Generative Artificial Intelligence in Clinical Practice: Undergraduate Experience

Carmen M. Alegría-Bernal[1], Jhan C. Fernández-Delgado[2], Fernando S. Andía-Alegría[1]

[1]Universidad Católica Santa María, Arequipa, Perú
[2]Universidad Nacional de Cajamarca, Jaen, Perú
Email: calegria@ucsm.edu.pe

Abstract

The objective of this article is to assess the impact of generative artificial intelligence (AGI) as a learning tool in clinical practice, as perceived by clinical students of human medicine. To this end, six learning activities were devised and executed, employing diverse pedagogical approaches and AGI tools, with the objective of addressing various facets of clinical practice. These included the creation of explanatory material, literature analysis, the selection of clinical cases for publication, the development of self-assessment questions, the production of explanatory videos, and the creation of scientific posters. These activities were conducted during the clinical internships of the fifth year of the medical curriculum and were evaluated using both quantitative and qualitative methods. The findings indicated that the incorporation of GAI as a pedagogical instrument in the clinical training of medical students yielded a favorable influence on their motivation, self-assurance, satisfaction, competencies, and knowledge. The students identified GAI as a novel, applicable, useful, and transferable tool and expressed interest in continuing to use it in the future. However, the results also indicated that students encountered certain challenges and difficulties in utilizing GAI as a learning tool, including overconfidence, resistance, and a lack of understanding. In conclusion, this study provides empirical evidence on the use of GAI as a learning tool for undergraduate medical students' clinical practices, and contributes to the knowledge base regarding the possibilities and challenges of GAI application in higher education.

Keywords: Generative artificial intelligence, learning, clinical practice, medical students, higher education.

1. Introduction

Generative artificial intelligence (AGI) represents a subset of artificial intelligence (AI) that is capable of generating original content from data or instructions. This is achieved through the use of advanced algorithms and neural networks. AGI has a multitude of applications, including but not limited to the creation of art, music, design, and writing. In the field of medicine, HAI is employed in a generic capacity to search for medical data and to discover new knowledge that is beneficial in terms of improving health outcomes and the patient experience (Lomis et al.,

2021). The IAG offers a series of applications that are expanding on a daily basis, competing with one another in terms of utility and accessibility. They are classified according to the model utilized (Table 1).

Table 1. Types of IAG

Tool Type	Description	Examples	Use
Generative adversarial networks (GANs)	They are a type of GAI that consists of two neural networks: the generator and the discriminator. The generator creates new data samples, and the discriminator evaluates whether these samples are real or generated.	Stable Diffusion, Mid Journey, DALL-E	Generate medical images, such as X-rays, CT scans, or MRIs
Generative Language Models	They are used to generate text in the form of conversations, stories, poems, etc. Fed large amounts of text, these models learn linguistic patterns and structures to generate coherent and relevant text.	Chaat Gupta, Bin Gupta, Bard, Lambda, Lama, Bloom, Gupt-4	Generate medical texts, such as summaries of medical records, diagnostic reports, scientific articles, or educational content
Variational Models (VAE)	They are a type of IAG that uses a neural network to encode input data into a probability distribution and then generate new data from this distribution.	VAE-GAN, DRAW, PixelVAE	Generate synthetic data, such as electrocardiograms, EEGs, or voice signals

Note: Prepared from Boscardin et al. (2023)

In the context of education, a range of policies and strategies are being implemented with the objective of integrating AI in recognition of its potential. This is evidenced by the publication of Reimagining Our Future Together by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The document, entitled A New Social Contract for Education, represents the inaugural international consensus on the nexus between AI and education. With regard to the latter, a substantial body of research has been conducted to demonstrate the benefits of AI in education (Chen et al., 2020; Hwang et al., 2020). Other studies, such as the Horizon Report 2019, have suggested that AI has the potential to personalize student experiences, reduce the workload of both students and teachers, and facilitate the analysis of large and complex datasets. This suggests that there are significant opportunities for AI in education (Zhang et al., 2023).

