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Mapping the Landscape of Artificial Intelligence in Teaching and Learning Across African Higher Education

Olusegun A. Oguntona[1*]
Chijioke E. Emere[2]

AFFILIATIONS

[1&2]Department of Built Environment, Faculty of Engineering, Built Environment and Information Technology, Walter Sisulu University, Butterworth, South Africa.

CORRESPONDENCE

Email: ooguntona@wsu.ac.za*

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Abstract: Artificial Intelligence (AI) is rapidly transforming global teaching and learning (T&L) processes in higher education. As the integration of AI in African higher education continues to accelerate, the body of research examining its implementation remains relatively limited. This study presents a bibliometric analysis of AI applications for T&L within higher education institutions on the African continent, utilising Scopus-indexed publications from 2008 to 2025. The analysis employs VOSviewer software to visualise publication trends, co-occurring keywords, and country-specific contributions. One hundred and five relevant documents were extracted and analysed, encompassing peer-reviewed journal articles, conference papers, book chapters, and books. The results reveal a sharp increase in AI-related publications since 2023, with South Africa, Nigeria, and Morocco emerging as key contributors. The University of South Africa and the University of Johannesburg are identified as the most active institutions in this domain. The co-occurrence analysis identified three main thematic clusters: AI-driven Knowledge Networks, Resilient Learning Technologies, and AI and Education Computing. Emerging keywords include generative AI, personalised learning, contrastive learning, and ChatGPT, while ethical considerations remain notably absent. The study highlights the growing academic interest and substantial research gaps, particularly concerning ethical and policy frameworks for AI integration in African universities. It concludes by recommending a deeper engagement with AI ethics and an expansion of research to underrepresented regions on the continent. The insights provided contribute to global discourse and offer a foundation for evidence-based policy and pedagogical innovation within the African higher education sector.

Keywords: Artificial intelligence, educational technologies, ethics, higher education, pedagogy.

1. Introduction

The global education sector is undergoing a profound transformation driven by the integration of emerging technologies, with artificial intelligence (AI) being the most prominent among them. In the context of higher education, AI technologies have increasingly become instrumental in reshaping pedagogical practices, administrative processes, student engagement, and learning outcomes (Holmes & Tuomi, 2022). As part of the broader Fourth Industrial Revolution (4IR), AI has evolved from a peripheral tool into a central component of digital teaching and learning (T&L) ecosystems (Zhai et al., 2021). This transformation is particularly significant in Africa, where higher education institutions face unique challenges, including limited access to quality educational resources, large student-to-teacher ratios, infrastructural deficits, and pedagogical constraints (Uunona & Goosen, 2023).

Artificial intelligence encompasses a range of technologies, such as machine learning, natural language processing, neural networks, and intelligent tutoring systems, which enable machines to simulate aspects of human cognition, including reasoning, learning, and self-correction (Pannu, 2015; Huynh-The et al., 2023). In higher education, AI applications support various academic activities,

including automated grading, intelligent feedback, adaptive learning, academic advising, plagiarism detection, and the development of personalised learning pathways (Sajja et al., 2024; Ayeni et al., 2024). These technologies also have the potential to impact classroom and campus culture, learner engagement, mentorship, and effective teaching strategies in the higher education sector (Oguntona & Aigbavboa, 2023). Such innovations enhance academic efficiency and enable educators to focus on high-impact activities such as mentoring and research (Embarak & Hawarna, 2024).

Although comparatively slower in adopting digital innovations, the African continent has demonstrated a growing interest in leveraging AI to overcome systemic limitations in higher education. Countries such as South Africa, Morocco, Nigeria, and Ghana are increasingly featured in scholarly discussions regarding AI integration in universities (Koen, 2024). South Africa has made strides in digital education initiatives and policy frameworks that support AI research and its deployment in academia (van den Berg & du Plessis, 2023). Moreover, AI-driven educational tools offer a strategic means to address equity and access in education by facilitating remote learning and supporting students in underserved regions (Lin & Chen, 2024).

Despite these opportunities, the literature indicates a paucity of African-authored research critically examining AI applications in teaching and learning within the continent's higher education institutions (Chagonda, 2024). Several studies from other regions have explored AI's ethical, pedagogical, and socio-technical implications in education (Kasneci et al., 2023; Jobin et al., 2019); however, localised insights remain limited. This lack of data-driven evidence hampers the formulation of context-specific policies and restricts the strategic deployment of AI in African universities. As such, there is a need for comprehensive reviews and mapping studies that capture the breadth, focus, and trajectory of AI-related educational research within the African context.

1.1 Applications of artificial intelligence in higher education

Artificial intelligence (AI) is one of the numerous technologies at the forefront of the fourth industrial revolution. According to Huynh-The et al. (2023), AI has shown significant promise in enabling human-like intelligence in virtual agents and enhancing users' immersive experiences. The application of AI cuts across various disciplines, including electrical and electronic systems, automotive and transportation systems, computer and communication systems, accounting, medicine and health, education, agriculture, entertainment and media, environmental science, security and defence systems, finance, and cybersecurity (Pannu, 2015; Holmes & Tuomi, 2022; Kamran et al., 2022; Iqbal et al., 2023; Javaid et al., 2023; Kuwaiti et al., 2023). However, the education sector is notably undergoing a significant transformation driven by the application of AI and other technologies. The teaching and learning space has seen the proliferation and interoperation of several technologies, resulting in the digital revolution witnessed in education. While there are records of hindrances and shortcomings in the application of AI in this sector, the potential benefits are considerable and provide ample reason to encourage its continued adoption and application. For example, issues related to student financing and the escalating costs associated with higher education globally are among the obstacles to the widespread deployment of AI in the sector (Oguntona, 2024). As indicated by Zhai et al. (2021), there is an urgent need for relevant stakeholders to comprehend and strategise on how best to utilise AI for an effective and efficient teaching and learning experience in education.

There are countless applications of AI in the higher education sector. AI has been employed for predictive analytics of student performance, assessment and grading, teacher and student support, development of curriculum and instructional materials, provision of accurate and timely evaluation and feedback, analysis and interpretation of students' and teachers' data, and automation of educational administrative tasks (Igbokwe, 2023). AI-driven platforms are revolutionising personalised education by adapting content to the individual teaching and learning styles and the needs of educators and learners, respectively. For example, intelligent tutoring systems and AI-

enabled assistants utilise natural language processing to provide tailored support and offer personalised teaching and learning pathways. These tools enhance student engagement and satisfaction by reducing cognitive load and facilitating self-paced learning (Sajja et al., 2024). Additionally, AI can analyse vast educational data, allowing for the customisation of learning materials and ensuring that students receive content aligned with their progress and areas requiring improvement (Ayeni et al., 2024).

