Desarrollo Sostenible e Innovación Global. 2026; 3(1):23
doi: 10.63688/desarrollo.v3.i1.23

ORIGINAL

Didactic Sustainability, Algorithmic Ethics, and Immersive Technologies in Initial Teacher Training: A Macro-Institutional Synthesis

Sustentabilidad Didáctica, Ética Algorítmica y Tecnologías Inmersivas en la Formación Inicial Docente: Una Síntesis Macro-Institucional

César-Antonio Acosta Fernández[1]

[1] Benemérita Escuela Normal Veracruzana "Enrique C. Rébsamen". Xalapa, México

Submitted: 04-01-2026 | Revised: 20-02-2026 | Accepted: 17-04-2026 | Published: 18-04-2026

Corresponding Author: César-Antonio Acosta Fernández

ABSTRACT

The incorporation of generative artificial intelligence and immersive technologies in teacher training opens up new possibilities for planning more dynamic, contextualized and sustainable classes. However, their use also requires a critical look, especially when digital tools produce general activities that do not always respond to the reality of public schools. This study analyzed the combined use of artificial intelligence, augmented reality and pedagogical curatorship in the elaboration of didactic sequences by teachers in training at the Meritorious Veracruz Normal School "Enrique C. Rébsamen". We worked with six teachers in training, 30 didactic sequences and 185 primary school students from six public institutions in Xalapa, Veracruz. The research had a mixed approach and made it possible to compare the planning time, the level of adaptation of the proposals and the use of material resources before and after the intervention. The results showed a reduction in weekly planning time from 10.4 to 5.2 hours, a significant improvement in the contextualization and inclusion of sequences, and a 40% decrease in the use of printed inputs. Greater student attention was also observed during activities supported by immersive resources. It is concluded that these technologies can strengthen initial teacher training when they are not used automatically, but as a support to think, adapt and improve teaching from ethical, inclusive and situated criteria.

Keywords: artificial intelligence, augmented reality, initial teacher training, algorithmic ethics, didactic sustainability.

RESUMEN

La incorporación de la inteligencia artificial generativa y las tecnologías inmersivas en la formación docente abre nuevas posibilidades para planificar clases más dinámicas, contextualizadas y sostenibles. Sin embargo, su uso también exige una mirada crítica, especialmente cuando las herramientas digitales producen actividades generales que no siempre responden a la realidad de las escuelas públicas. Este estudio analizó el uso combinado de inteligencia artificial, realidad aumentada y curaduría pedagógica en la elaboración de secuencias didácticas por docentes en formación de la Benemérita Escuela Normal Veracruzana "Enrique C. Rébsamen". Se trabajó con seis docentes en formación, 30 secuencias didácticas y 185 estudiantes de educación primaria de seis instituciones públicas de Xalapa, Veracruz. La investigación tuvo un enfoque mixto y permitió comparar el tiempo de planificación, el nivel de adaptación de las propuestas y el uso de recursos materiales antes y después de la intervención. Los resultados mostraron una reducción del tiempo semanal de planificación de 10.4 a 5.2 horas, una mejora importante en la contextualización e inclusión de las secuencias y una disminución del 40% en el uso de insumos impresos. También se observó mayor atención estudiantil durante las actividades apoyadas en recursos inmersivos. Se concluye que estas tecnologías pueden fortalecer la formación inicial docente cuando no se usan de forma automática, sino como apoyo para pensar, adaptar y mejorar la enseñanza desde criterios éticos, inclusivos y situados.

Palabras clave: inteligencia artificial, realidad aumentada, formación docente inicial, ética algorítmica, sustentabilidad didáctica.

INTRODUCTION

The incorporation of generative artificial intelligence, augmented reality, and other immersive environments in education has progressively transformed approaches to planning, teaching, assessment, and support of learning processes. In recent years, these technologies have moved beyond experimental resources to become tools utilized at various educational levels, particularly due to their capacity to support content organization, the creation of didactic materials, scenario simulation, and the personalization of formative experiences (1,2).