The current advantages of AI in medical education (AIMED) include the ability to offer personalized learning experiences, interactivity, and the simulation of realistic scenarios or interactions with patients. Additionally, it has the potential to enhance communication skills, which are essential in healthcare. The potential drawbacks of AIMED include the quality of the information, specifically the validity and accuracy of the data trained by the tools; over-reliance on the tools by the learner; and limited AI competencies. The latter refers to AI literacy in healthcare and includes understanding of the tools, integration into learning, and ethical use of the tool (Boscardin et al., 2023; Malerbi et al., 2023).

In the context of medical education, the clinical or hospital internship represents a pivotal component of the training program for medical students in their final years of university studies. This period of practical training provides students with the opportunity to develop the competencies and skills that are essential for professional practice, including abilities such as diagnosis, treatment, communication, reasoning, and decision-making (Banerjee et al., 2021). However, it presents a number of challenges and difficulties for both students and educators that can affect the quality and effectiveness of learning. Among the challenges and difficulties are

the variability of clinical cases, the assessment of clinical competence, the influence of the hidden curriculum, and the lack of pedagogical preparation of educators (Salas-Pilco and Yang, 2022).

In light of these challenges, there is a pressing need to identify novel and efficacious solutions to enhance the clinical practice of undergraduate medical students, ensuring that these solutions are tailored to the specific characteristics and requirements of each context and situation, including learning, evaluation, and formative research. One potential solution is the integration of GAI as a learning tool, as it has the capacity to generate realistic, pertinent, and personalized content that aligns with the needs and preferences of the students, in addition to offering automated assessment and formative feedback (Table 2).

Table 2. IAG applications in clinical practice

PROGRAMMATIC PHASE	APPLICATIONS
TEACHING/LEARNING	– Intelligent Tutoring Systems (ITS) that personalize the learning experience. – Virtual Patients for practice of communication skills and clinical reasoning. – Gamification to improve motivation and engagement with learning material. – Chatbots as virtual teaching assistants. – Adaptive learning systems that adjust content and difficulty are based on student progress.
EVALUATION	– Optical Mark Recognition (OMR) for objective evaluation. – Automated essay scoring (AES) to evaluate written responses. – Quizzing and other gamification tools for self-assessment and in-class assessment. – Virtual Reality (VR) for the evaluation of procedural skills. – Simulation to provide a hands-on learning experience with immediate feedback.
FORMATIVE RESEARCH	– Analysis of large data sets to validate results and reduce bias. – Identification of cause-effect relationships in value chains to optimize spending patterns. – Development of AI models to avoid biased results and improve decision-making.

Note: Prepared from Cooper (2023).

In recent times, the manifold advantages of HAIs in clinical or hospital practice have come to be acknowledged. These include the broadening and diversifying of clinical cases, the improvement of feedback and self-assessment, the stimulation of motivation and interest, the encouragement of reflection and critical thinking, and the facilitation of knowledge transfer and application (Lee et al., 2021). However, it also presents certain challenges and limitations, including the verification and validation of generated content, the establishment of user trust and acceptance (Mousavi Baigi et al., 2023), the consideration of ethical implications (Zhony et al., 2023), the accountability of users for the use of IAG, and the necessity for educators to receive training and support (Charow et al., 2021).

In this regard, several studies have employed GAI to develop clinical cases, examination questions, and educational materials (McCoy et al., 2020; Pupic et al., 2023). However, no studies have yet evaluated the use of GAI in clinical or hospital settings. In this study, six learning activities were designed and implemented using a variety of teaching methodologies and GAI tools to address different aspects of clinical practice. These included the creation of explanatory material, literature analysis, the selection of clinical cases for publication, the development of self-assessment questions, the creation of explanatory videos, and the design of scientific posters.

The aforementioned activities were implemented as part of the Clinical Practice, which constitutes the fifth and sixth year of the Human Medicine course. They were carried out over the course of the 12-week program period. Each activity lasted one hour and was conducted in collaborative work groups under the guidance and support of the instructor. At the conclusion of the period, the activities were evaluated based on learning outcomes and user satisfaction indicators, employing both quantitative and qualitative methods (Table 3).