AI applications also offer tools that stimulate innovative thinking. Interactive AI elements, such as gamified learning environments, can enhance student engagement and support emotional well-being (Lin & Chen, 2024). The analytical capabilities of AI enable institutions to monitor student performance in real time, identifying at-risk individuals and facilitating timely interventions (Embarak & Hawarna, 2024). Machine learning algorithms can predict academic outcomes, allowing educators to adjust teaching strategies proactively. This predictive modelling can assist in supporting student retention and success rates by addressing potential challenges before they escalate. Similarly, AI-driven analytics can aid in curriculum development by highlighting which teaching methods are most effective, thereby informing evidence-based pedagogical decisions (George, 2023). There are also numerous instances of AI-powered chatbots that handle routine inquiries and self-services (Wang, 2025), enhancing communication efficiency between students and the administrative staff of higher education institutions. Additionally, the application of AI assists in resource allocation by analysing usage patterns, ensuring optimal distribution of institutional resources and improving operational efficiency (Abulibdeh et al., 2025). Hence, this study aims to assess the use of AI for teaching and learning in the African higher education sector from a bibliometric viewpoint.

2. Research Methodology

This study aimed to identify the key subjects of interest in publications regarding AI for teaching and learning in the African higher education sector. A bibliometric analysis was employed to map knowledge areas and pinpoint research trends. Bibliometrics, as a research method, was proposed in 1969 by Alan Pritchard and has since emerged as an independent discipline in scientific quantification research. Bibliometric analysis involves the use of quantitative methods and statistical evaluation of specific indicators (such as annual publication volume, prominent research topics, leading institutions, top journals, prolific authors, citation counts, and keywords) to assess the scientific output of publications within a particular field or journal (Pritchard, 1969; Öztürk et al., 2024). The unique role of bibliometrics as a research method is to evaluate bibliometric indicators from specific research fields (Wang et al., 2024).

The Scopus search engine was used to find publications pertinent to the investigation, which constituted the bibliographic data. Scopus was chosen because it covers most papers in other databases, such as Web of Science, ScienceDirect, and Google Scholar (Aliu et al., 2024; Emere et al., 2025). Additionally, Scopus is regarded as the largest citation and abstract database of peer-reviewed scholarly research outputs (Oguntona et al., 2022). Furthermore, several colleges and institutions have Scopus subscriptions, and as one of the rapidly growing databases, its access and popularity are quite high in Africa (Aghimien et al., 2020).

The employed search keywords were "Artificial Intelligence" AND "Teaching and Learning." The data search and extraction exercise was conducted on April 29, 2025. The initial search, without any restrictions, yielded 2,051 documents. All publications were from 2008 to 2025. However, after filtering and refinement exercises, 105 documents were extracted and used for the dataset of the study. The restriction parameters included consideration of only "journals," "conference papers," "books," and "book chapters," emphasising the most important sources of knowledge. Similarly, only publications from African nations were incorporated into the research. Moreover, the search was limited to the English language, considering the medium of dissemination of the journal, the language proficiency of the researcher, and the predominant language medium on the African

continent. The VOSviewer application was utilised to conduct and provide a bibliometric and graphical dataset analysis. VOSviewer is a programme and application suitable for bibliometric literature evaluations and is used to analyse bibliometric data graphically (Aghimien et al., 2020). Figure 1 illustrates the research methodological process. The outputs and graphics included "number of yearly publications," "publications per country," "publications by document source," "most cited papers," and "co-occurring analysis."

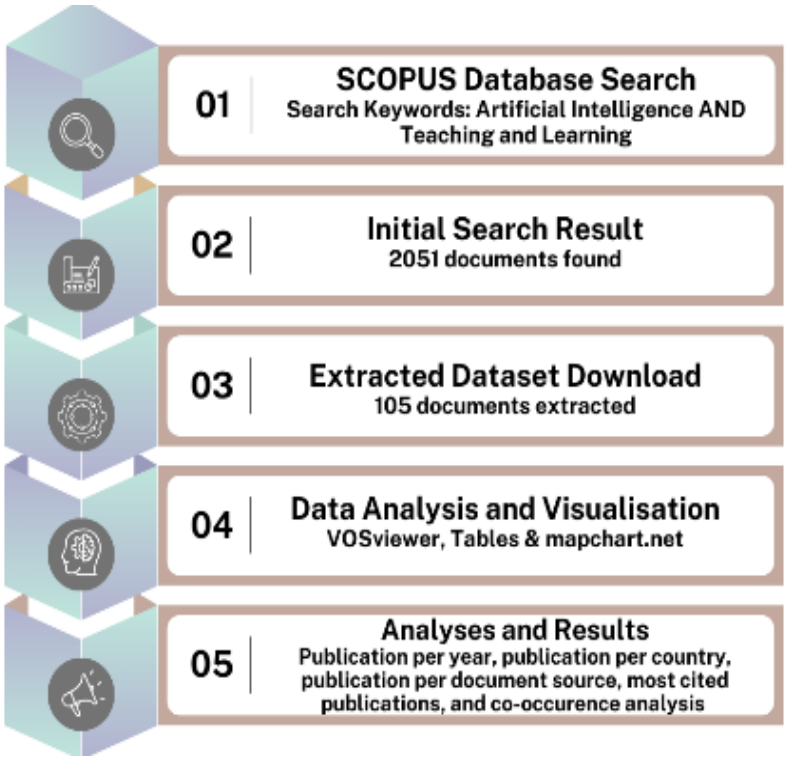

Figure 1: *Research methodological process of the study*

3. Results and Discussion

A total of 105 documents were extracted, forming the datasets for this study. The documents include journal articles, books, book chapters, and conference proceedings. Utilising the VOSviewer application, the analysis presents publication data per year, per country, per document source, as well as the most cited publications and co-occurrence analysis, using tables, figures, and maps.

