently into their learning practices.

Relationship between variables and learning improvement

To identify which variables were related to the improvement of learning, a correlational analysis was applied between the dimensions of the questionnaire and the difference obtained between the pre-test and the post-test. The results showed that AI literacy had the highest correlation with improved learning, followed by critical thinking and digital competence.

Table 5 Correlation between variables and learning improvement

Related variable	Correlation coefficient	Interpretation
AI Literacy	0,68	High Ratio
Critical thinking	0,64	High Ratio
Digital competence	0,59	Moderate-to-high ratio
Perception of usefulness	0,55	Moderate relationship
Academic motivation	0,51	Moderate relationship
Frequency of AI use	0,43	Moderate relationship

Note. Statistical synthesis of the effectiveness of AI intervention in student learning.

The data show that the variable with the highest association was AI literacy. This means that students who better understood the workings, possibilities and limits of artificial intelligence were the ones who showed the greatest improvements in learning. This result shows that it is not enough to use AI tools, but that it is necessary to know how to use them critically, responsibly and oriented to academic objectives.

Critical thinking also had a high relationship with improved learning. This indicates that students who analyzed, contrasted, and verified the information generated by the AI achieved better results in the post-test. Therefore, the use of artificial intelligence was more effective when it was accompanied by information review, interpretation, and validation processes.

Digital competence showed a moderate-high relationship, which shows that students with greater mastery of technological tools took better advantage of the intervention. This is because the efficient use of AI requires formulating clear instructions, interpreting answers, adjusting searches and adapting results to academic activities.

On the other hand, the frequency of use showed a lower correlation, which shows that using AI often does not guarantee a significant improvement if there is no understanding, judgment and guidance.

Overall, the results show that the academic intervention based on artificial intelligence had a positive impact on the learning of engineering students from Bolivian universities. The pre-test-posttest comparison showed a significant improvement in performance, while the correlational analysis identified that the variables most related to this improvement were AI literacy, critical thinking and digital competence. These results support the importance of incorporating AI in higher education from a pedagogical, critical and oriented approach to the development of academic competencies.

4. Discussion

The results of the study show that the academic intervention based on artificial intelligence produced a significant improvement in the learning of engineering students from two Bolivian universities. The increase observed between the pre-test and the post-test shows that AI can function as a support resource when integrated in a guided way, with activities aimed at understanding, problem solving, information organization and academic feedback. This finding is in line with Pallant et al. (2025), who point out that generative AI can positively influence learning outcomes when used for training purposes and not just as an automatic response production tool.

The improvement obtained is also related to the contributions of Marzano et al. (2025), who argue that generative AI can strengthen teaching and learning processes by offering adapted explanations, immediate support, and possibilities for personalized interaction. In this study, the increase in the average score after the intervention suggests that students were able to take advantage of these possibilities, especially since AI was used as a complement to learning and not as a substitute for academic reasoning. This is important in engineering careers, where conceptual understanding and problem solving require processes of analysis, verification, and application.

Another relevant result was that the improvement occurred in the two participating universities, although with a slightly greater difference in University B. This similarity allows us to interpret that the intervention had a favorable effect in both groups, regardless of the size of the institutional sample. On this point, Molina et al. (2025) highlight that AI is generating transformations in higher education in Latin America, but its impact depends on the way in which institutions manage to integrate it into their academic processes. Therefore, the findings of this study provide evidence from the Bolivian context, where further empirical research on the educational application of these technologies is still required.

AI literacy was the variable that presented the highest relationship with learning improvement. This finding confirms that simple access to smart tools does not guarantee better results, as students need to understand how to use them, how to formulate instructions, how to interpret responses, and how to recognize potential errors. Laupichler et al. (2023) argue that AI literacy should be measured as a necessary skill for non-experts, because its use has spread to different academic and professional fields. From this perspective, students with greater AI literacy were better able to turn the tool into a real support for their learning.