Table 3. IAG activities developed

Activities	Teaching methodology	IAG Tool	Expected Result
Creation of explanatory material in practice with clinical cases	Flipped classroom	Copilot BING	Interactive clinical cases
Analysis of literature on the subject of clinical practice	Role reversal	Humata AI	High-volume summaries of text.
Selection of clinical cases for publication	Formative Research	Rabbit, Consensus	Systematic literature search.
Creating self-assessment questions on the topic of clinical practice	Problem-Based Learning	QuizBox	Self-assessment questions.
Creation of explanatory videos on the topic of clinical practice	Flipped classroom	Lumen5	Explainer videos
Creation of scientific posters on the topic of clinical practice	Project-based learning	Canva	Pósters científicos

Therefore, the objective of this article is to evaluate the impact of the use of the IAG as a learning tool in clinical practice based on the perception of undergraduate medical students.

2. Method

Design

The present study employs a quantitative-qualitative approach, is descriptive in nature, and is conducted in a correlational and non-experimental or observational manner.

Sample

The study population consisted of 680 undergraduate medical students engaged in clinical internships between 2023 and 2024, hailing from a private university in Peru. In order to be included in the study, participants were required to have successfully completed the preceding subjects in their curriculum, have attended a minimum of 80% of the sessions for the subject in question, and have consented to participate on a voluntary basis. The exclusion criteria were as follows: presence of a disability or condition that precludes use of the AGI, history of ethical or disciplinary infractions during the course, and request for withdrawal or change from the subject. The sample was randomly selected and consisted of 240 students who met the inclusion and exclusion criteria and were distributed into 48 groups of five students each.

Instruments

Two evaluation methods were employed at the conclusion of the learning activities, with the objective of measuring the impact of the IAG on clinical training through the perceptions of the students to whom they were applied. The initial method employed a Likert scale comprising 10 statements, which assessed various aspects, including the advancement of competencies, the

diversity of clinical scenarios, formative feedback, motivation, usefulness, and satisfaction. Students were requested to indicate their level of agreement with each statement on a scale of 1 to 5, with 1 indicating a strong disagreement and 5 indicating a strong agreement. The instrument was validated by the creator (Banerjee et al., 2021), and in this study, an adaptation was made in terms of the language and content of the items. The latter were validated through the opinion of six experts. To analyze the quantitative data obtained from the Likert scale, reliability criteria were employed, including the calculation of Cronbach's alpha coefficient, which yielded a value of 0.89, indicating a satisfactory level of internal consistency among the items. Furthermore, the responses were classified into one of five categories: negative, indifferent, neutral, optimistic, and positive. Ultimately, a factor analysis was conducted using the Oblimin rotation method, which yielded four dimensions. The four factors were motivation, competence, understanding, and confidence.

The second method was an interview with the delegates of each group, conducted via video call and recorded and transcribed with the consent of the participants. The interviews, which were conducted based on a script of open-ended questions, lasted approximately 20 minutes and explored the perceptions, opinions, and suggestions of the students regarding their learning experience with the IAG. The results of the interviews were subjected to content analysis and classified into four semantic categories. Themes emerging from the analysis included assessment, recognition, reflection, and difficulties (Table 5).

Procedure

The quantitative and qualitative data were processed with the appropriate software, namely SPSS and NVivo, respectively. For the quantitative data, the data were entered into a spreadsheet, cleaned, and verified by frequency calculations. For the qualitative data, the interviews were recorded and transcribed, organized in NVivo, and classified into categories and codes.

Data Analysis

A statistical analysis was conducted using descriptive and inferential statistical techniques, as well as content analysis techniques for quantitative and qualitative data, respectively. In the case of the Likert scale, responses were categorized using medians, a homogeneity test was applied, and proportions were compared. For the qualitative data, the categories were correlated and related to the dimensions of the quantitative method, applying a contrast test.