3.1 Publication per year

The 105 publications related to AI for teaching and learning included 39 journal articles, 42 conference papers, 23 book chapters, and one book. Figure 2 illustrates the yearly publications. According to this figure, one publication was recorded in 2008, 2012, 2016, and 2018. However, none were recorded from 2009 to 2011 and from 2013 to 2015. Two publications were recorded in both 2017 and 2022, while three were recorded in 2019. Additionally, six publications were recorded in 2020, and 2023 saw 19 publications. Furthermore, 51 publications were recorded in 2024, and 18 were recorded in 2025. Thus, the highest number of publications was noted in 2024. The results indicate that AI has gained increasing attention over the past three years.

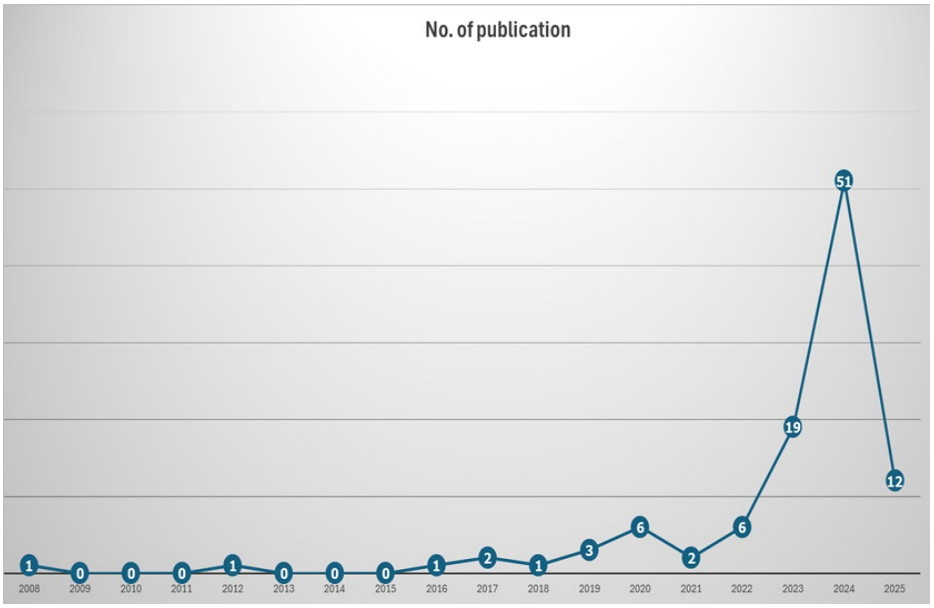

Figure 2: *Number of publications per year on AI-related T&L research in African HEI*

3.2 Publication per document source

The 105 downloaded documents came from 82 sources. Using a default threshold of 3 papers, 4 sources were identified. To improve the data, a second threshold of 2 papers with at least one citation was applied, resulting in 13 sources, as shown in Table 1. The top-ranked source based on the number of scholarly articles published included "Lecture Notes in Networks and Systems" (7 docs; 7 cites) and "2020 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems, ICABCD 2020 – Proceedings" (3 docs; 12 cites). This was followed by "International Journal of Learning, Teaching and Educational Research" (3 docs; 0 cites) and "Proceedings of the International Conference on Education Research, ICER 2024" (3 docs; 0 cites). Similarly, the top three sources in terms of citations included "Education Sciences" (2 docs; 124 cites), "International Journal of Advanced Computer Science and Applications" (2 docs; 35 cites), and "International Symposium on Project Approaches in Engineering Education" (2 docs; 11 cites). The results indicate that more publications are required in several sources, especially those not listed in Table 1, to enhance the conversation on the topic.

Table 1: *Number of publications per document source*

Sources	Documents	Citations
Lecture Notes in Networks and Systems	7	7
2020 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems, ICABCD 2020 – Proceedings	3	12
International Journal of Learning, Teaching and Educational Research	3	0
Proceedings of the International Conference on Education Research, ICER 2024	3	0
Education Sciences	2	124
International Journal of Advanced Computer Science and Applications	2	35
International Symposium on Project Approaches in Engineering Education	2	11

International Journal of Information and Education Technology	2	7
Discover Education	2	4
Artificial Intelligence, Digital Learning, And Leadership: Redefining Higher Education	2	3
Communications In Computer and Information Science	2	3
2023 IEEE IFEES World Engineering Education Forum and Global Engineering Deans Council: Convergence for A Better World: A Call to Action, WEEF-GEDC 2023 – Proceedings	2	2
E-Learning and Digital Media	2	1

3.3 Publication per higher education institution

The 105 extracted sources came from 180 organisations. At a threshold of two (2) documents, seven (7) organisations (higher education institutions) were identified. The top three contributing organisations included the "University of South Africa, South Africa" (5 docs; 90 cites), the "University of Johannesburg, South Africa" (4 docs; 3 cites), and "Lead City University, Nigeria" (2 docs; 12 cites). Overall, the results, as shown in Table 2, confirm that higher education institutions in South Africa have significantly contributed to the subject compared to others on the African continent (Uunona & Goosen, 2023).

Table 2: *Number of higher education institutions*

Higher Education Institutions	Documents	Citations
University of South Africa, South Africa	5	90
University of Johannesburg, South Africa	4	3
Lead City University, Nigeria	2	12
Kisii University, Kenya	2	3
Cape Peninsula University of Technology, Cape Town, South Africa	2	0
North-West University, South Africa	2	0

3.4 Publication per country

Fifteen countries on the African continent contributed to the conversation on AI for teaching and learning in the published papers in the Scopus database. Nevertheless, at a 3-document threshold, eight (8) countries were identified as the most significant contributors, as shown in Figure 3. Among these eight (8) countries, five were particularly notable. These five (5) countries included South Africa (49 docs; 342 cites), Morocco (20 docs; 81 cites), Nigeria (12 docs; 57 cites), Ghana (7 docs; 38 cites), and Egypt (6 docs; 27 cites). The results in Figure 3 align with Uunona and Goosen (2023) and Koen (2024), who identified some of these countries as leading in the integration of AI in their higher education.