Artificial intelligence has demonstrated significant potential in educational processes, particularly in content generation, information analysis, feedback, assessment, and the design of learning experiences tailored to diverse needs (3,4). However, its implementation in school contexts requires careful consideration, as algorithmic systems are not neutral and may reproduce biases present in the data, programming criteria, or in the ways users interpret their results (5,6).

In teacher education, this challenge is particularly significant. Future teachers must not only learn how to use digital tools, but also understand how these tools influence content selection, activity organization, learning assessment, and attention to classroom diversity. Literacy in artificial intelligence has become an emerging competency for teachers, enabling them to recognize possibilities, risks, biases, and criteria for responsible use in real educational settings (7,8). In this regard, digital teaching competence is related to the willingness to integrate technologies into teaching, as well as the ability to make pedagogically sound and contextually appropriate decisions (9).

Alongside artificial intelligence, immersive technologies such as augmented reality and virtual reality have expanded the possibilities for visual representation, interaction, and experimentation in the classroom. Various studies have indicated that these tools can enhance the understanding of abstract concepts, collaborative learning, and student motivation, especially when integrated with clear pedagogical objectives (11,12). In areas such as natural sciences, chemistry, or elementary education, augmented reality enables the visualization of phenomena, objects, or processes that cannot always be directly observed in the classroom, thereby strengthening the connection between theory, experience, and meaningful learning (13,14).

Nevertheless, the educational value of immersive technologies does not depend solely on their novelty or visual appeal. Their effectiveness is related to didactic design, the cognitive load they generate, the clarity of instructions, and the alignment between the digital resource and the learning objective (15). When these resources are used without pedagogical criteria, they can become distracting elements or isolated experiences without formative impact. Therefore, the integration of augmented reality and virtual reality in teacher education must be accompanied by processes of planning, assessment, and reflection on their relevance, accessibility, and sustainability.

Educational sustainability is also an important dimension in the analysis of these technologies. The use of digital resources can help reduce printed materials, diversify teaching strategies, and optimize planning time, but it also requires consideration of access gaps, device availability, connectivity, technical training, and resource maintenance (16).

Within this framework, initial teacher education requires working models that integrate artificial intelligence, immersive technologies, algorithmic ethics, and criteria for pedagogical sustainability. Recent research on artificial intelligence in education has emphasized the need to strengthen the active role of teachers, not as passive users of automated tools, but as critical mediators capable of reviewing, adapting, and contextualizing products generated by digital systems (17,18).

METHODS

The study was conducted using a mixed-methods approach, with a descriptive-explanatory scope and a concurrent triangulation design. This methodological choice enabled the integrated analysis of quantitative information related to planning times, levels of adaptation of didactic sequences, and indicators of material sustainability, along with qualitative information derived from the pedagogical review of lesson plans developed by pre-service teachers. The combination of both types of data made it possible to assess not only the measurable changes produced by the use of generative artificial intelligence and immersive resources, but also the quality of the teaching decisions applied during the adaptation of materials to the school context.

The research was carried out at the Benemérita Escuela Normal Veracruzana "Enrique C. Rébsamen," in Xalapa, Veracruz, Mexico, during the 2025-2026 academic year. The reference population consisted of fourth-year students in the Bachelor's Degree in Primary Education. The sample was selected through intentional non-probabilistic sampling, considering the availability of participants, their involvement in professional practice in public primary schools, and their prior participation in activities related to digital literacy, artificial intelligence, and technology-mediated didactic design. Thus, the sample consisted of six pre-service teachers.

The units of analysis consisted of 30 didactic sequences developed and implemented by pre-service teachers. These sequences were primarily oriented toward the formative fields of Knowledge and Scientific Thinking, as well as Ethics, Nature, and Societies. Their implementation involved a combined school population of 185 primary education students, distributed across six fully organized public institutions in the municipality of Xalapa. The participating schools shared common characteristics, including diversity in learning paces, limited technological resources, and material conditions typical of public school contexts.