Table 5. Categories of the qualitative method

CATEGORIES	CODES	ANSWERS
Recognition	The IAG is novel	"The IAG is a novel tool that I did not know about and that has surprised me for what it can do"
	Applicable to clinical practice	"The IAG is a tool applicable to clinical practice, which allows me to generate content that fits my needs and preferences"
	Useful for learning and performance	"The IAG is a useful tool that helps me learn and improve my performance in clinical practice"
	Transferable to other contexts	"The IAG is a transferable tool that I can use in other contexts or situations, both academic and professional"
Assessment	Rewarding Experience	"I really liked the experience of using AGI, because it allowed me to see clinical cases that I would not have been able to see otherwise"
	Immediate and personalized feedback	"I found the experience of using the IAG very interesting, because it has given me immediate and personalized feedback on my performance"

	Motivation for creativity and criticism	"I have been very motivated by the experience of using AGI, because it has challenged me to be more creative and critical in clinical practice"
	Facilitating collaborative work	"I have been very satisfied with the experience of using the IAG, because it has made it easier for me to work collaboratively with my classmates and my teacher"
Reflection	Reflection on one's own practice	"I have learned a lot with AGI, because it has made me reflect on my own practice and improve it"
	Understanding concepts and relationships	"I have understood better with AGI, because it has made me think about the concepts and relationships behind clinical practice"
	Knowledge of strengths and weaknesses	"I have learned more about the IAG, because it has made me aware of my strengths and weaknesses in clinical practice"
	Autonomy in decision-making	"I have been more autonomous with the AGI, because it has made me make decisions and solve problems in clinical practice"
Difficulties	Trust in the content generated	"I have had difficulties with the IAG, because I do not trust the content it generates and I compare it with that of other sources"
	Teachers' resistance	"I have had difficulties with the IAG, because I have encountered resistance from some of my teachers, who do not value or support it"
	Lack of information and support	"I've struggled with AGI, because I haven't received enough information, guidance or support to use it"
	Technical or connection issues	"I have had difficulties with the IAG, because I have not been able to access it due to technical or connection problems"

3. Results

The quantitative results, analyzed in terms of medians, indicate that the perception of GAI among medical students is predominantly positive and optimistic, with 46% and 28% of respondents, respectively, expressing such views. A small percentage of respondents (8%) held negative perceptions (Table 6).

Table 6. Perception of the Use of SAI in Clinical Practice by Median

Categories	Frequency	Proportion	P value
Negative Perception	8	0.075	2.79e-33
Indifferent perception	5	0.050	1.54e-38
Neutral Perception	14	0.142	2.79e-22
Optimistic Perception	28	0.275	7.10e-09
Positive Perception	46	0.458	3.05e-01

Nota: Chisq = 136.667, df = 4, p-value = 0.000

In relation to each item on the Likert scale, the results demonstrate that the majority of respondents expressed agreement or total agreement with the statements that valued the benefits of AGI. These included the variety of clinical cases (66.6%), immediate and personalized feedback (46%), and the ability to customize learning (46%). Additionally, respondents indicated high levels of motivation and interest in learning (58.3%), usefulness in applying and transferring knowledge (41.6%), satisfaction with learning (58.3%), reflection and improvement of one's own practice (41.6%), stimulation of creativity and critical thinking (66.6%), and facilitation of collaborative work (50%). Similarly, only a small proportion of respondents indicated disagreement or total disagreement with the statement assessing trust in the content generated by the IAG and its comparability with other sources (10%). This could suggest a high level of confidence and a need for verification of the quality and veracity of the information provided by the IAG (Figure 1).