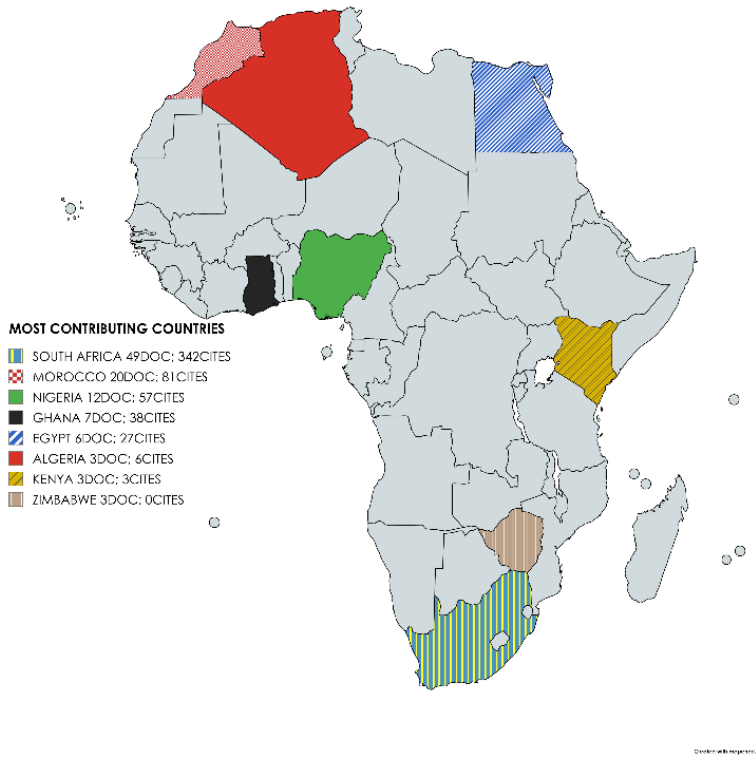

Figure 3: *Publication per country on AI-related T&L research in African HEI*

3.5 Most cited publications

Table 3 presents the most cited scholarly publications on AI for teaching and learning in the African higher education sector. The most pertinent works were identified using a criterion of ten citations, resulting in 13 publications. Many of these publications are derived from reviews, surveys, and interviews. There is a pressing need for experiments and case studies on this topic.

Table 3: *Most cited publications*

Sources	Title	Citations	Method
van den Berg & du Plessis (2023)	ChatGPT and generative AI: Possibilities for its contribution to lesson planning, critical thinking and openness in teacher education	116	Document analysis
Boubker (2024)	From chatting to self-educating: Can AI tools boost student learning outcomes?	58	Questionnaire
Uunona & Goosen (2023)	Leveraging ethical standards in artificial intelligence technologies: A guideline for responsible teaching and learning applications	49	Empirical
Dake & Ofosu (2019)	5 G-enabled technologies for smart education	24	Systematic Review
Bubou et al. (2017)	Why research-informed teaching in engineering education?	24	Review
Dube & Jacobs (2023)	Academic library services extension during the COVID-19 pandemic: Considerations in higher education institutions in the Gauteng Province, South Africa	23	Questionnaire & Interviews

Van Wyk et al. (2023)	Why all the hype about ChatGPT?	22	Interviews
Pillay et al. (2018)	AI in engineering and computer science education in preparation for the 4th industrial revolution: A South African perspective	19	Case Study
Maphoto et al. (2024)	Advancing students' academic excellence in distance education: Exploring the potential of generative AI integration to improve academic writing skills	12	Interviews
Enakrire et al. (2024)	Skills Required of Academics to Use Digital Technologies in Open Distance Learning Institutions	12	Questionnaire & Interview
Havenga & Swart (2022)	Preparing first-year engineering students for cooperation in real-world projects	11	Questionnaire
Sam et al. (2020)	Meta-analysis of artificial intelligence works in ubiquitous learning environments and technologies	11	Meta-analysis
Megahed et al. (2022)	Post-pandemic education strategy: framework for artificial intelligence-empowered education in engineering (AIEd-Eng) for lifelong learning	10	Systematic Review

3.6 Research focus based on co-occurring keywords

Figure 4 presents the network visualisation map for the keywords. The co-occurrence of the keywords "author" and "indexed" was investigated to ascertain the areas of concentration in previous studies. A total of 725 keywords were identified. However, at the threshold of five (5) occurrences, 26 keywords met the criteria, which were then grouped into three clusters. These clusters are as follows:

- ***Cluster 1-AI-Driven Knowledge Network***: Mapped in red, this cluster includes ten keywords, totalling 85 occurrences and 433 total link strength. The keywords are: teaching and learning (32 occurrences), higher education (8 occurrences), adversarial machine learning (6), contrastive learning (6), generative artificial intelligence (6), higher education institutions (6), personalised learning (6), blended learning (5), federated learning (5), and South Africa (5). This grouping can be interpreted as keywords associated with a knowledge network powered by AI. For instance, adversarial machine learning (AML) can optimise security, personalise learning, and refine assessment processes and methods in higher education institutions (Alsmadi et al., 2022; Crompton & Burke, 2023). AML can assist institutions in protecting sensitive student data by detecting and mitigating adversarial attacks on AI-driven educational platforms (Crompton & Burke, 2023). For personalised learning, AML-trained AI models can better adjust to each learner's individual needs, guaranteeing sound and equitable learning path suggestions (Crompton & Burke, 2023). Similarly, contrastive learning in AI helps models differentiate between similar and dissimilar data sets (Zhou et al., 2024). AI-powered contrastive learning can improve grading schemes by ensuring impartial and equitable assessments, and grading can be automated (Sokač et al., 2025). Likewise, federated learning can assist in privacy-preserving education, enhance personalised learning, and improve collaboration in higher education institutions without exposing sensitive data, fostering research and innovation (Hridi et al., 2024). Furthermore, the mention of South Africa among the keywords suggests that these AI-driven

knowledge networks have received increased attention in the country's higher education institutions (Uunona & Goosen, 2023).

