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RECEIVED 17 May 2024
ACCEPTED 22 May 2024
PUBLISHED 31 May 2024

CITATION

Okoye K, Nganji JT, Hiran KK and Hosseini S (2024) Editorial: Impact and implications of AI methods and tools for the future of education. *Front. Educ.* 9:1434052. doi: 10.3389/educ.2024.1434052

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Editorial: Impact and implications of AI methods and tools for the future of education

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KEYWORDS

artificial intelligence, digitized-education, AI methods, intelligent systems, educational innovation, future of education, sustainable education, SDG4

Editorial on the Research Topic

Impact and implications of AI methods and tools for the future of education

Overview

The congruence of *technology* such as artificial intelligence (AI) and its use for *education* can help transform pedagogical practices and the future of education (Walsh, 2020; ICFE, 2021; UNESCO, 2023; Okoye et al., 2024a). Leading educational bodies like UNESCO (2021a,b, 2023) and the World Bank (2021) are advocating for research and development initiatives or endeavors focused on leveraging technology to reimagine education, and operationalize the use of AI tools and methods, commonly referred to as “digitized education.” This paradigm shift entails the formulation of methodological frameworks and guidelines to facilitate widespread adoption of AI methodologies in the educational settings (Nganji, 2018; UNESCO, 2019a,b; Arqawi et al., 2022; Okoye et al., 2024b). Also noteworthy is the fact that “digitized education” is now an inevitable and integral element to achieving the global sustainable development goals (SDGs) (UN, 2015; Pedró et al., 2019; UNESCO, 2019a; Okoye et al., 2021, 2022, 2024a; UIS, 2023) particularly the SDG4 that promotes quality of education (Global Goals, 2023).

This Research Topic is based on the premise that the different stakeholders, researchers, and AI practitioners, can commit to the creation, rethinking, and re-imagining of the AI methods and technologies that could result in effective adoption and implementation of TEL-based (technology-enhanced) education, science, and innovations. This collection of research aimed to collect state-of-the-art studies that looks into (i) why digitized-education may or may not be effectively implemented in different settings, particularly in education (ii) intelligent tools, models, and manifestos that support instructional AI design for scale or learning sustainability (iii) strategies, policies, and frameworks that supports AI-based interventions to facilitate the teacher-students learning processes and outcome (iv) digitally engaging the educational ecosystem, and (v) data-driven methods or analytical approaches for human learning development and life-long learning (UNESCO, 2019a; World Bank, 2021; UIS, 2023; Okoye et al., 2024a).

The topics in this collection encompass studies employing diverse methodologies, including case studies, exploration of emerging technologies like ChatGPT, and comprehensive reviews aimed at understanding the impact, benefits, barrier and bottleneck associated with digital technologies or AI tools in education. The articles collected for this Research Topic focus on providing the readers with wide knowledge of the “Use, impact and implications of AI methods and tools for the future of education” ranging from the ChatGPT and AI chatbots, predictive learning analytics, to transition from face-to-face to digital/online modalities of learning, distance learning pre- and -post COVID-19 pandemic, intelligent tutoring systems, virtual reality, augmented reality, flipped classrooms, and blended learning, challenges and opportunities with AI for digitized-education, e.g., students’ learning and engagement, ethics and policies, and digitized-education and its transformative implications for achieving the global sustainable development goals (SDGs), e.g., quality of education, inclusive education, and topic of sharing economy.

Spanning Original Research, Review and Opinion Articles, Methods, Hypothesis and Theory, and Curriculum, Instruction, and Pedagogy Articles; this Research Topic brings together leading scholars and researchers from diverse geographical regions and disciplinary backgrounds. By presenting the latest advancements and historical insights into the intersection of AI and Education, this Research Topic serves as a valuable resource for the global academic community and readership.

Articles in this Research Topic

The editors received a diverse range of submissions, including original research and review articles, focusing primarily on the “Use, impact and implications of AI methods and tools for the future of education.” In total, 23 manuscripts were submitted for consideration, each undergoing thorough evaluation by at least two to three independent experts in the field. Following a rigorous review process and assessment of relevance and scientific merit of the received manuscripts; 14 articles were chosen for inclusion in this Research Topic. These articles were authored by 52 esteemed experts from around the world, all renowned in their respective fields. Below is a concise overview of the accepted papers in this Research Topic:

In the paper by [Dempere et al.](#), the authors explored the effects of Artificial Intelligence (AI) chatbots, with a particular focus on OpenAI’s ChatGPT, on Higher Education Institutions (HEIs). The systematic review study revealed diverse perspectives on ChatGPT’s potential in education, and identified notable benefits to include research support, automated grading, and enhanced human-computer interaction. Conversely, risks such as privacy breaches, misuse, bias, misinformation, decreased human interaction, and accessibility issues were also identified in the review study.