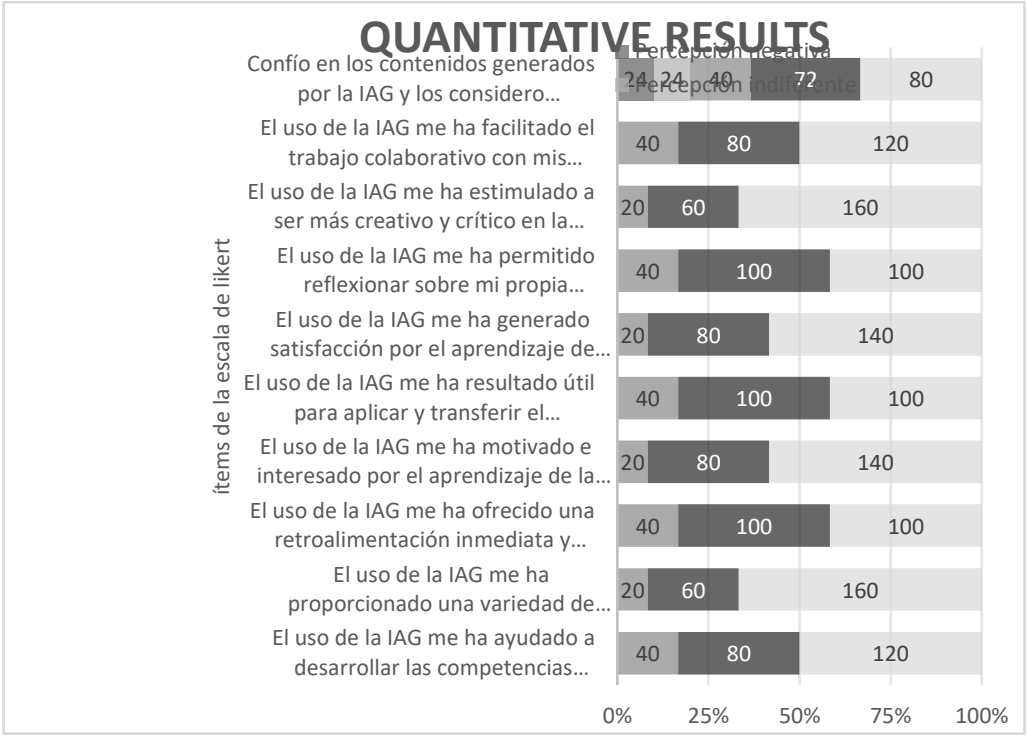

Figure 1. Likert Scale Frequency Graph

A factor analysis of Banergee's adapted Likert scale yielded four dimensions. The four dimensions are motivation, competencies, understanding, and confidence. A notable correlation was identified between the latter and the semantic categories derived from the qualitative approach, namely Assessment, Recognition, Reflection, and Difficulties. The results demonstrate a robust correlation between motivation and competencies with appreciation and recognition, whereas understanding and confidence are exclusively associated with difficulties. The Cramer's V measure of association is 0.619, indicating a moderate to strong relationship between the variables. The Chi-square test (Chi-sq = 276,000, df = 9, $p < 0.001$) corroborates that these associations are statistically significant, indicating that perceptions of value and recognition are linked to motivation and competencies. Furthermore, it suggests that lack of understanding and confidence primarily emerge in the context of difficulty in the application of the HAI (Table 7).

Table 7. Correlation between semantic categories and dimensions of the Likert scale

DIMENSIONS	C A T E G O R I E S				Total
	Assessment	Recognition	Reflection	Difficulties	
Motivation	48	24	0	0	72
Competence	72	24	48	0	144
Comprehension	0	0	0	12	12
Confidence	0	0	0	12	12

Total	120	48	48	24	240

Note: Cramer's V value = 0.619, Chi-square Test results: Chisq = 276.000, df = 9, p-value < 0.001.

The qualitative analysis of the perception of the use of AI in clinical practice reveals a positive overall assessment in all the dimensions evaluated (confidence, understanding, competence, and motivation). In particular, competence and trust are rated highly, with 75% and 55% of respondents, respectively, indicating a favorable perception of AI. The practice of critical reflection is more prevalent in the domains of comprehension (30%) and motivation (40%), indicating a consistent evaluation of these aspects. With regard to formal recognition, it is particularly evident in the area of comprehension (40%), indicating that participants are cognizant of their comprehension levels and are actively engaged in assessing them. Finally, with regard to the issue of difficulties, these are minimal in all dimensions, with only 5% in Confidence and Understanding, and none in Competence and Motivation. This indicates that clinical professionals encounter few significant obstacles in the use of AI, a finding that is consistent with the results of the quantitative method (Figure 2).