This result is also related to Mansoor et al. (2024), who show that AI literacy in university students differs according to context, previous training, and experience with digital tools. In the case of this study, engineering students in the fifth semester and above possibly had a more solid technological base, which could facilitate the understanding and application of AI in academic tasks. However, the results also indicate that this competence should be formally strengthened within the university, to avoid superficial, dependent or uncritical uses.

Critical thinking was the second variable most closely related to improved learning. This finding is critical because AI can deliver fast, but not always accurate, sufficient, or contextualized answers. Therefore, students who contrasted, reviewed, and validated the information generated by the AI achieved better results. Favero et al. (2024) highlight that critical thinking can be strengthened when interaction with intelligent systems is guided by questions, dialogue, and reflective reasoning. Consequently, the educational use of AI must encourage the student to question the information received and not accept it automatically.

Digital competence also showed a moderate-high relationship with improved learning. This result indicates that students with greater technological proficiency were able to take better advantage of the intervention, especially when formulating indications, exploring responses, organizing information and adjusting the results obtained. Salas-Pilco et al. (2022) point out that AI and learning analytics have a growing role in teacher and university education, but their use requires digital skills that allow information to be interpreted and used appropriately. Although this study focused on engineering students, the finding reinforces the need to integrate advanced digital skills into university education.

The perception of usefulness was also moderately related to improved learning. This means that students who rated AI positively tended to make better use of it during the intervention. However, this variable was not the most influential, which shows that considering a tool useful is not enough to achieve better results. Perceived usefulness must be accompanied by literacy, critical thinking and academic guidance. Along these lines, Feigerlova et al.

(2025) argue that the impact of AI on learning outcomes depends not only on the presence of the technology, but also on the way in which it is integrated into the training process.

The frequency of use showed a lower correlation compared to the other variables. This result is especially important, because it shows that using AI more frequently does not necessarily guarantee a greater improvement. What was decisive was not the quantity of use, but the quality of academic use. This finding is connected to warnings about the unreflective use of AI, since excessive dependence can reduce cognitive effort, affect autonomy or limit the personal construction of knowledge. Therefore, the intervention should focus on teaching how to use AI strategically, ethically, and critically.

In this sense, the results must also be analyzed from an ethical perspective. The use of artificial intelligence in higher education involves risks related to privacy, technological dependence, bias, academic authorship, and inappropriate use of information. The U.S. Department of Education (2023) warns that educational AI must be implemented with human oversight, transparency, and criteria for protecting students. In the present study, the guided use of AI allowed to orient activities towards learning, but future institutional applications should consider clear policies on academic integrity, data protection and limits of use.

Privacy is another relevant aspect. Mutimukwe et al. (2022) note that students may have concerns about the use of their data in learning analytics systems and educational technologies. In a complementary way, Viberg et al. (2022) argue that research in learning analytics should strengthen practices related to privacy and responsible use of student information. Although the present study did not focus on massive data collection systems, the incorporation of AI in university contexts should consider these aspects to avoid risks associated with the management of academic and personal information.

The effects of AI should also be observed in relation to student well-being. Klimova et al. (2025) argue that artificial intelligence can influence both students and teachers, generating opportunities for academic support, but also possible tensions linked to dependency, technological pressure, or changes in learning dynamics. In this study, the intervention showed positive results in performance; however, this does not eliminate the need to accompany its implementation with teaching guidance, criteria for responsible use and spaces for reflection on its benefits and limits.

Overall, the findings allow us to affirm that artificial intelligence can contribute to improving the learning of university engineering students when applied through a structured academic intervention. The improvement observed between the pre-test and the post-test supports its educational potential, while the correlational analysis shows that the most important variables were AI literacy, critical thinking and digital competence. Therefore, the main contribution of the study is to show that the impact of AI does not depend only on access to the tool, but also on the capacities that students develop to use it in a critical, reflective and learning-oriented way.