- ***Cluster 2-AI Resilient Learning Technologies***: Mapped in red, this cluster includes ten keywords, totalling 85 occurrences and 433 total link strength. The keywords are: teaching and learning (32 occurrences), higher education (8 occurrences), adversarial machine learning (6), contrastive learning (6), generative artificial intelligence (6), higher education institutions (6), personalised learning (6), blended learning (5), federated learning (5), and South Africa (5). This grouping can be interpreted as keywords associated with a knowledge network powered by AI. For instance, adversarial machine learning (AML) can optimise security, personalise learning, and refine assessment processes and methods in higher education institutions (Alsmadi et al., 2022; Crompton & Burke, 2023). AML can assist institutions in protecting sensitive student data by detecting and mitigating adversarial attacks on AI-driven educational platforms (Crompton & Burke, 2023). For personalised learning, AML-trained AI models can better adjust to each learner's individual needs, guaranteeing sound and equitable learning path suggestions (Crompton & Burke, 2023). Similarly, contrastive learning in AI helps models differentiate between similar and dissimilar data sets (Zhou et al., 2024). AI-powered contrastive learning can improve grading schemes by ensuring impartial and equitable assessments, and grading can be automated (Sokač et al., 2025). Likewise, federated learning can assist in privacy-preserving education, enhance personalised learning, and improve collaboration in higher education institutions without exposing sensitive data, fostering research and innovation (Hridi et al., 2024). Furthermore, the mention of South Africa among the keywords suggests that these AI-driven knowledge networks have received increased attention in the country's higher education institutions (Uunona & Goosen, 2023).
- ***Cluster 3: AI and Education Computing***: This cluster, represented in blue, comprises nine keywords with a total of 96 occurrences and a total link strength of 391. The keywords, with their occurrences in brackets, are teaching (30), students (21), education (12), ChatGPT (11), learning (11), education computing (6), and AI (5). These keywords are thus related to AI and education computing. ChatGPT is a "cutting-edge language model developed by OpenAI that uses artificial intelligence to generate human-like text. It is designed to communicate with users effectively" (van den Berg & du Plessis, 2023). AI can support instructors with lesson planning by providing materials, ideas, and structure (Opara et al., 2023). For instance, teachers can engage in dialogue with ChatGPT and other AI technologies to generate ideas for objectives and strategies and to gather relevant educational resources (van den Berg & du Plessis, 2023). Although it can enhance critical thinking, overreliance on AI tools like ChatGPT can negatively impact problem-solving abilities (Kasneci et al., 2023). Furthermore, ChatGPT is only as effective as the data on which it was trained, potentially leading to bias, and it does not capture emotions (van den Berg & du Plessis, 2023). Thus, human oversight is necessary for ongoing supervision, quality control, and verification (Kasneci et al., 202).

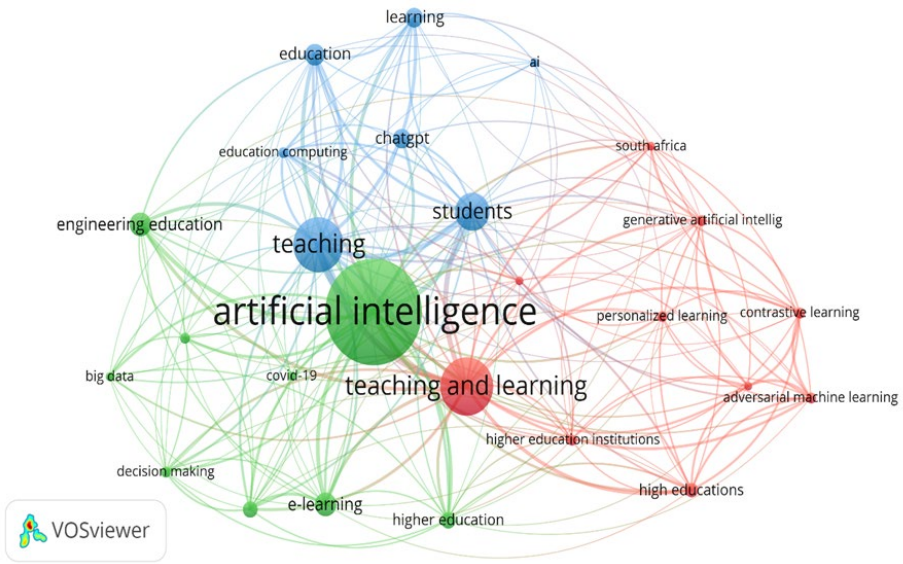

Figure 4: *Network visualisation map on AI-related T&L research in African HEI*

3.7 Research focus by year of publication

Figure 5 shows the "overlay visualisation map" for the keywords. It was observed that, in at least five keyword occurrences, studies relating to AI-driven Resilient Learning Technologies and AI and education computing became more evident from 2020 to 2023. Applicable keywords were represented in blue and green. From late 2024 to the present, studies have focused on various AI-driven Knowledge Networks, which included keywords such as adversarial machine learning, contrastive learning, generative artificial intelligence, personalised learning, blended learning, and federated learning, mainly represented in yellow. Conversely, ethics was absent from the keyword analysis, suggesting that this area has not been thoroughly researched in Africa. Therefore, there is a need for a comprehensive study on ethical considerations in using AI systems to develop effective ethical guidelines. This proposition aligns with Chagonda (2024), who stated that, given the notable advancements in generative AI-powered technologies, the African continent must act quickly to ensure that any potential risks from this cutting-edge technology are minimised. For example, the absence of ethical standards and laws governing the creation and application of AI systems may cause public suspicion and doubt about their advantages (Jobin et al., 2019).

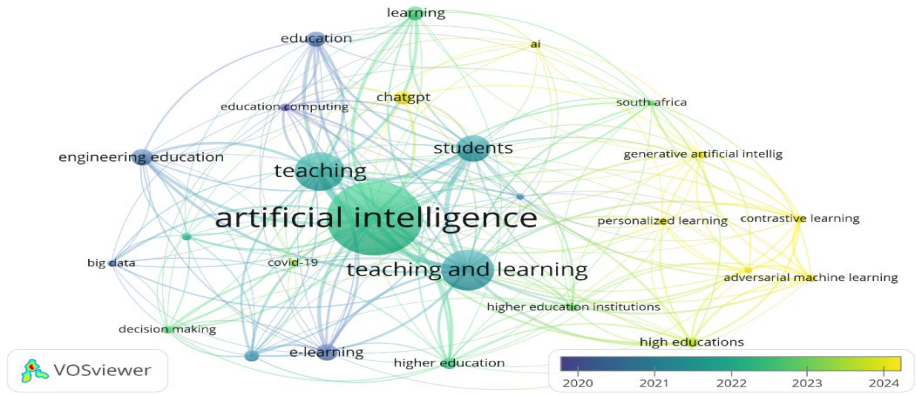

Figure 5: *Overlay visualisation map on AI-related T&L research in African HEI*

4. Conclusions and Recommendations

This study employed a bibliometric review to ascertain the concentration of research on AI for teaching and learning in the African continent. The extracted publications were included in the Scopus database and were published from 2008 to 2025. The findings revealed a paucity of research articles on the topic in Africa, indicating that AI adoption is still at an infant stage in most African nations. The highest number of Scopus-indexed published papers on the subject was recorded in 2024. The benefits of AI in teaching and learning call for a full embrace of the concept across all institutional levels, especially in higher education. South Africa was the leading contributor among African countries to the discourse on AI for teaching and learning. This suggests that more studies are required to bridge the knowledge gap and improve AI adoption across Africa.