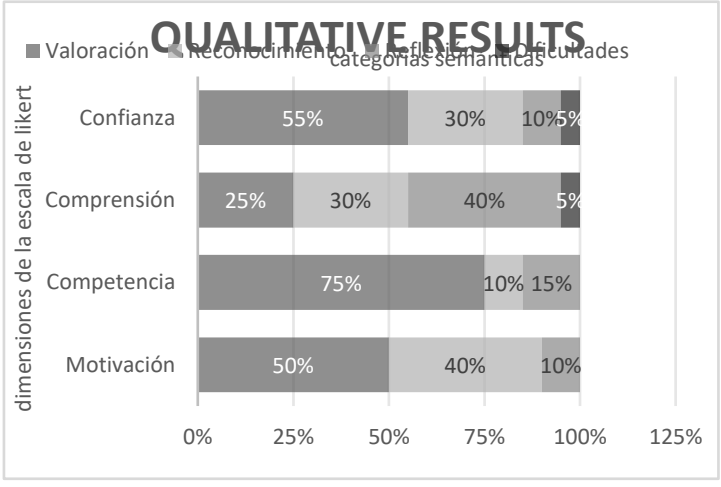

Figure 2. Qualitative results graph

4. Discussion

The objective of this study was to assess the influence of artificial intelligence (AI) as a learning instrument in clinical settings, as perceived by medical students. The results of the quantitative and qualitative analysis indicate a predominantly positive and optimistic perception of the use of AI in clinical practice among medical students. This positive perception is clearly reflected in the quantitative results, wherein 46% of respondents expressed a positive perception and 28% an optimistic perception of AI (Table 6). These findings are consistent with the existing literature, which highlights the potential of AI to improve medical education and clinical practice

through the personalization of learning and the optimization of study time (Banerjee et al., 2021). Indeed, the majority of respondents indicated agreement or full agreement with statements that value the benefits of AI, including the variety of clinical cases (66.6%), immediate and personalized feedback (46.7%), and motivation and interest in learning (58.3%). These findings highlight the perceived utility of AI in facilitating the application and transfer of knowledge (41.6%) and in enhancing learning satisfaction (58.3%). Furthermore, the respondents identified reflection and improvement of one's own practice (41.6%), stimulation of creativity and critical thinking (66.6%), and facilitation of collaborative work (50%) as significant benefits. These findings indicate that AI has the potential to facilitate the development of more reflective and collaborative physicians, who are essential in modern clinical practice (Banerjee et al., 2021; Boscardín et al., 2023; Calderón et al., 2018; Chen et al., 2020).

These results align with those reported in other studies that have explored the perception and impact of AI on medical education, particularly in research and auditing (Banerjee et al., 2021). However, there is skepticism about AI's ability to provide quality and veracious information, as well as the necessity for faculty and clinical experts to oversee and validate the data generated by AGI (Calderón et al., 2018; Chen et al.; Kimmerle et al., 2023; Mousavi Baigi et al., 2023).

Conversely, the results align with research indicating inadequate training in AI within current curricula. This situation requires an urgent formalization of the matter in order to reduce the existing gap, not only for students but also for the academic body. The integration of AI as an educational resource during initial teacher training is of paramount importance, as it has the potential to facilitate the personalization of learning and prepare young people for an ever-changing labor market (Ayuso-del Puerto & Gutiérrez, 2022).

With regard to the challenges and opportunities of IAG, the majority of authors concur that AI enhances self-directed learning, provides invaluable simulation opportunities, and, in the case of AIG, offers unparalleled assistance in the generation of content. However, some areas for improvement for GAI were also identified, especially with regard to trust in the content generated by GAI and its comparability with other sources, as well as considerations on academic integrity (Boscardin et al., 2023; Charow et al., 2021).

Another issue presented for analysis by other authors is the balance of domains between optimism around the improvement of skills and the quality of research, as opposed to possible reductions in educational opportunities to develop critical judgment and practical skills. As artificial intelligence (AI) technologies continue to evolve, a number of strategies have been proposed to safeguard these essential domains (Chen et al., n.d.; Hwang et al., 2020; Lee et al., 2021; Pupic et al., 2023; Zhang et al., 2023).