The intervention procedure was organized into three phases. In the first phase, didactic plans developed through traditional design processes were collected to establish a baseline regarding planning time, activity structure, level of contextualization, and use of material resources. In the second phase, pre-service teachers used generative artificial intelligence tools to support the initial development of didactic sequences, as well as augmented reality or visual modeling resources to enhance the representation of school content. In the third phase, the generated proposals underwent a process of pedagogical curation, during which participants reviewed, adjusted, and contextualized the materials, taking into account the needs of the group, the school curriculum, didactic inclusion, and the feasibility of classroom implementation.

Two primary instruments were used for data collection. The first was a temporal registration form, which measured the weekly time allocated to didactic planning before and after the implementation of the workflow mediated by artificial intelligence and immersive resources. This instrument enabled a comparison of the workload associated with activity design, material organization, sequence writing, and classroom resource preparation.

The second instrument was a situated instructional adaptation scale, designed to assess the pedagogical quality of the didactic sequences. The scale considered four dimensions: sociocultural relevance of the activities, control of biases in content generated by artificial intelligence, diversification of strategies to address heterogeneous learning paces, and sustainability in the use of physical resources. Each dimension was evaluated using a four-level ordinal rubric: standardized, partially homogeneous, adapted and situated, and inclusive and sustainable. The internal consistency of the instrument was estimated using Cronbach's alpha coefficient, yielding an overall value of 0.88, which is considered adequate for data analysis.

Quantitative analysis was conducted using descriptive and inferential statistics. Means, standard deviations, frequencies, and percentages were first calculated to describe the behavior of the main variables. Subsequently, the Wilcoxon signed-rank test was applied to compare planning times before and after the intervention, due to the small sample size and the non-parametric nature of the data. To analyze changes in the levels of instructional adaptation of the didactic sequences, Pearson's Chi-square test was used, with a significance level of $p < 0.05$. Data processing was performed using statistical software.

The qualitative component was addressed through content analysis of the didactic sequences, focusing on the changes made by pre-service teachers during pedagogical curation. Aspects reviewed included the contextualization of activities, the relevance of examples, the appropriateness of language, the inclusion of students with varying learning paces, and the coherence between technological resources and educational objectives. This analysis complemented the statistical results and facilitated an understanding of how the teaching intervention modified the products initially generated by automated tools.

Regarding ethical considerations, the study was conducted exclusively for academic and educational purposes. The information was organized in aggregate form to prevent the individual identification of primary school students and participating institutions. Pre-service teachers participated voluntarily, and the didactic evidence was used solely for pedagogical analysis. Additionally, efforts were made to ensure that the use of artificial intelligence and immersive technologies did not replace the professional responsibility of the teacher, but rather served as a support subject to critical review, contextualization, and pedagogical validation.

RESULTS

Data analysis identified significant changes in three main dimensions: the optimization of time allocated to didactic planning, the improvement in the level of instructional adaptation of sequences developed with artificial intelligence support, and the reduction in the use of printed resources through the incorporation of digital and immersive materials. The results are presented in an integrated manner, considering both the quantitative data obtained through the applied instruments and the qualitative review of the didactic sequences developed by the pre-service teachers.

A significant decrease was observed in the weekly time dedicated to didactic planning. Before the intervention, pre-service teachers devoted an average of 10.4 hours per week to information searching, activity organization, material preparation, and sequence writing. After incorporating the workflow mediated by generative artificial intelligence, visual resources, and pedagogical curation, the average time was reduced to 5.2 hours per week. This difference represents a 50% decrease in the time burden associated with didactic design.

Table 1. Comparison of weekly time allocated to didactic planning before and after the intervention

Measurement point	Mean weekly hours	Standard deviation	95% confidence interval	Observed reduction
Pre-intervention	10.4	1.2	9.4 – 11.4	—
Post-intervention	5.2	0.6	4.7 – 5.7	50%

Note. Prepared by the authors based on teaching planning records.

The Wilcoxon signed-rank test confirmed that the difference between the two time points was statistically significant ($Z = -2.20$; $p = 0.028$). This result indicates that the use of digital tools not only expedited the formal preparation of lesson plans but also enabled more efficient organization of tasks prior to classroom intervention. However, the reduction in time was not interpreted as a substitution of teaching work, but rather as a redistribution of effort toward processes of review, adaptation, and improvement of the initially generated proposals.