In the paper by [Schön et al.](#), the authors discussed the impact of AI assistants in the context of higher education, outlined possible changes to the context, and present recommendations for adapting to change. The study reviewed related works in the topic and developed a conceptual structure that visualizes the role of AI assistants in higher education. They argued that AI assistants will change the context of higher education in a disruptive manner,

and note that the tipping point for this transformation has already been reached.

In the paper by [Dasari et al.](#), the authors adopted the didactical tetrahedron model, which addresses the issue of integrating technology into the didactical triangle, by examining the role of ChatGPT within educational settings. They found that students who rely solely on ChatGPT for learning resulted in lower performance in comparison to those receiving instruction from teachers, either alone or supported by ChatGPT. The study notes that the integration of ChatGPT into educational frameworks remains questionable within a didactic context, particularly due to its limitations in fostering deep information comprehension, stimulating critical thinking, and providing human-like guidance. It advocates for a balanced approach, suggesting that ChatGPT can augment the learning process effectively when used in conjunction with guidance.

In the paper by [Yee et al.](#) the authors propose an AI-assisted labeling process that uses advanced natural language processing techniques to train machine learning models capable of labeling a large dataset while minimizing human annotation effort. They fine-tune pretrained transformer-based deep learning models on category, structure, and emotion classification tasks. The study found significant differences in how learners of different age groups, gender, and course ask for help, provide help, and make posts with emotional (positive or negative) sentiment.

In the paper by [Lo and Hew](#), the authors investigate the emerging concept of integrating AI-based chatbots into flipped learning (chatbot-supported flipped learning) and its potential to enhance students’ learning experience. The findings of the review study suggest that this emerging instructional approach could result in benefits such as increased student interaction with learning content, improved class preparation, and data-driven teaching and learning. The review offers insights into future research and development in the topic area, and highlights the potential challenges in the topic to include limited technical functionality, lack of authenticity, and insufficient student motivation.

In the paper by [Gonzalez-Nucamendi et al.](#), the authors conducted quantitative research using machine learning tools to detect undergraduate students at risk of dropping out, and the factors associated with this phenomenon. In their approach, Clustering algorithms and Classification methods were tested to determine the predictive power of the different analyzed variables regarding the dropout/retention rate using data ($n = 14,495$) about the undergraduate students. The study found that the main variables associated with student dropouts were their academic performance during the early weeks of the first semester, their average grade in the previous academic levels, the previous mathematics score, and the entrance exam score.

In the paper by [Mondragon-Estrada et al.](#), the authors investigated professors’ perception of the key competences, and the best educational strategies and technological tools to guide digital transformation (DT) in education, according to their experience in emergency remote teaching (ERT). The outcome of the study showed social intelligence as an underlying competence for teaching performance, and that implementing information and communication technologies resulted in maintaining students’ interest and building trust in the online environment. It suggests

learning-by-doing, flipped learning, problem-based learning, game-based learning, and holistic education as some pedagogical methodologies that were successfully applied in ERT and could be implemented for DT.

In the paper by [Michalon and Camacho-Zuñiga](#), the authors investigated how ChatGPT was integrated in an undergraduate course for an International Relations program in a private Mexican university. The students were evaluated on their ability to explain to ChatGPT several discipline-specific methods and to make the AI implement these methods step by step. The outcome of the study which prove useful toward curriculum and educational policy development, shows that the students not only learned how to use the new AI tool and deepen their understanding of prospective methods, but also strengthened three soft or transversal competencies: communication, critical thinking, and logical and methodical reasoning.