In conclusion, the application of AI in medical education is facilitating student access to vast quantities of data, personalised feedback and the simulation of clinical scenarios in a secure setting. In order to achieve this, it is necessary to accept and adapt teaching and learning methods in order to make the most of AI's capabilities. Furthermore, there is a need for standardisation in research in this area, in order to facilitate the amplification of empirical evidence regarding the advantages and risks of AI, and thus accelerate its implementation in current medical practice (Gonzales-Gonzales, 2023; Keemerle et al., 2023; Lee et al., 2021; Lomis et al., 2023).

5. Conclusion

The present study has addressed the relevance of generative artificial intelligence (AGI) as a learning tool in clinical practice, with a particular focus on the perception of medical students. The results, both quantitative and qualitative, have demonstrated a positive impact on student motivation, confidence, satisfaction, competencies, and knowledge acquisition. The IAG has been regarded as a novel, applicable, and useful educational tool with the potential to be a lasting contribution to future medical practices.

For effective implementation, it is essential to formalize AI in curricula and adapt teaching and learning methods, as well as standardize research to facilitate a more nuanced understanding of its advantages and risks. This will facilitate the incorporation of AI into medical practice, equipping future professionals with the skills to navigate an evolving work environment and contribute to more efficient and personalized healthcare.

WORKS CITED

Ayuso del Puerto, D., & Gutiérrez Esteban, P. (2022). La Inteligencia Artificial como recurso educativo durante la formación inicial del profesorado. RIED-Revista Iberoamericana de Educación a Distancia, 25(2), 347–362. https://doi.org/10.5944/ried.25.2.32332

Banerjee, M., Chiew, D., Patel, K. T., Johns, I., Chappell, D., Linton, N., Cole, G. D., Francis, D. P., Szram, J., Ross, J., & Zaman, S. (2021). The impact of artificial intelligence on clinical education: perceptions of postgraduate trainee doctors in London (UK) and recommendations for trainers. BMC Medical Education, 21(1). https://doi.org/10.1186/S12909-021-02870-X

Boscardin, C. K., Gin, B., Golde, P. B., & Hauer, K. E. (2023). ChatGPT and Generative Artificial Intelligence for Medical Education: Potential Impact and Opportunity. Academic Medicine. https://doi.org/10.1097/ACM.0000000000005439

Calderón, M., Zúñiga, D., Leiva, I., Padilla, O., Bitrán, M., Calderón, M., Zúñiga, D., Leiva, I., Padilla, O., & Bitrán, M. (2018). Clinical learning strategies among medical students. Revista Médica de Chile, 146(7), 854–861. https://doi.org/10.4067/S0034-98872018000700854

Chan, K. S., & Zary, N. (2019). Applications and Challenges of Implementing Artificial Intelligence in Medical Education: Integrative Review. JMIR Medical Education, 5(1), e13930. https://doi.org/10.2196/13930

Charow, R., Jeyakumar, T., Younus, S., Dolatabadi, E., Salhia, M., Al-Mouaswas, D., Anderson, M., Balakumar, S., Clare, M., Dhalla, A., Gillan, C., Haghzare, S., Jackson, E., Lalani, N., Mattson, J., Peteanu, W., Tripp, T., Waldorf, J., Williams, S., … Wiljer, D. (2021). Artificial Intelligence Education Programs for Health Care Professionals: Scoping Review. JMIR Medical Education, 7(4), e31043. https://doi.org/10.2196/31043

Chen, L., Chen, P., & Lin, Z. (n.d.). Artificial Intelligence in Education: A Review. https://doi.org/10.1109/ACCESS.2020.2988510

Gonzales-Gonzales, C.S. (2023). El impacto de la inteligencia artificial en la educación: Transformación de la forma de enseñar y de aprender. Revista Qurriculum; 36(1),1-20. https://doi.org/10.25145/j.qurricul.2023.36.03

Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. In Computers and Education: Artificial Intelligence (Vol. 1). https://doi.org/10.1016/j.caeai.2020.100001