Secondly, the level of instructional adaptation of the 30 didactic sequences included in the study was analyzed. In the baseline condition, that is, when the sequences were generated through direct prompts without in-depth pedagogical review, a predominance of standardized or partially homogeneous proposals was identified. 65% of the corpus presented general activities, examples with limited connection to the school context, and insufficient attention to the diversity of learning paces.

After the teacher curation process, the results showed a favorable change. The majority of the sequences shifted toward the higher levels of the scale, especially the categories “adapted/situated” and “inclusive/sustainable.” Overall, 88.3% of the lesson plans achieved adequate levels of contextualization, inclusion, and didactic relevance.

The Pearson Chi-square test showed a statistically significant association between the evaluation moment and the level of adaptation of the didactic sequences ($\chi^2 = 32.4$; $p < 0.001$). This indicates that teacher intervention played a decisive role in improving the proposals initially generated by artificial intelligence. The final sequences demonstrated greater coherence between learning objectives, proposed activities, resources used, and actual classroom conditions.

Qualitative analysis revealed that the main adjustments made by pre-service teachers were related to the contextualization of examples, simplification of language, incorporation of differentiated activities, and selection of more feasible resources for schools with technological limitations. In several cases, the initial versions generated by artificial intelligence included broad activities or those with limited connection to students’ realities; however, after pedagogical curation, the sequences incorporated references to the local environment, materials available in the classroom, and more inclusive participation strategies.

Table 2. Level of instructional adaptation of didactic sequences before and after teacher curation

Level of instructional adaptation	Baseline condition	Final condition	Observed change	Final percentage
Standardized / biased	19	1	-18	3.3%
Partially homogeneous	7	3	-4	10.0%
Adapted / contextualized	3	11	+8	36.7%
Inclusive / sustainable	1	15	+14	50.0%
Total	30	30	—	100%

Note. Prepared by the authors based on the Situated Instructional Adaptation Scale.

Third, favorable results were identified in the dimension of material sustainability. The incorporation of digital resources, visual models, and activities supported by augmented reality contributed to a reduction in the use of printouts, photocopies, and single-use physical materials. According to the records analyzed, the hybrid workflow resulted in an approximate 40% reduction in waste of printed supplies in the six participating institutions.

Table 3. General indicators of material sustainability and student interaction

Analyzed indicator	Observed result	Interpretation
Reduction in printed materials	40%	Decrease in the use of photocopies and repetitive materials
Participating students	185	Implementation of sequences in primary education
Didactic sequences applied	30	Total corpus reviewed and adjusted
Sustained attention during immersive resources	90%	Increased engagement in the activity during the first 25 minutes

Note. Prepared by the authors based on records of implementation and observation of the didactic sequences.

Regarding student interaction, observations during the implementation of the sequences showed high levels of sustained attention during the use of immersive resources and visual materials. Peaks of nearly 90% active participation were recorded during the first 25 minutes of interaction with content supported by three-dimensional representations, particularly in activities related to natural sciences and geography. This result suggests that immersive resources can promote concentration and participation when integrated with guided activities, clear objectives, and consistent teacher mediation.

The results indicate that the incorporation of generative artificial intelligence and immersive technologies, accompanied by a process of pedagogical curation, led to improvements in planning efficiency, contextual quality of didactic sequences, and sustainable use of material resources. However, the findings should be interpreted with caution due to the small sample size of teachers and the situated nature of the study. Rather than demonstrating broad generalizability, the data highlight the potential of this model as an exploratory institutional experience to strengthen initial teacher training from an ethical, inclusive, and sustainable perspective.

Discussion

The results of the study indicate that the incorporation of generative artificial intelligence and immersive technologies can improve didactic planning when these tools are integrated through a deliberate pedagogical review process. The reduction in weekly planning time, from 10.4 to 5.2 hours, demonstrates that artificial intelligence can support operational tasks such as content organization, initial drafting of activities, and structuring of sequences. This finding is consistent with recent studies indicating that AI can enhance teaching work by reducing repetitive workloads and facilitating instructional design processes, provided its use does not displace the teacher's pedagogical decision-making (19,20).