Considering the clusters revealed, studies have focused on AI-driven Knowledge Networks, Resilient Learning Technologies, and AI and Education Computing. Current research in this area points towards adversarial machine learning, federated learning, personalised learning, contrastive learning, ChatGPT, and more. Likewise, the study encourages a focus on ethical considerations regarding AI adoption and other important keywords not highlighted in the visualisation map. Therefore, this study contributes to global literature by stressing areas where AI has been prioritised for teaching and learning-related studies in Africa. Its conclusions have also outlined possible directions for future research.

Nonetheless, there is a limitation to the study conducted. The findings only considered scholarly articles extracted from the Scopus database. While there are other databases, such as Web of Science, that can also be utilised, the choice of Scopus is based on its accessibility, popularity, and acceptance across African higher education institutions. Similarly, further studies utilising systematic reviews and meta-analyses are recommended to comprehensively examine the impediments to and methods for promoting AI's effective adoption and implementation within the African higher education sphere. This study also suggests that African higher education institutions should intensify efforts to integrate AI technologies into their pedagogical frameworks, focusing on ethical implementation and contextual relevance. Policymakers and academic leaders should prioritise capacity building and infrastructure development and formulate clear ethical guidelines to govern AI usage in higher education. Furthermore, collaborative research across institutions and regions is essential to bridge knowledge gaps and foster inclusive innovation. It is also recommended that studies exploring underrepresented countries should be conducted for empirical investigations into AI's pedagogical impact, ensuring that AI adoption supports equitable, effective, and sustainable educational transformation across the continent.

5. Future Research Direction

The findings were based on scholarly articles extracted from the Scopus database. Future studies may incorporate and integrate additional databases for further analysis and conclusions. Future artificial intelligence (AI) research in African higher education should advance beyond continental overviews to encompass more nuanced, context-specific analyses. Comparative studies across diverse settings, such as South Africa, Kenya, and Egypt (where AI adoption is relatively advanced), Ghana, Nigeria, and Rwanda (where integration is emerging), and under-researched Francophone contexts like Senegal, Côte d'Ivoire, and Cameroon, could elucidate distinct infrastructural, policy, and pedagogical drivers or barriers. Combining large-scale surveys with in-depth classroom ethnographies, mixed-methods investigations are needed to assess the perceptions of educators and students, pedagogical shifts, and measurable learning outcomes. Longitudinal studies on policy–practice alignment, tracking the translation of national AI and digital education strategies, such as Rwanda's Vision 2050, Nigeria's National AI Strategy, and South Africa's AI Institute initiatives, into sustained institutional adoption, would provide valuable insights into implementation dynamics. This is also crucial for conceptualising a continental AI strategy by the African Union and other

agencies tasked with such responsibility. In parallel, geographic information system (GIS)-based mapping of campus connectivity, AI-capable hardware availability, and digital literacy initiatives for educators could reveal regional disparities and guide infrastructure investment. Similarly, cross-continental benchmarking with regions such as Southeast Asia or Latin America could identify transferable strategies for integrating AI in resource-constrained environments. Furthermore, future research should address the ethical, cultural, and linguistic dimensions of AI use, including the capacity of AI tools to support multilingual learning in African languages and the mitigation of cultural biases in imported technologies, employing approaches such as qualitative discourse analysis and participatory design.

6. Declarations

Author Contributions: Conceptualisation (O.A.O. & C.E.E.); Literature review (O.A.O. & C.E.E.); methodology (O.A.O. & C.E.E.); software (O.A.O. & C.E.E.); validation (O.A.O. & C.E.E.); formal analysis (O.A.O. & C.E.E.); investigation (O.A.O. & C.E.E.); data curation (O.A.O. & C.E.E.) drafting and preparation (O.A.O. & C.E.E.); review and editing (O.A.O. & C.E.E.); supervision (N/A); project administration (N/A); funding acquisition (N/A). All authors have read and approved the published version of the article.

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Conflicts of Interest: The authors declare no conflict of interest.

Data Availability Statement: This review is based entirely on publicly available data and information sourced from peer-reviewed articles, reports, and other academic publications cited in the manuscript. No new primary data were generated or analysed during this study. Readers may refer to the cited sources for detailed information.

References

Abulibdeh, A., Baya Chatti, C., Alkhereibi, A., & El Menshawy, S. (2025). A scoping review of the strategic integration of artificial intelligence in higher education: Transforming university excellence themes and strategic planning in the digital era. *European Journal of Education*, *60*(1), e12908. https://doi.org/10.1111/ejed.12908

Aghimien, D. O., Aigbavboa, C. O., Oke, A. E., & Thwala, W. D. (2020). Mapping out research focus for robotics and automation research in construction-related studies: A bibliometric approach. *Journal of Engineering, Design and Technology*, *18*(5), 1063–1079. https://doi.org/10.1108/JEDT-09-2019-0237

Al Kuwaiti, A., Nazer, K., Al-Reedy, A., Al-Shehri, S., Al-Muhanna, A., Subbarayalu, A. V., ... & Al-Muhanna, F. A. (2023). A review of the role of artificial intelligence in healthcare. *Journal of Personalized Medicine*, *13*(6), 951. https://doi.org/10.3390/jpm13060951

Aldulaimi, S. H., Abdeldayem, M. M., Keir, M. A., & Al-Sanjary, O. (2021). E-learning in higher education and COVID-19 outbreak: Challenges and opportunities. *Psychology and Education Journal*, *58*(2), 38–43. https://doi.org/10.17762/pae.v58i2.1054