Kimmerle, J., Timm, J., Festl-Wietek, T., Cress, U., & Herrmann-Werner, A. (2023). Medical Students' Attitudes Toward AI in Medicine and their Expectations for Medical Education. Journal of Medical Education and Curricular Development, 10. https://doi.org/10.1177/23821205231219346

Lee, J., Wu, A. S., Li, D., & Kulasegaram, K. (mahan). (2021). Artificial Intelligence in Undergraduate Medical Education: A Scoping Review. Academic Medicine (Vol. 96, Issue 11, pp. S62–S70). Wolters Kluwer Health. https://doi.org/10.1097/ACM.0000000000004291

Lomis, K., Jeffries, P., Palatta, A., Sage, M., Sheikh, J., Sheperis, C., & Whelan, A. (2021). Artificial Intelligence for Health Professions Educators. NAM Perspectives. https://doi.org/10.31478/202109a

Malerbi, F. K., Nakayama, L. F., Dychiao, R. G., Ribeiro, L. Z., Villanueva, C., Celi, L. A., & Regatieri, C. V. (2023). Digital Education for the Deployment of Artificial Intelligence in Health Care. Journal of Medical Internet Research (Vol. 25). JMIR Publications Inc. https://doi.org/10.2196/43333

McCoy, L. G., Nagaraj, S., Morgado, F., Harish, V., Das, S., & Celi, L. A. (2020). What do medical students actually need to know about artificial intelligence. Npj Digital Medicine (Vol. 3, Issue 1). https://doi.org/10.1038/s41746-020-0294-7

Mousavi Baigi, S. F., Sarbaz, M., Ghaddaripouri, K., Ghaddaripouri, M., Mousavi, A. S., & Kimiafar, K. (2023). Attitudes, knowledge, and skills towards artificial intelligence among healthcare students: A systematic review. Health Science Reports, 6(3), e1138. https://doi.org/10.1002/hsr2.1138

Ötleş, E., James, C. A., Lomis, K. D., & Woolliscroft, J. O. (2022). Teaching artificial intelligence as a fundamental toolset of medicine. Cell Reports Medicine, 3(12). https://doi.org/10.1016/j.xcrm.2022.100824

Paranjape, K., Schinkel, M., Panday, R. N., Car, J., & Nanayakkara, P. (2019). Introducing Artificial Intelligence Training in Medical Education. JMIR Medical Education, 5(2). https://doi.org/10.2196/16048

Pucchio, A., Rathagirishnan, R., Caton, N., Gariscsak, P. J., Del Papa, J., Nabhen, J. J., Vo, V., Lee, W., & Moraes, F. Y. (2022). Exploration of exposure to artificial intelligence in undergraduate medical education: a Canadian cross-sectional mixed-methods study. BMC Medical Education, 22(1). https://doi.org/10.1186/s12909-022-03896-5

Pupic, N., Ghaffari-zadeh, A., Hu, R., Singla, R., Darras, K., Karwowska, A., & Forster, B. B. (2023). An evidence-based approach to artificial intelligence education for medical students: A systematic review. PLOS Digital Health, 2(11), e0000255. https://doi.org/10.1371/journal.pdig.0000255

Salas-Pilco, S. Z., & Yang, Y. (2022). Artificial intelligence applications in Latin American higher education: a systematic review. International Journal of Educational Technology in Higher Education, 19(1), 1–20. https://doi.org/10.1186/S41239-022-00326-W/TABLES/6

Thammasitboon, S., & Brand, P. L. P. (2022). The physiology of learning: strategies clinical teachers can adopt to facilitate learning. European Journal of Pediatrics, 181, 429–433. https://doi.org/10.1007/s00431-021-04054-7/Published

Zhang W, Cai M, Lee HJ, Evans R, Zhu C, M. C. (2023). AI in Medical Education: Global situation, effects and challenges. Education and Information Technologies, 10, 1–23. https://doi.org/10.1007/s10639-023-12009-8

Zohny, H., McMillan, J., & King, M. (2023). Ethics of generative AI. Journal of Medical Ethics (Vol. 49, Issue 2, pp. 79–80). Institute of Medical Ethics. https://doi.org/10.1136/jme-2023-108909