The data indicate that the initial versions generated through direct prompts exhibited a high degree of methodological homogenization, with general activities that were not well adapted to the school context. This result is consistent with research warning that the use of ChatGPT and other generative tools in education can offer advantages for personalization and material production, but may also reproduce standardized responses if there is no rigorous teacher review (21,22). Therefore, technological efficiency acquires educational value only when accompanied by curation, contextualization, and professional judgment.

The changes observed in the 30 didactic sequences confirm this need. Before teacher curation, most proposals were at standardized or partially homogeneous levels; after pedagogical review, 88.3% reached adapted, situated, inclusive, or sustainable levels. This finding aligns with studies on artificial intelligence literacy in teacher education, which argue that future teachers require specific competencies to critically analyze AI-generated products, identify biases, adjust language, and assess the relevance of resources according to classroom conditions (23,24). In this context, AI does not act as a substitute for teachers, but as a tool that expands their design possibilities when there is critical mediation.

Another relevant result was the improvement in the instructional adaptation of the lesson plans. The final sequences demonstrated a greater alignment between objectives, activities, resources, and student needs. This is important because one of the main challenges of educational technologies is to avoid reducing innovation to the use of attractive tools that are poorly connected to learning. The literature on artificial intelligence in teacher professional development emphasizes that technological integration must be accompanied by pedagogical training, reflection on practice, and evaluation criteria that allow for assessment of its real impact on learning (25).

Regarding immersive technologies, the results show that augmented reality and three-dimensional visual resources supported students' sustained attention during the first 25 minutes of interaction. This finding is consistent with research identifying positive effects of virtual and augmented reality in basic education, especially in the understanding of abstract content and student motivation (26). However, these benefits depend on didactic design, the clarity of activities, and teacher mediation. Immersive technology alone does not guarantee improved learning; its contribution emerges when it is integrated into a coherent sequence with clear educational purposes.

The 40% reduction in the use of printed materials also allows for discussion of the relationship between technological innovation and didactic sustainability. This result suggests that digital resources can help reduce the consumption of physical materials, especially in activities that previously depended on photocopies, posters, or repetitive documents. However, sustainability should not be understood solely as paper reduction, but as the responsible, viable, and contextualized use of technology.

The findings also highlight that algorithmic ethics must occupy a central place in initial teacher education. The fact that the initial proposals exhibited biases or low contextualization confirms that AI systems do not always respond to the sociocultural realities of students. Research on algorithmic bias has indicated that these systems can reproduce inequalities or use general patterns as references that do not adequately represent all educational groups (27). Therefore, teachers must be prepared to critically review automated responses, identify possible omissions, and adapt content to the characteristics of their school community.

Taken together, the results support the view that generative artificial intelligence and immersive technologies can strengthen initial teacher education when used from an ethical, critical, and contextualized perspective. The main contribution of the study does not lie in demonstrating that technology replaces teaching work, but in showing that it can enhance it when combined with algorithmic literacy, pedagogical curation, and sustainability criteria.

CONCLUSIONS

The study demonstrated that the integration of generative artificial intelligence and immersive technologies in initial teacher education can contribute to improving didactic planning when their use is accompanied by pedagogical curation, critical review, and adaptation to the school context. The reduction in weekly time devoted to the development of didactic sequences shows that these tools can support operational teaching tasks, such as content organization, activity structuring, and initial material production. However, the results also confirm that technological efficiency should not be equated with the substitution of professional judgment.

The improvement observed in the levels of instructional adaptation of the didactic sequences demonstrates that teacher intervention was a decisive component of the process. The proposals initially generated by artificial intelligence exhibited characteristics of homogenization and low contextualization, while the final versions, after pedagogical review, achieved higher levels of relevance, inclusion, and sustainability.

The findings related to the reduction in the use of printed materials and the sustained attention of students during activities with immersive resources suggest that these technologies can contribute to more dynamic and sustainable teaching. However, their incorporation must take into account the actual conditions of public schools, especially the availability of devices, connectivity, infrastructure, and technical training.