5. Conclusions

The academic intervention based on artificial intelligence generated a significant improvement in the learning of university engineering students, evidenced by the increase in scores between the pre-test and the post-test. This shows that AI can function as an effective pedagogical tool when used with guidance, clear objectives and activities linked to the training process.

The comparison between the two Bolivian universities showed that both groups improved after the intervention, although with a slight difference in favor of University B. This result indicates that the academic use of AI can be adapted to different institutional contexts, as long as students receive adequate support and the activities are aligned with their learning needs.

Literacy in artificial intelligence was the variable most related to the improvement of learning, above the frequency of use. This shows that it is not enough to use AI tools constantly, but that students need to understand their scope, limitations and correct ways of application to obtain better academic results.

Critical thinking and digital competence also had an important influence on the results obtained, which confirms that AI must be incorporated from a formative approach and not only an instrumental one. Therefore, universities must promote strategies that teach students to analyze, contrast and validate the information generated by these tools, avoiding mechanical or dependent uses.

References

[1] Almasri, F. (2024). Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review. Research in Science Education. https://doi.org/10.1007/s11165-024-10176-3

[2] Anaya Giorgis, J. J. (2024). La Educación Superior en Bolivia y la Agenda del Desarrollo: 1960-1964. Revista de Historia de América, (169). https://doi.org/10.35424/rha.169.2024.5820

[3] Banihashem, S. K., Noroozi, O., van Ginkel, S., Macfadyen, L. P., & Biemans, H. J. A. (2022). A systematic review of the role of learning analytics in enhancing feedback practices in higher education. Educational Research Review, 37, 100489. https://doi.org/10.1016/j.edurev.2022.100489