In the paper by [Miralrio et al.](#), the authors uncovered the historical development of distance education (DE) in Latin America (LATAM) by drawing connections with five generations or milestones of the evolution of ICT in the region: Correspondence, Audiovisual, ICTs-based, Web-based, and Interactive. The review study of well-known International databases from end of nineteenth century to the COVID-19, confirms the critical role of Higher Education Institutions (HEIs) in LATAM in supporting ICT integration, and demonstrating a synergistic interplay with DE. The research highlights the value of DE as a cost-effective solution to traditional education, addressing social barriers and broadening educational access in LATAM, especially during emergencies.

In the paper by [Sánchez-López et al.](#), the authors conducted an immersive virtual reality (IVR) intervention in an analytical biotechnology course to evaluate its effectiveness in promoting student learning and academic engagement. The findings of their approach which included theoretical framework, IR spectra exercises, an individual quiz, and competition games; highlighted the effectiveness of IVR in enhancing learning outcomes, curiosity, motivation, and engagement among students. It also provides empirical evidence of IVR's positive impact on student learning and engagement in the context of biotechnology engineering.

In the paper by [Camacho-Zuñiga et al.](#), the authors examined the challenges associated with transitioning from face-to-face to online/digital lessons, according to perceptions of professors ($n = 105$) in a Mexican private university, few months after mandatory online/digital teaching was implemented. By analyzing data collected through a survey using statistical and data mining techniques, the authors identified factors that should be considered when designing future education in emergency situations. The study found that while most professors positively evaluated their performance in emergency remote teaching (ERT), they still preferred face-to-face teaching due to the lack of personal interaction and distractions. Best practices for online and face-to-face modalities to improve future education in emergencies were also discussed in the paper.

In the paper by [Sanabria-Z et al.](#), the authors apply a proof-of-concept study of an AI-based platform aimed to integrate a sequence of activities into the design of an online

platform to assess the development of complex thinking competency in higher education students. In their study, Transition Design method was used to explore the complex thinking meta-competency and its sub-competencies of critical, innovative, scientific, and systemic thinking in a sharing economy challenge for the students. The study found the two tested hypothesis: (a) the functioning of the constructed learning situation and (b) the model of the learning situation, to be true.

In the paper by [Cuevas-Cancino et al.](#), the authors adopted a research-based learning methodology to implement a horizontal (intra-class), vertical (inter-class), and interdisciplinary (multiple courses) student collaboration done by analyzing survey data on the perceived learning outcomes (87% confidence level) and letter for future classes through sharing their experience on The Monarch Route Project (MRP) on Sustainable Development Engineering (SDE) program. The study analysis which includes a mixed methodology (i.e., quantitative and qualitative, including text mining) evidenced that the participants strengthened both, transverse competences (collaboration, citizenship, communication, and critical thinking) and disciplinary competences (subject matter). It highlights the importance of integrating the UN's Sustainable Development Goals (SDGs) and the 2030 Agenda into the HEI's curricula.

In the paper by [Fuchs](#), the author theoretically discusses a range of challenges and opportunities with the generative AI tools such as Chat GPT for higher education, as well as the underlying implications that may expose gaps in the literature, stimulate research ideas, and, finally, advance the discussion about NLP in higher education. The article points to the potential benefits of using NLP models for personalized learning and on-demand support, such as providing customized learning plans, generating feedback and support, and offering resources to students whenever and wherever they need them. In addition, it highlights and discusses the challenges that NLP models may bring to include the potential loss of human interaction, bias, and ethical implications.

Final thoughts

The guest editors anticipate that this Research Topic, along with the accepted papers in the Research Topic, will not only benefit readers and researchers in AI and Education but also the broader scientific community interested in exploring the "Impact and implications of AI methods and tools for the future of education." This Research Topic serves as a valuable reference for educators, AI professionals, and PhD students, while also offering methodological guidance for educational policymakers and AI developers. The editors would like to thank the contributing authors for their insightful and impactful research. We would also like to thank the Editorial Office, Editor-in-Chief of the Digital Education Section, Editorial Manager and Assistance team, and the Expert Reviewers of the Frontiers in Education, for their immense and professional support toward the successful completion of this Research Topic "Impact and implications of the AI methods and tools for the future of education."