In terms of teacher preparation, the study underscores the need to enhance literacy in artificial intelligence, algorithmic ethics, and critical digital competence within initial teacher education programs. Prospective teachers require both conceptual and practical tools to identify biases, evaluate the quality of content generated by automated systems, and make responsible decisions regarding the use of emerging technologies.

The results should be interpreted with caution due to the small sample size of teachers and the context-specific nature of the experience. Although 30 didactic sequences and 185 primary school students were involved, the participation of only six pre-service teachers limits the generalizability of the findings. Therefore, it is recommended that future research be conducted with larger samples, comparison groups, and longitudinal follow-ups to assess the persistence of the observed effects. Despite these limitations, the study provides valuable evidence for understanding how artificial intelligence and immersive technologies can enhance teacher education when integrated from an ethical, inclusive, and contextualized perspective.

REFERENCES

1. Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. Social Sciences & Humanities Open, 8(1), 100532. https://doi.org/10.1016/j.ssaho.2023.100532
2. AlBlooshi, S. (2026). Artificial intelligence in higher education, opportunities, and challenges: A review. Frontiers in Education, 10, 1683968. https://doi.org/10.3389/feduc.2025.1683968
3. Almasri, F. (2024). Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review of empirical research. Research in Science Education, 54, 977–997. https://doi.org/10.1007/s11165-024-10176-3
4. Archambault, S. G., Ramachandran, S., Acosta, E., & Fu, S. (2024). Ethical dimensions of algorithmic literacy for college students: Case studies and cross-disciplinary connections. The Journal of Academic Librarianship, 50(3), 102865. https://doi.org/10.1016/j.acalib.2024.102865
5. Burbules, N. C., Fan, G., & Repp, P. (2020). Five trends of education and technology in a sustainable future. Geography and Sustainability, 1(2), 93–97. https://doi.org/10.1016/j.geosus.2020.05.001
6. Candido, V., & Cattaneo, A. (2025). Applying cognitive theory of multimedia learning principles to augmented reality and its effects on cognitive load and learning outcomes. Computers in Human Behavior Reports, 18, 100678. https://doi.org/10.1016/j.chbr.2025.100678
7. Ding, A.-C. E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. Computers and Education Open, 6, 100178. https://doi.org/10.1016/j.caeo.2024.100178
8. Galindo-Domínguez, H., Delgado, N., Campo, L., & Losada, D. (2024). Relationship between teachers' digital competence and attitudes towards artificial intelligence in education. International Journal of Educational Research, 126, 102381. https://doi.org/10.1016/j.ijer.2024.102381
9. Hanna, M. G., Pantanowitz, L., Jackson, B., Palmer, O., Visweswaran, S., Pantanowitz, J., Deebajah, M., & Rashidi, H. H. (2025). Ethical and bias considerations in artificial intelligence/machine learning. Modern Pathology, 38(3), 100686. https://doi.org/10.1016/j.modpat.2024.100686
10. Idowu, J. A., Koshiyama, A. S., & Treleaven, P. (2024). Investigating algorithmic bias in student progress monitoring. Computers and Education: Artificial Intelligence, 7, 100267. https://doi.org/10.1016/j.caeai.2024.100267
11. Jin, Y., Yan, L., Echeverria, V., Gašević, D., & Martinez-Maldonado, R. (2025). Generative AI in higher education: A global perspective of institutional adoption policies and guidelines. Computers and Education: Artificial Intelligence, 8, 100348. https://doi.org/10.1016/j.caeai.2024.100348
12. Kazlaris, G. C., Keramopoulos, E., Bratsas, C., & Kokkonis, G. (2025). Augmented reality in education through collaborative learning: A systematic literature review. Multimodal Technologies and Interaction, 9(9), 94. https://doi.org/10.3390/mti9090094
13. Lameras, P., & Arnab, S. (2022). Power to the teachers: An exploratory review on artificial intelligence in education. Information, 13(1), 14. https://doi.org/10.3390/info13010014
14. 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
15. Martínez-Comesaña, M., Rigueira-Díaz, X., Larrañaga-Janeiro, A., Martínez-Torres, J., Ocarranza-Prado, I., & Kreibel, D. (2023). Impacto de la inteligencia artificial en los métodos de evaluación en la educación primaria y secundaria: Revisión sistemática de la literatura. Revista de Psicodidáctica, 28(2), 93–103. https://doi.org/10.1016/j.psicod.2023.06.001
16. Memarian, B., & Doleck, T. (2023). ChatGPT en la educación: Métodos, potencialidades y limitaciones. Computadoras en el Comportamiento Humano: Humanos Artificiales, 1(2), 100022. https://doi.org/10.1016/j.chbah.2023.100022
17. Merino, C., Pino, S., Meyer, E., Garrido, J. M., & Gallardo, F. (2015). Realidad aumentada para el diseño de secuencias de enseñanza-aprendizaje en química. Educación Química, 26(2), 94–99. https://doi.org/10.1016/j.eq.2015.04.004
18. Palacios-Núñez, M. L., Mendoza-García, E. M., Narciso Zarate, J. W., & Deroncele-Acosta, A. (2025). ChatGPT en la enseñanza de la escritura académica en educación superior: Perspectivas docentes sobre sus usos, desafíos y futuro en el aprendizaje personalizado. Edutec, Revista Electrónica de Tecnología Educativa, 93, 33–50. https://doi.org/10.21556/edutec.2025.93.3995
19. Perezchica-Vega, J. E., Sepúlveda-Rodríguez, J. A., & Román-Méndez, A. D. (2024). Inteligencia artificial generativa en la educación superior: Usos y opiniones de los profesores. European Public & Social Innovation Review, 9, 1–20. https://doi.org/10.31637/epsir-2024-593
20. Robayo Avendaño, O. (2026). Integración de analíticas de aprendizaje e inteligencia artificial en una aplicación web para la enseñanza de neurociencias: Evaluación de su impacto. Educación Médica, 27(2), 101148. https://doi.org/10.1016/j.edumed.2025.101148
21. Sperling, K., Stenberg, C.-J., McGrath, C., Åkerfeldt, A., Heintz, F., & Stenliden, L. (2024). In search of artificial intelligence (AI) literacy in teacher education: A scoping review. Computers and Education Open, 6, 100169. https://doi.org/10.1016/j.caeo.2024.100169
22. Sumba Arévalo, V. M., & Segarra Figueroa, O. P. (2026). Competencias digitales e inteligencia artificial en docentes que cursan un posgrado en educación – Ecuador. European Public & Social Innovation Review, 11, 1–19. https://doi.org/10.31637/epsir-2026-2439