[4] Baum, A., & Trzcińska-Król, M. (2024). Students' attitudes towards artificial intelligence and their digital competence. The New Educational Review, 75, 142–157. https://doi.org/10.15804/tner.2024.SI.5.09
[5] Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. International Journal of Educational Technology in Higher Education, 21, 4. https://doi.org/10.1186/s41239-023-00436-z
[6] Denny, P., Gulwani, S., Heffernan, N. T., Käser, T., Moore, S., Rafferty, A. N., & Singla, A. (2024). Generative AI for education: Advances, opportunities, and challenges. arXiv. https://arxiv.org/abs/2402.01580
[7] Dringó-Horváth, I., Dombi, J., & Kovács, L. (2025). University teachers' digital competence and AI literacy. Education Sciences, 15(7), 868. https://doi.org/10.3390/educsci15070868
[8] Fan, Y., Tang, L., Le, H., Shen, K., Tan, S., Zhao, Y., Shen, Y., Li, X., & Gašević, D. (2024). Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance. https://bera-journals.onlinelibrary.wiley.com/doi/epdf/10.1111/bjet.13544
[9] Favero, L., Pérez-Ortiz, J. A., Käser, T., & Oliver, N. (2024). Enhancing critical thinking in education by means of a Socratic chatbot. https://doi.org/10.48550/arXiv.2409.05511
[10] Feigerlova, E., Hani, A., & Pradère, B. (2025). A systematic review of the impact of artificial intelligence on learning outcomes in health professions education. BMC Medical Education, 25, 558. https://doi.org/10.1186/s12909-025-06719-5
[11] Hornberger, M., Bewersdorff, A., & Nerdel, C. (2023). What do university students know about artificial intelligence? Development and validation of an AI literacy test. Computers and Education: Artificial Intelligence, 5, 100165. https://doi.org/10.1016/j.caeai.2023.100165
[12] Ifenthaler, D., & Yau, J. Y. K. (2020). Utilising learning analytics to support study success in higher education: A systematic review. Educational Technology Research and Development, 68, 1961–1990. https://doi.org/10.1007/s11423-020-09788-z
[13] Klimova, B., Pikhart, M., & Kacetl, J. (2025). Exploring the effects of artificial intelligence on student and teacher well-being. Frontiers in Psychology.
[14] Laupichler, M. C., Aster, A., Haverkamp, N., & Raupach, T. (2023). Development of the "Scale for the Assessment of Non-Experts' AI Literacy": An exploratory factor analysis. Computers in Human Behavior Reports, 12, 100338. https://doi.org/10.1016/j.chbr.2023.100338
[15] Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2022). Artificial intelligence literacy in higher and adult education: A scoping literature review. Computers and Education: Artificial Intelligence, 3, 100101. https://doi.org/10.1016/j.caeai.2022.100101
[16] Mansoor, H. M. H., Bawazir, A., Alsabri, M., & Alharbi, A. (2024). Artificial intelligence literacy among university students: A comparative transnational survey. Frontiers in Communication, 9, 1478476. https://doi.org/10.3389/fcomm.2024.1478476
[17] Marzano, D., Vegliante, R., & Miranda, S. (2025). Generative artificial intelligence in teaching and learning: A systematic review. Technology, Knowledge and Learning. https://doi.org/10.1007/s10758-025-09853-7
[18] Miao, F., & Holmes, W. (2023). Guidance for generative AI in education and research. UNESCO.
[19] Molina, E., Cobo, C., Pineda, J., & Rovner, H. (2025). AI revolution in higher education: What you need to know. World Bank. https://openknowledge.worldbank.org/entities/publication/81b862e6-fdda-470a-a142-4a7c43e7b049
[20] Mujica-Seguera, R. M. (2015). Paradigma en la Educación Superior en Bolivia. Revista Docentes 2.0, 3(1), 4–6. https://doi.org/10.37843/rted.v3i1.48
[21] Mustafa, M. Y., & García, M. B. (2024). A systematic review of literature reviews on artificial intelligence in education. Smart Learning Environments, 11, 51. https://doi.org/10.1186/s40561-024-00350-5
[22] Mutimukwe, C., Viberg, O., Oberg, L. M., & Cerratto-Pargman, T. (2022). Students' privacy concerns in learning analytics: Model development. British Journal of Educational Technology, 53(4), 932–951. https://doi.org/10.1111/bjet.13234
[23] Pallant, J. L., Sands, S., & Karpen, I. O. (2025). The impact of generative AI on student learning outcomes. Studies in Higher Education. https://doi.org/10.1080/03075079.2025.2487570
[24] Salas-Pilco, S. Z., Xiao, K., & Hu, X. (2022). Artificial intelligence and learning analytics in teacher education: A systematic review. Education Sciences, 12(8), 569. https://doi.org/10.3390/educsci12080569
[25] Saritepeci, M. (2024). Effectiveness of artificial intelligence integration in design-based learning on students' computational thinking and learning performance. Education and Information Technologies. https://doi.org/10.1007/s10639-024-12829-2
[26] U.S. Department of Education, Office of Educational Technology. (2023). Artificial intelligence and future of teaching and learning: Insights and recommendations. U.S. Department of Education. https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf
[27] Viberg, O., Mutimukwe, C., & Grönlund, Å. (2022). Privacy in learning analytics research: Understanding the field to improve the practice. Journal of Learning Analytics, 9(3), 1–14. https://doi.org/10.18608/jla.2022.7751
[28] Vieriu, A. M., & Petrea, G. (2025). The impact of artificial intelligence on students' learning processes and academic performance. Education Sciences, 15(3), 343. https://doi.org/10.3390/educsci15030343
[29] Weng, X., Chiu, T. K. F., & Tsang, C. C. (2024). Assessment and learning outcomes for generative AI in higher education: A scoping review on current research status and future directions. Australasian Journal of Educational Technology, 40(1), 1–18. https://doi.org/10.14742/ajet.9540
[30] Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education: Where are the educators? International Journal of Educational Technology in Higher Education, 16, 39. https://doi.org/10.1186/s41239-019-0171-0