Author contributions

KO: Conceptualization, Project administration, Resources, Supervision, Validation, Writing—original draft. JN: Conceptualization, Project administration, Resources, Supervision, Validation, Writing—original draft. KH: Project administration, Resources, Supervision, Validation, Writing—review & editing. SH: Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing—review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

References

- Arqawi, S. M., Zitawi, E. A., Rabaya, A. H., Abunasser, B. S., and Abu-Naser, S. S. (2022). Predicting university student retention using artificial intelligence. *Int. J. Adv. Comput. Sci. Appl.* 13, 315–324. doi: 10.14569/IJACSA.2022.0130937
- Global Goals (2023). *Goal 4: Quality Education - The Global Goals*. Available online at: <https://www.globalgoals.org/goals/4-quality-education/> (accessed March 17, 2022).
- ICFE (2021). “Reimagining our futures together: a new social contract for education - UNESCO Report by International Commission on the Futures of Education (ICFE),” in *Reimagining our Futures Together: A New Social Contract for Education*. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000379707.locale=en> (accessed June 27, 2022).
- Nganji, J. T. (2018). Towards learner-constructed e-learning environments for effective personal learning experiences. *Behav. Inf. Technol.* 29:470673. doi: 10.1080/0144929X.2018.1470673
- Okoye, K., Daruich, S. D. N., Castaño, R., Enríquez de la, J. F., Escamilla, J., and Hosseini, S. (2024a). Analyzing the impact of digitized-education toward the future of education: a comparative study based on students' evaluation of teaching data. *Stu. Educ. Eval.* 82:101359. doi: 10.1016/j.stueduc.2024.101359
- Okoye, K., Hussein, H., Arrona-Palacios, A., Quintero, N., Luis, -P., Ortega, O. P., et al. (2022). Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks. *Educ. Inf. Technol.* 2022, 1–70. doi: 10.1007/s10639-022-11214-1
- Okoye, K., Nganji, J. T., Escamilla, J., and Hosseini, S. (2024b). Machine learning model (RG-DMML) and ensemble algorithm for prediction of students' retention and graduation in education. *Comput. Educ. Artif. Int.* 12 :100205. doi: 10.1016/j.caeai.2024.100205
- Okoye, K., Rodriguez-Tort, J. A., Escamilla, J., and Hosseini, S. (2021). Technology-mediated teaching and learning process: a conceptual study of educators' response amidst the COVID-19 pandemic. *Educ. Inf. Technol.* 26, 7225–7257. doi: 10.1007/s10639-021-10527-x
- Pedró, F., Subosa, M., Rivas, A., and Valverde, P. (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. Education Sector – UNESCO – ED-2019/WS/8. p. 46. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000366994> (accessed May 26, 2022).
- UIS (2023). *Data for Education - A Guide for Policymakers to Leverage Education Data - UNESCO*. Available online at: <https://ces.uis.unesco.org/wp-content/uploads/sites/23/2024/01/Data-for-Education-final.pdf> (accessed January 23, 2024).
- UN (2015). *United Nations Sustainable Development - 17 Goals to Transform Our World*. Available online at: <https://www.un.org/sustainabledevelopment/> (accessed June 28, 2020).
- UNESCO (2019a). *Beijing Consensus on Artificial Intelligence and Education - UNESCO Digital Library*. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000368303> (accessed March 11, 2022).
- UNESCO (2019b). *How can Artificial Intelligence Enhance Education? | UNESCO*. Available online at: <https://www.unesco.org/en/articles/how-can-artificial-intelligence-enhance-education> (accessed January 24, 2023).
- UNESCO (2021a). *Education and Technological Transformations for Human-Centered Recovery: The Global Education Coalition in Action - ED/GEC/2021/04*. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000379133> (accessed October 28, 2021).
- UNESCO (2021b). *Education Research and Foresight*. Available online at: <https://en.unesco.org/themes/education/research-foresight> (accessed May 3, 2022).
- UNESCO (2023). *Artificial Intelligence and the Futures of Learning | UNESCO*. Available online at: <https://www.unesco.org/en/digital-education/ai-future-learning>
- Walsh, P. (2020). *Innovative Technology is the Future of Education*. Available online at: <https://www.forbes.com/sites/forbestechcouncil/2020/07/23/innovative-technology-is-the-future-of-education/?sh=16c19bfa70e3> (accessed July 7, 2020).
- World Bank (2021). *Digital Technologies in Education*[[*Inline Image*]] | *Education and Technology Overview: Development News, Research, Data*. Available online at: <https://www.worldbank.org/en/topic/edutech#2> (accessed December 3, 2021).

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