Aliu, J., Emere, C., & Oguntona, O. (2024). Mapping smart city and industry 4.0 research in construction-related studies. *Baltic Journal of Real Estate Economics and Construction Management*, *12*(1), 258–275. https://doi.org/10.2478/bjreecm-2024-0017

Alsmadi, I., Aljaafari, N., Nazzal, M., Alhamed, S., Sawalmeh, A. H., Vizcarra, C. P., Khreishah, A., Anan, M., Algosaibi, A., Al-Naeem, M. A., & Aldalbahi, A. (2022). Adversarial machine learning in text processing: A literature survey. *IEEE Access*, *10*, 17043–17077. https://doi.org/10.1109/access.2022.3146405

Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalised learning and educational technology. *GSC Advanced Research and Reviews*, *18*(2), 261–271. https://doi.org/10.30574/gscarr.2024.18.2.0062

Borges, A. F., Laurindo, F. J., Spínola, M. M., Gonçalves, R. F., & Mattos, C. A. (2021). The strategic use of artificial intelligence in the digital era: Systematic literature review and future research directions. *International Journal of Information Management*, *57*, 102225. https://doi.org/10.1016/j.ijinfomgt.2020.102225

Boubker, O. (2024). From chatting to self-educating: Can AI tools boost student learning outcomes? *Expert Systems with Applications*, *238*, 121820. https://doi.org/10.1016/j.eswa.2023.121820

Bubou, G. M., Offor, I. T., & Bappa, A. S. (2017). Why research-informed teaching in engineering education? A review of the evidence. *European Journal of Engineering Education*, 42(3), 323–335. https://doi.org/10.1080/03043797.2016.1158793

Chagonda, T. (2024). Chatbot programmes race: Africa & artificial intelligence (AI) ethics. *The Thinker*, 101(4), 11–19. https://doi.org/10.36615/qmfegd44

Chikileva, L. S., Chistyakov, A. A., Busygina, M. V., Prokopyev, A. I., Grib, E. V., & Tsvetkov, D. N. (2023). A review of empirical studies examining the effects of e-learning on university students' academic achievement. *Contemporary Educational Technology*, 15(4). https://doi.org/10.30935/cedtech/13418

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education*, 20(1), 22. https://doi.org/10.1186/s41239-023-00392-8

Dake, D. K., & Ofosu, B. A. (2019). 5G enabled technologies for smart education. *International Journal of Advanced Computer Science & Applications*, 10(12). https://doi.org/10.14569/ijacsa.2019.0101228

Dube, T. V., & Jacobs, L. (2023). Academic library services extension during the COVID-19 pandemic: Considerations in higher education institutions in the Gauteng Province, South Africa. *Library Management*, 44(1/2), 17-39. https://doi.org/10.1108/lm-04-2022-0039

Embarak, O. H., & Hawarna, S. (2024). Automated AI-driven system for early detection of at-risk students. *Procedia Computer Science*, 231, 151-160. https://doi.org/10.1016/j.procs.2023.12.187

Emere, C., Oguntona, O., Ohiomah, I., & Ayorinde, E. (2025). Harnessing emerging technologies in the global mining sector from a bibliometric standpoint. *Mining*, 5(1), 13. https://doi.org/10.3390/mining5010013

Enakrire, R. T., Fombad, M. C., & Morodi, L. (2024). Skills required of academics to use digital technologies in open distance learning institutions. *Innovative Higher Education*, 1-24. https://doi.org/10.1007/s10755-024-09758-w

George, A. S. (2023). Preparing students for an AI-driven world: Rethinking curriculum & pedagogy in the age of artificial intelligence. *Partners Universal Innovative Research Publication*, 1(2), 112-136. https://doi.org/10.5281/zenodo.10245675

Havenga, M., & Swart, A. J. (2022). Preparing first-year engineering students for cooperation in real-world projects. *European Journal of Engineering Education*, 47(4), 558-576. https://doi.org/10.1080/03043797.2022.2037521

Holmes, W., & Tuomi, I. (2022). State of the art & practice in AI in education. *European Journal of Education*, 57(4), 542-570. https://doi.org/10.1111/ejed.12533

Hridi, A. P., Sahay, R., Hosseinalipour, S., & Akram, B. (2024). Revolutionising AI-assisted education with federated learning: A pathway to distributed, privacy-preserving, & debiased learning

ecosystems. In *Proceedings of the AAAI Symposium Series* (Vol. 3, No. 1, 297-303). https://doi.org/10.1609/aaaiss.v3i1.31217

Huynh-The, T., Pham, Q. V., Pham, X. Q., Nguyen, T. T., Han, Z., & Kim, D. S. (2023). Artificial intelligence for the metaverse: A survey. *Engineering Applications of Artificial Intelligence*, 117, 105581. https://doi.org/10.1016/j.engappai.2022.105581

Igbokwe, I. C. (2023). Application of artificial intelligence (AI) in educational management. *International Journal of Scientific and Research Publications, 13*(3), 300–307. https://doi.org/10.29322/IJSRP.13.03.2023.p13536

Iqbal, S., Rizvi, S. W. A., Haider, M. H., & Raza, S. (2023). Artificial intelligence in security and defense: Explore the integration of AI in military strategies, security policies, and its implications for global power dynamics. *International Journal of Human and Society, 3*(4), 341–353.

Javaid, M., Haleem, A., Khan, I. H., & Suman, R. (2023). Understanding the potential applications of artificial intelligence in the agriculture sector. *Advanced Agrochem, 2*(1), 15–30. https://doi.org/10.1016/j.aac.2022.10.001

Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence, 1*(9), 389–399. https://doi.org/10.1038/s42256-019-0088-2

Kamran, S. S., Haleem, A., Bahl, S., Javaid, M., Prakash, C., & Budhhi, D. (2022). Artificial intelligence and advanced materials in the automotive industry: Potential applications and perspectives. *Materials Today:* Proceedings, 62, 4207–4214. https://doi.org/10.1016/j.matpr.2022.04.727

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., & Krusche, S. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual* Differences, 103, 102274. https://doi.org/10.1016/j.lindif.2023.102274

Koen, J. (2024). Publicly available AI access and integration in African higher education: Usage, impact, and barriers in the continent's largest regional economies. https://tinyurl.com/44jtu4we

Lin, H., & Chen, Q. (2024). Artificial intelligence (AI)-integrated educational applications and college students' creativity and academic emotions: Students and teachers' perceptions and attitudes. *BMC Psychology, 12*, 487. https://doi.org/10.1186/s40359-024-01979-0

Lopez, S. (2023). Optimising marketing ROI with predictive analytics: Harnessing big data and AI for data-driven decision making. *Journal of Artificial Intelligence Research, 3*(2), 9-36.