23. Tan, X., Cheng, G., & Ling, M. H. (2025). Artificial intelligence in teaching and teacher professional development: A systematic review. Computers and Education: Artificial Intelligence, 8, 100355. https://doi.org/10.1016/j.caeai.2024.100355
24. Villena-Taranilla, R., Tirado-Olivares, S., Cózar-Gutiérrez, R., & González-Calero, J. A. (2022). Effects of virtual reality on learning outcomes in K-6 education: A meta-analysis. Educational Research Review, 35, 100434. https://doi.org/10.1016/j.edurev.2022.100434
25. Zúñiga Zárate, A. G. (2025). Uso de ChatGPT por parte del estudiantado universitario y reflexión mediante blogs: Una experiencia compartida con docentes. European Public & Social Innovation Review, 11, 1–12. https://doi.org/10.31637/epsir-2026-2128
26. González Oneto, H., Moreno Yáñez, Y., & D'Andrea Pincheira, M. (2024). Realidad virtual inmersiva como complemento en la educación odontológica: Un proceso de implementación para la docencia. Educación Médica, 25(5), 100931. https://doi.org/10.1016/j.edumed.2024.100931
27. Cabero Almenara, J., Barroso Osuna, J., & Obrador, M. (2017). Realidad aumentada aplicada a la enseñanza de la medicina. Educación Médica, 18(3), 203–208. https://doi.org/10.1016/j.edumed.2016.06.015

FUNDING

None.

CONFLICT OF INTEREST

None exist.

AUTHORSHIP CONTRIBUTIONS

Conceptualization: César-Antonio Acosta Fernández.
Writing – Original draft: César-Antonio Acosta Fernández.
Writing – Review and editing: César-Antonio Acosta Fernández.