Maphoto, K. B., Sevnarayan, K., Mohale, N. E., Suliman, Z., Ntsopi, T. J., & Mokoena, D. (2024). Advancing students' academic excellence in distance education: Exploring the potential of generative AI integration to improve academic writing skills. *Open Praxis, 16*(2), 142-159. https://doi.org/10.55982/openpraxis.16.2.649

Megahed, N. A., Abdel-Kader, R. F., & Soliman, H. Y. (2022). Post-pandemic education strategy: Framework for artificial intelligence-empowered education in engineering (AIEd-Eng) for lifelong learning. In *International Conference on Advanced Machine Learning Technologies and Applications* (pp. 544-556). Springer International Publishing. https://doi.org/10.1007/978-3-031-03918-8_45

Oguntona, O. A. (2024). Biomimicry potentials for sustainable student financing in higher education. In *The Focus Conference (TFC 2024) (pp. 119-128). Atlantis Highlights in Social Sciences, Education and* Humanities. Atlantis Press. https://doi.org/10.2991/978-94-6463-630-7_7

Oguntona, O., & Aigbavboa, C. (2023). Biomimicry lessons for teaching and learning in higher education. In *The 10th Focus Conference (TFC 2023) (pp. 172-183). Atlantis Highlights in Social Sciences, Education and* Humanities. Atlantis Press. https://doi.org/10.2991/978-2-38476-134-0_12

Oguntona, O., Aigbavboa, C., & Dywili, S. (2022). Scientometric analysis of engineering and built environment publications output of public universities. *Proceedings of International Structural Engineering and Construction, 9*(1), EPE-04. http://www.doi.org/10.14455/ISEC.2022.9(1).EPE-04

Opara, E., Mfon-Ette Theresa, A., & Aduke, T. C. (2023). ChatGPT for teaching, learning and research: Prospects and challenges. *Global Academic Journal of Humanities and Social Sciences, 5*(2), 33-40. https://doi.org/10.36348/gajhss.2023.v05i02.001

Pannu, A. (2015). Artificial intelligence and its application in different areas. *Artificial Intelligence, 4*(10), 79-84.

Here is the text revised for APA 7th edition style:

Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: An overview and a framework proposal. *Review of Managerial Science*, 18(11), 3333–3361. https://doi.org/10.1007/s11846-024-00738-0

Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, 25, 348.

Pillay, N., Maharaj, B. T., & van Eeden, G. (2018). AI in engineering and computer science education in preparation for the 4th industrial revolution: A South African perspective. In *2018 World Engineering Education Forum–Global Engineering Deans Council (WEEF-GEDC)* (pp. 1-5). IEEE. https://doi.org/10.1109/WEEF-GEDC.2018.8629703

Sajja, R., Sermet, Y., Cikmaz, M., Cwiertny, D., & Demir, I. (2024). Artificial intelligence-enabled intelligent assistant for personalised and adaptive learning in higher education. *Information*, 15(10), 596. https://doi.org/10.3390/info15100596

Sam, C., Naicker, N., & Rajkoomar, M. (2020). Meta-analysis of artificial intelligence works in ubiquitous learning environments and technologies. *International Journal of Advanced Computer Science and Applications*, 11(9), 1-14. https://doi.org/10.14569/ijacsa.2020.0110971

Singh, R., Singh, S. K., & Mishra, N. (2024). Influence of e-learning on the students of higher education in the digital era: A systematic literature review. *Education and Information Technologies*, 29(15), 20201–20221. https://doi.org/10.1007/s10639-024-12604-3

Sokač, M., Fabijanić, M., Mekterović, I., & Mršić, L. (2025). Automated grading through contrastive learning: A gradient analysis and feature ablation approach. *Machine Learning and Knowledge Extraction*, 7(2), 41. https://doi.org/10.3390/make7020041

Stojanov, A., & Daniel, B. K. (2024). A decade of research into the application of big data and analytics in higher education: A systematic review of the literature. *Education and Information Technologies*, 29(5), 5807–5831. https://doi.org/10.1007/s10639-023-12033-8

Uunona, G. N., & Goosen, L. (2023). Leveraging ethical standards in artificial intelligence technologies: A guideline for responsible teaching and learning applications. In *Handbook of Research on Instructional Technologies in Health Education and Allied Disciplines (pp. 310–330). I*GI Global. https://doi.org/10.4018/978-1-6684-7164-7.ch014

van den Berg, G., & du Plessis, E. (2023). ChatGPT and generative AI: Possibilities for its contribution to lesson planning, critical thinking, and openness in teacher education. *Education Sciences, 13*(10), 998. https://doi.org/10.3390/educsci13100998

Van Wyk, M. M., Adarkwah, M. A., & Amponsah, S. (2023). Why all the hype about ChatGPT? Academics' views of a chat-based conversational learning strategy at an open distance e-learning institution. *Open Praxis, 15*(3), 214–225. https://doi.org/10.55982/openpraxis.15.3.563

Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education reform and change driven by digital technology: A bibliometric study from a global perspective. *Humanities and Social Sciences Communications, 11*(1), 1–17. https://doi.org/10.1057/s41599-024-02717-y

Wang, P. Q. (2025). Personalising guest experience with generative AI in the hotel industry: There's more to it than meets a Kiwi's eye. *Current Issues in Tourism, 28*(4), 527–544. https://doi.org/10.1080/13683500.2023.2300030

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y. (2021). A review of artificial intelligence (AI) in education from 2010 to 2020. *Complexity, 2021*, 8812542. https://doi.org/10.1155/2021/8812542

Zhou, P., Huang, Y. L., Xie, Y., Gao, J., Wang, S., Kim, J. B., & Kim, S. (2024). Is contrastive learning necessary? A study of data augmentation vs. contrastive learning in sequential recommendation. In *Proceedings of the ACM Web Conference 2024* (pp. 3854–3863). https://doi.org/10.1145/3589334.3645661